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Aquaculture

Fish biodiversity

Open water fisheries

Product development

Marine fisheries

BFRF Bangladesh Fisheries Research Forum

8th BFRF Biennial Conference 2018

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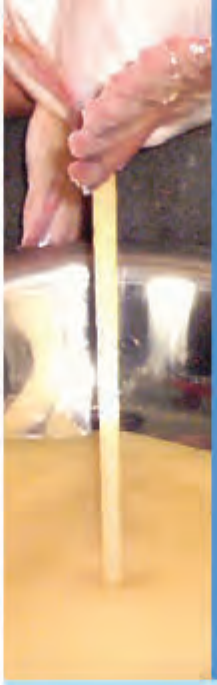

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The membership is open to all students, teachers, researchers, farmers, hatchery owners, traders, fish & feed processors, GO & NGO officials, donors, policy makers, private entrepreneurs and anybody who are involved with fisheries and aquaculture of Bangladesh.

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editor's column

Editor's Column

After being self-sufficient in fish production for the first time in the year 2017-18, Bangladesh has started to get global recognition as one of the biggest fish producers. The country was ranked third in producing fish from inland water-bodies, behind China and India, according to a report of Food and Agriculture Organization (FAO). The country is now also the fifth biggest aquaculture producer in the world, according to "The State of World Fisheries and Aquaculture 2018". The country's per capita fish consumption is now all time high and reached to about 63 g per day. Approximately 60 percent of animal protein that we consume every day comes from fish. And the fisheries sector contributes 3.57 percent to the country's GDP. To ensure continuity of the success, intensifying the aquaculture production, conservation of wild fishes with special emphasis on jatka, protection of natural fish-breeding grounds, initiation of deep sea fishing, and socioeconomic and livelihood upliftment of the fishers, fish farmers and other stakeholders in the value chain - need to be prioritized.

Bangladesh Fisheries Research Forum (BFRF) is a national, non-political and non- profit professional body with the memberships from the universities, DOF, BFRI, BFDC, NGOs, private sectors and other departments involved and committed to fisheries and aquatic resources development. BFRF has been playing a key role in maintaining the pace of the rapidly growing fisheries sector of Bangladesh. As the forum rightly identified, with the rapid growth, fisheries sector is threatened by a wide variety of factors including loss of aquatic habitat, urbanization, environmental degradation, pollution, overexploitation and climate as well as natural environmental change. BFRF would like to work on the priority issues to ensure the continued and sustainable development of the fisheries sector of the country.

In this volume of BFRF's publication - FAN -Bangladesh, a number of ongoing issues pertinent to different sub-sectors of fisheries.

It is hoped that the fisheries and aquaculture stakeholders would be benefited from the articles and all other information published in the FAN-Bangladesh. We hope that FAN-Bangladesh now and in future would play an effective role in the improvement of the fisheries sector. The e-version of the magazine is available in the webpage of the forum - www.bfrf.org.

We welcome your suggestions and feedback on the published articles. Please send us your research outcomes, innovations, project report for inclusion in the future issues of FAN-Bangladesh. I sincerely thank all our readers for their continuous support in our endeavor.

Mostafa A R Hossain

Silent Revolution in Freshwater Fish Farming in Bangladesh

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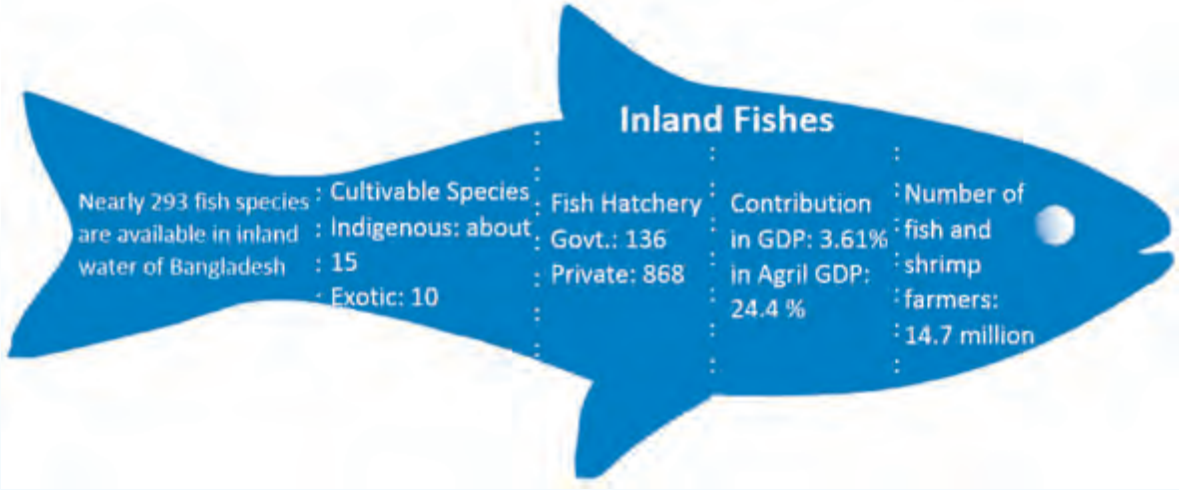
'Fish and rice make a Bengali' has been a known aphorism since the ancient times. The fish-based history and culture of Bangladesh is approximately four and half thousand years old. The region has been formed from the silt carried by its rivers and most of its people choose fishing and paddy farming as their major livelihood strategies. Generations after generations, people of Bengal catch fish from rivers, streams, floodplains, wetlands and ponds to meet up the demand of family nutrition. Many of them used to sell these wild caught fish in the markets as well. Historically, in the past, only the castes like Nomoshudra, Majhi, Jaila, Barman and Malo of Hindu Community used to catch wild fish. With times, many other became involved in fishing and in recent times people from many caste and creed have been involved in fishing. Even many upper class rich people have also taken fishing as a hobby.

However, since 1960s, the rivers and floodplains - the natural habitats of fish have gradually been deteriorated. The natural water flow has long been obstructed due to heavily silted rivers and floodplains and infrastructural development like roads, culverts, bridges, and embankments on and across the waterbodies. As a result, the production of fish in natural waterbodies has gradually reduced. Since 1980, the industrial installation and factories set up at the riverbank started to pollute the water severely. Due to this, fish disappeared from many rivers, streams and floodplain. The decreasing supply has gradually made the fish from freshwater natural waterbodies expensive. As a result, these wild indigenous fishes have long been out of the reach of the poor rural and urban consumers.

The fisheries scientists were searching for a way out from this dismal scenario. In this country, the improved aquaculture started since 1970s. The then Director of the Department of Fisheries, Dr. Najir Ahmed initiated the aquaculture in pond and wetlands. Dr. Najir Ahmed worked relentlessly throughout his career to improve the aquaculture sector. Particularly, through his initiative, pond polyculture of carps and hypophysation were started in the country from that time.

In 1967, the renowned fisheries scientist, Dr. A. K. M. Aminul Haque, for the first time established a full-fledged Faculty of Fisheries in the then East Pakistan Agricultural University (Bangladesh Agricultural University at present). The main goal was to produce skilled and trained manpower to ensure sustainable and optimum usage of country's aquatic resources withenormous future. Presently, the country has more than ten universities with fisheries faculty/department. The graduates produced by the universities employed by different government and non-governmental organizations and research institutes are in the forefront of the silent revolution of fish farmingthrough different activities such as developing modern aquaculture technologies and transferring at the field level, training the fish farmers, exhibiting sustainable need-based technologies, demonstrating and displaying model fish farm etc.

Tireless efforts of Department of Fisheries (DoF) under Ministry of Fisheries & Livestock (MoFL), Bangladesh Fisheries Research Institute and rural fisheries entrepreneurs placed Bangladesh in the 4th position globally in inland fisheries. More than 1000 fish hatcheries of Bangladesh (Govt.: 136 and Private: 868) have been playing a crucial role in the growth of fisheries sector of the country. At present, the area of closed waterbodies of Bangladesh is nearly 0.8 million ha, that includes ponds, ditches, baor (oxbow lakes), gher (shrimp/prawn farms) etc. Fish production from these waterbodies reached to a massive 2.2 million tones through carp polyculture, catfish (pangas, magur, shing, pabda, gulsha etc.) culture, culture of tilapia and koi (climbing perch), shrimp and prawn faming, fish farming in cages and pens, crab farming, carp fattening, fish farming in beels and jolmohals (floodplain), farming of small fish, rice cum fish farming and integrated fish and vegetable farming etc. If the growing trend of fish farming continues, the total fish production would be boosted manifolds within a few decades.



At present, about 15 fish of indigenous and 10 fish of exotic origin are cultured in the country. An additional 15 indigenous fish species are possible to domesticate and to bring under culture. The number of inland fishes documented in the country is 293. People of Bangladesh are more interested to consume indigenous fishes rather than the exotic ones. The indigenous fishes are much tastier and more nutrient-rich than any of the exotic fishes. For example, vitamin A present in 1 kg indigenous mola fish is equivalent to the vitamin A present in nearly 100 kg exotic silver carp. The small indigenous fishes (SIS) are the rich source of essential vitamins and minerals, such as calcium, zinc, phosphorus and iron. The SIS are indispensable sources of micronutrients, very effective as remedy in curing anemia and night blindness and enhancing eyesight, and in construction and maintenance of bones particularly for the children, lactating and pregnant mothers and convalescingpeople. Therefore the inclusion of small fish in aquaculture needs to be increased. Introduction of any more exotic species must be stopped. More and more indigenous fish should be domesticated and be brought under aquaculture.

Along with modernizing the aquaculture, working on the sustainable development and maintenance of openwater fisheries is the need of the time. In the past, the rivers, streams, canals, beels, floodplain and wetlands of Bangladesh were very rich in the biodiversity of fish and other aquatic flora and fauna. In recent time, many of the freshwater fishes, prawns, crabs, snails, mussel etc. became nearly extinct due to a number of natural and man-made causes like overfishing, climate change and environmental catastrophe. Gradually diminishing upstream water flow is the root cause of the worrying biodiversity loss of riverine fishes. Fish biodiversity in the inland waters of Bangladesh is in dire state due to siltation of the rivers, increased use of water for irrigating the crop field, pollution and overfishing. Dams and barriers at the upstream and increasingly low rainfalls have made the biodiversity of many fishes critically endangered. The migratory routes of many local migrant fishes that have long been used for seasonal spawning are now completely destroyed. Though the number of species and the overall production from openwater fisheries have been decreased, the number of fishermen and fishing gearshave not. As a result the overfishing of fish and their eggs, spawns, fry and fingerlings didn't stop. The siltation of rivers has been accelerated due to the indiscriminate destruction of forest by the river bank. Over the last few decades the number of people living by the riverbank and on the riverhas been increased several folds. The spawning and rearing grounds of fish in the rivers have totally been damaged. The important fishes like mohashol (*Tor tor*), kalibaus (*Labeo calbasu*), rangarui (*L. angra*), kursha (*L. dero*), Baitkya (*L. pangusia*), gutum (*Lepidocephalichthys guntea*), puiya (*L. irrorata*), joiya (*Barilius bendilisis*), Koksa (*B. shacra*), patharchata (*B. tileo*), baghair (*Bagarius* spp.), bou (*Botia* spp.), chaka (*Chaca chaca*), kabasi tengra (*Mystus cavasius*), dhela (*Osteobrama cotio*), bacha (*Eutropiichthys vacha*), gang tengra (*Gagata* spp.), debari (*Devario devario*), kutakanti (*Hara hara*), ghagla (*Hemibagrus menoda*), balitora (*Psilorhynchus* spp.), bhol (*Raiamas* spp.), chenua (*Sisor rabdophorus*), guizza air (*Sperata seenghala*) are now on the verge of extinction. As it is assumed, among these, many had already been extinct.

The effort of improving the habitats of freshwater fish needs to be continued by coordinated effort. The freshwater fishes of vibrant colour and mouthwatering taste must be protected. To do this, a harmonized and integrated efforts of Department of Fisheries, research institutes and development organizations, teachers, researchers, fishers, fish farmers, fish traders and general mass are needed. Mass awareness should be created among the people of Bangladesh to conserve the freshwater fishes. The destruction of the hills and forests by the river needs to be stopped. To restore the fish habitats, measuressuch as setting up of fish friendly structures, dredging of rivers, establishment of fish sanctuaries, and removal of detrimental dams and dykes need to be taken. Overfishing and catching of eggs, spawn and small fry must be stopped. The laws, rules and acts on fisheries must be properly applied. In the crucial time of the year, particularly in the breeding season, harvesting of brood fish, use of destructive gear and kua and katha fishing must be brought to an end. Long term activities must be planned to protect environments and ecosystems. All national and internationals bodies, donor organizations, policy makers, teachers, researchers, fishers, fish farmers and general mass should come forward to safeguarding the valuable freshwaterfisheries resources.

The role of fisheries sector is very vital in the socioeconomic upliftment, poverty alleviation, manpower development and food and nutrition security of the agriculture dependent Bangladesh. At present, 3.61 % of overall GDP and one fourth (24.41%) of agri GDP come from fisheries. Through gradual intensification of fish farming in closed waterbodies, nearly 57% (3.878 million tons) of total fish production was obtained from aquaculture in the country in 2015-'16. Presently, the number of fish and shrimp farmers in Bangladesh is 14.7 million. If the fish production of Bangladesh over the last decade is reviewed, it is clearly seen that, the sector was grown almost sustainably at a rate of 5.24 % annually.

To reduce the land use in aquaculture, fish production per unit area must be increased substantially. At present, the fish production per ha in the closed waterbodies is only 2.77 tons. Through applying the modern scientific tools and technologies and improved intensive farming mode, this production can easily be doubled, at least. Everyone at the government and non-governmental level should come forward to achieving this target by disseminating research outputs to the field level using a coordinated approach.

The livelihood, socioeconomic status, benefit and cost of the people involved with fish farming must be taken into consideration. Most of the fish farmers, now a days, don't receive due price for their fish and face financial catastrophe. To ensure good price of the farmed fishes of Bangladesh, the country needs to look for the overseas market. To do this, along with increasing the quantity of farmed fish, quality needs to be improved and different value added fish product needs to be developed.

Only enhanced and sustainable management of freshwater fishesin natural waterbodies and substantial improvement of aquaculture practices can take the country to its much expected success of silver revolution. This revolution will lead to building a healthy, strong, meritorious and scholarly nation- may this be the earnest prayer of all Bangladeshis.

The article is the English translation of the Bangla article - 'Swadu Panir Machh Chase Nirab Biplob, published in the Daily Newspaper- The Prothom Alo on 5 November 2017. The author duly acknowledges the revision of the text by his three colleagues - Profs. M S Alam, MGQ Khan and K. Fatema, that substantially improved the text quality.

Nutrition-Sensitive Aquaculture: WorldFish Initiatives in Southwest Bangladesh

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Fish species and culture practice

Policy maker along with respective scientist are concerned about availability, accessibility and utilization of healthy and nutritious food to meet the growing demand of the large population of Bangladesh. Most of the Bangladeshi people are suffering from essential nutrient deficiency due to lack of in-depth knowledge on nutrition. Nutrition sensitive aquaculture alongside agriculture can perform the effective role to combat the under nutrition problem of growing population. Nutrition sensitive aquaculture approach includes- introduction and promotion of indigenous nutrient rich small fish culture with carp polyculture in homestead pond along with unused water body prevailing in the community, promotion and distribution of easy harvesting technology (mola gill net) for frequent small fish consumption, encouraging dyke cropping with improved varieties of vegetables and also encouraging the food product producing company to introduce nutritious fish based food product. Respective ministry of government, different non-government organizations and different company should come forward to effectively implement this new approach.

Nutritional importance

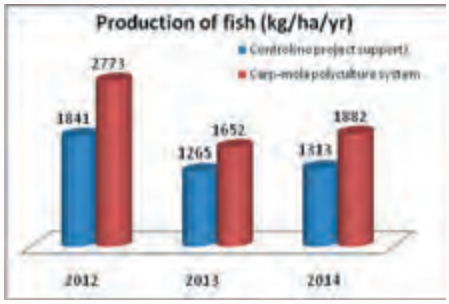
First 1000 days of life is very important for cognitive development of children. Proper nutrition is required for this time period for healthy and active life of children. In case of improper nutrition, child could fail to show their productivity in their respective working area in future.Most of the people are unaware of their food habit and even many of literate people don't know about energy and nutrient requirement for different age group and nutrient composition of different essential food which may lead our next generation in alarming situation. There is numerous numbers of small and large pondsin our rural community but most of the farmer does not follow the systemic fish culture and dyke cropping. Though some of farmer started systematic fish culture, they either kill or put small indigenous fish away from the pond due to lack of knowledge of nutritional value of small fish. In consideration of micronutrient, small fish contain very high amount compared to large fish. Small indigenous fish such as Mola, Dhela, Darkina contain essential micronutrient like Vitamin A, Calcium, Iron, Zinc, Phosphorous along with animal protein which have various important role in human body development. Vitamin A can protect from night blindness and increase immunity, iron can address the iron deficiency anemia, calcium helps to make stronger the bone and Zinc helps the cognitive development and protect from stunting. Mola fish are sometimes compared with Vitamin A capsule due to its' high Vitamin A content (2600RAE/100g) and market price is also high compared to other large fish. Only 6-7 mola fish (17g) can meet the daily Vitamin A requirement of under-five child. Therefore mola culture in homestead pond along with unused water body is inevitable for family nutrition and bonus profit.

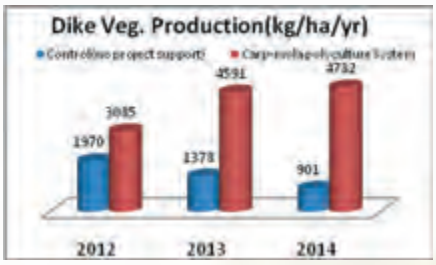
Interventions of USAID-AIN project

Mola brood distribution to the farmer pond: At the beginning of the project, a survey was conducted to identify the mola brood source. Mola was distributed to farmer using polybag incorporating oxygen from the oxygen jar after catching live mola by fisherman. Based on 200g/dec., total 4,728 kg mola was distributed to the 65,743 ponds following two methods: project to farmer distribution and farmer to farmer distribution. Moreover, mola was ensured in many ponds by stocking wild source mola instead of killing them during pond preparation. Last three year monitoring data of the project revealed that household total fish production increased in mola carp polyculture system than the control group (no project intervention). A recent published paper also showed that the fish production in mola-carp polyculture(2185 86.9 kg/ha)is significantly higher than carp polyculture(1841 76.4 kg/ha.) and small fish with carp polyculture have no negative impact on the carp production and no extra cost is required for management of small fish cultivation except brood cost.

Orange Flesh Sweet Potato (OFSP) vine distribution: Vitamin A and iron rich 2.8 million OFSP vines were distributed as seed to the 26,890 farmers by following two methods: project to farmer distribution and farmer to farmer distribution. Each Farmer yields average 155 kg OFSP from which major portion was consumed and a portion was sold. Last three year monitoring data of project showed that dyke vegetables production significantly increased in carp mola polyculture system than the control farmer (no project support).

Training on mola culture, mola precooking processing and basic nutrition: Total 69,484 farmer was trained through 48000 sessions with practical demonstration. Training included importance of mola, mola carp polyculture system, mola precooking processing technique, mola recipe preparation for child and lactating and pregnant mother and importance of dietary diversity. Training evaluation report revealed that knowledge about mola had been increased in trainee group than non-trainee group





Outcome of farmer training on importance of mola and mola processing for cooking:

Knowledge Type	Trained by LSP (%)	Trained by EF and/or CF (%)	Trained by both LSP and EF and/or CF (%)	Control (%)
No. of Respondents	127	91	94	112
What percentage of total Vitamin-A is contained in mola fish eye?	59	73	80	18
What are the considerations during mola/small fish cooking preparation?	68	71	79	43

(*LSP=Local Service Provider; *CF=Community Facilitator; *EF=Extension Facilitator)

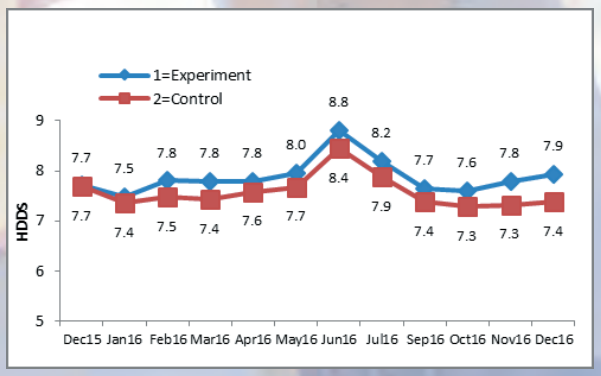
Training materials and learning materials distribution: Total 69,484 farmers were distributed with different type of learning materials which included mola-carp polyculture manual, food card, food plate, dyke cropping manual, OFSP poster and mola video.

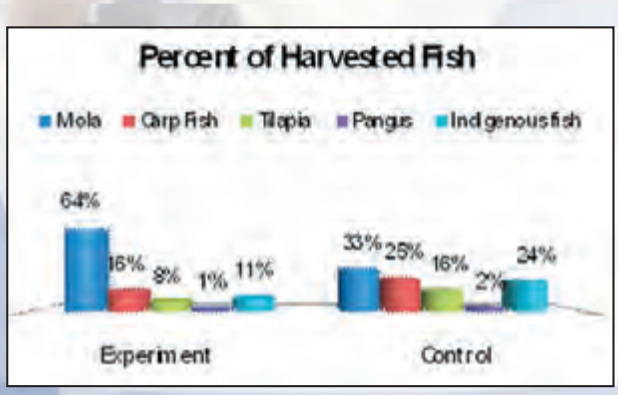
Women friendly mola gill net innovation and distribution

To address frequent harvesting problem, USAID-AIN project innovate mola gill net with easy operation technique by conducting different trial with different gear. Two different mesh size (0.6" and 0.7") nets were used for preparing a 50' x 4.5' mola gill net. To easily operate the mola gill net, two bamboo poles with a hook in each pole were used in two sides of the pond. The rope is passed through the hook of bamboo pole in such a way that, the rope can be easily moved. Two hooks act as smooth handlers to pass the rope through them. The selected net then can be hold from the rope in the water. Net is usually set and deployed to the water from the one of the two bamboo poles. Operator needs to tow the rope (opposite side of the net hanged) simultaneously and pass the rope through the hook of bamboo pole. The net is then hanged into the water from the rope which is attached to poles on two sides of the pond that keep the net rigid. Unused plastic bottles are used as floats of the net and broken pieces of bricks are used as weight to maintain the net straight in water. The net operator need to set the net in the pond and leave it for a while. To bring the net back from the pond, operator need to tow the rope (opposite side of the net hanged) simultaneously and pass the rope through the hook of bamboo pole. This allows pulling the net toward the operator. Fish can be harvested from the net by standing on the pond bank even without getting into the pond. For operating this special women friendly gill net to catch mola, no special equipment is required except an operator. Total 155 female farmers were trained up with preparation and operation technique of newly developed mola gillnet who further sold 227 mola gill net to the interested neighbor and 20 % of trained farmer earned average 993 taka per year. The cost of mola gill net is 450 taka including 200 taka for labor cost.

Study on the effect of mola gill net on the frequency and quantity of mola consumption

The result of our study revealed that farmer who have mola gill net harvest mola fishalmost 7 times compared to the farmer who haven't mola gill net and mola gill net user consume more than double mola than control group (no mola gill net). Study found that small fish contribution(17%) to the total fish consumption has been increased by 5% in mola gill net user group than the control group (12%). Mola gill net also has positive role in bringing dietary diversity.





Challenges

- Mola is highly sensitive so that mola brood harvesting and distribution is a difficult task.
- Existing mola precooking processing practice is not nutrition friendly i.e. most of people cut the head off which contains 53% of total Vitamin A content.
- Mola gill net materials like specific mesh size of net (0.6" and 0.7") is not available in the rural market.
- Fish consumption taboos still are followed by rural community people.
- Nutrition focused project run for short duration so that sustainable behavioral change couldn't be attained.
- No effective coordination between central and field level of different govt. /non govt. organization is a problem.
- Regular, effective and mass communication is absent in promotion of nutrition sensitive aquaculture approach.

Learning

- Farmers were found to be interested in nutrition education since nutrition is closely related with their health.
- People are positive in mola culture and most of the farmers follow the precooking processing technique learned from training.

Recommendations

- Mola carp polyculture in homestead pond along with unused water body should be increased.
- Easy harvesting technology (like mola gill net) should be scaled up to ensure frequent harvesting and consumption of small indigenous fish.
- Food product manufactuers should be encouraged to introduce nutritious fish-based food product.
- Dyke cropping along with homestead vegetables gardening should be encouraged.
- Mass communication with appropriate promotional materials on popularizing small fish is necessary.
- Intensive collaboration and cooperation between govt. and non-govt. organization is necessary to promote nutrition sensitive aquaculture approach.

Bangladesh has a potential to be lead country in fish production. There are about 4.7 million small and large ponds in Bangladesh where more or less fish are produced. But most of the rural people are suffering from essential nutrient deficiency due to lack of in-depth knowledge on nutrient rich small indigenous fish culture. In general, Fish production means commercial fish culture, fish cultivation in Gher, rui-catla-mrighel cultivation, tilapia-pungas cultivation, koi-shing-magur cultivation but nutrient rich small fish culture are still overlooked. Indigenous small fish especially mola culture with existing carp polyculture system alongside dyke cropping and availability of easy harvesting technology can address the micronutrient deficiency problem of Bangladesh.

Effective Fish Pass: An Environmental Friendly Approach for Bangladesh Flood Control and Road Infrastructure

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Bangladesh is facing challenges in conserving open water fishes in its flood lands, beels and rivers. One of the reason it the blocking the spawning ground of natural fish stocks in the flood lands by flood control or road infrastructure. The only solution is the installation of fish passes.

Fish Pass is a hydraulic structure that enables fishes to overcome obstructions in the passage, to assist the fish to pass them safely to the spawning grounds. Any form of conduit, channel, lift, other device or structure which facilitates the free passage of migrating fish over through or around any dam or other obstruction, natural or manmade, in either upstream or downstream direction. Fish passes are designed that its velocity attracts fishes readily and allow them to enter, pass through and exit safely with no undue stress, injury and especially without any undue delay for spawners. There are some rest areas within the fish passage (pools) in which the migrating fish can restore energy.

Fish Pass in Bangladesh: The concept of fish pass was introduced in Bangladesh in the 1990s and since then four (4) fish friendly structures and fish passes have been built in the country.

1. Sariakandi Fish Pass in Jamuna to Bangali River in Bogra 2001
2. Kashimpur Fish Pass in Kawadighi Haor in Moulovibazar 1995
3. Fish Friendly Structure in Lohajong River of Tangail 1996
4. Fish Friendly Structure at Morichardanra in Chapainawabganj 1997.

Fig 1. Sariakandi Fish Pass in Bogra.

Sariakandi Fish Pass, Bogra: The most recent and largest fish pass is the country, which is connecting the Jamuna river and the Bengali River at Sariakandi Upazilla, Bogra is an integral component of Bramaputra Right Embankment system which was designed as a vertical slot fish pass. The number of species increases after establishment of fish pass, there are some species recorded as endangered or threatened species Potka, Sarputi, Kalibaush, Bata, Rani, Gulsha, Tengra, Pholi, Veda, Shol, Chanda, Tin kata etc.

Kashimpur Regulator, Moulvibazar: Kashimpur Fish pass structure was installed for revival of the old status of Kawadighi haor. The Fish Pass Pilot project (F.P.P) was designed as Vertical Slot type to re-store the fish migration between the Kushiyara river and Kawadighi Haor which was disrupted by the flood embankments constructed under the Manu river flood control and Irrigation project. Small Indigenous Species increases after establishment of Fish Pass: Puti, Shingi, Magur, Chingri, Koi, Chanda, Tengra, Meni, Shol, Taki, Kakila, Boicha, Ghaghot, Gura, Tengra, Icha, Bain, Baim, Rui, Catla, Mrigel, Ayr, Chapila, Boal, Pabda, Gulsha, Kalbush.

Fish Friendly Structures in Tangail and Chapainawabganj: Jugini Regulator was constructed on the Lohajang to regulate the water level inside the Compartment Pilot Project (CPP) at Tangail. The hydraulic structure consists of 5 vents of which 3 vents are main regulator. Additionally two vents were constructed on the two sides of the main regulator with an objective to maintain the fish migration between Dhaleshwari to the Lohajang River to its floodplain. Chapainawabganj fish friendly structure is located at the Mahananda river inlet to Morichadanra beel. Long chains of beels are mainly dependent on this structure for receiving floodwater upon which the wetland biodiversity depends for their survival.

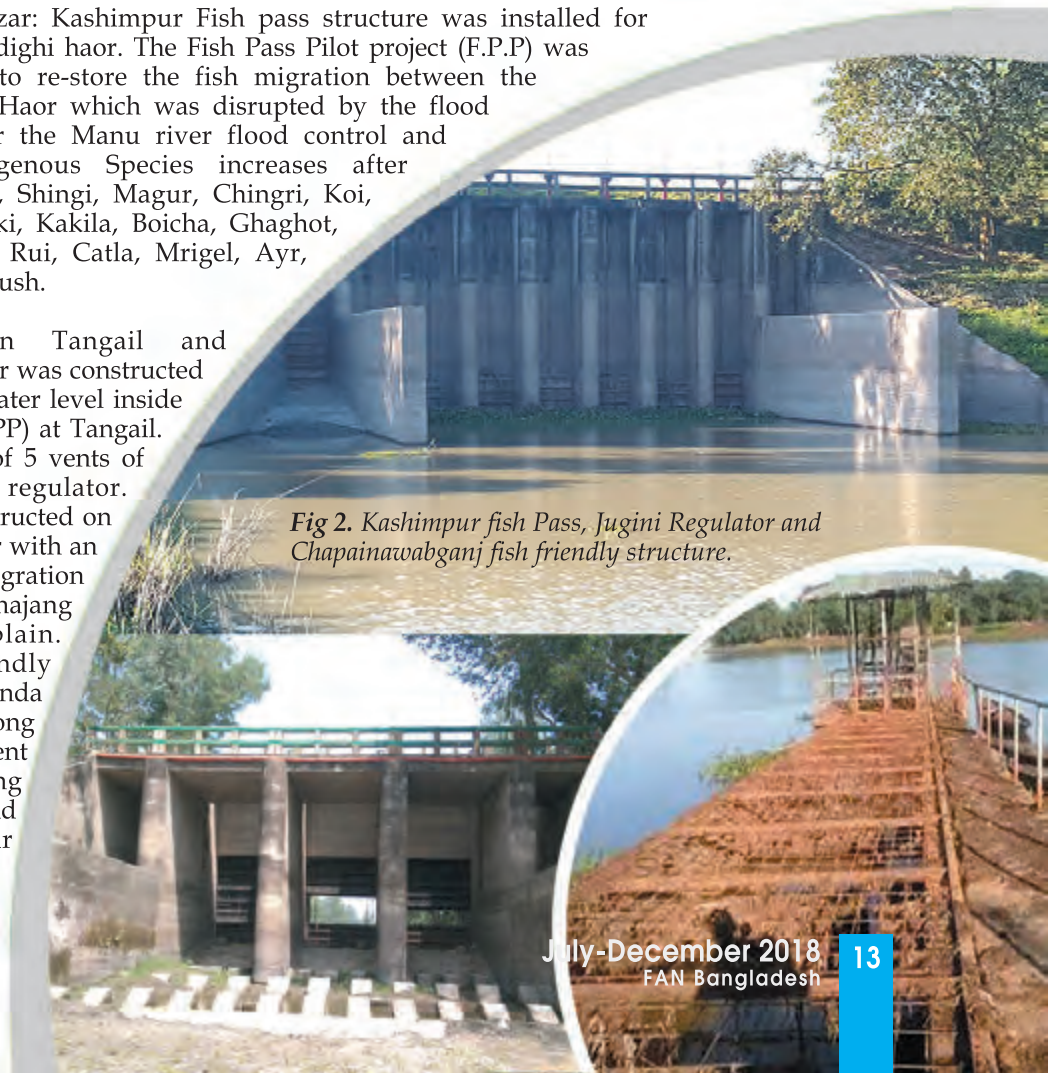


***Fig 2.** Kashimpur fish Pass, Jugini Regulator and Chapainawabganj fish friendly structure.*

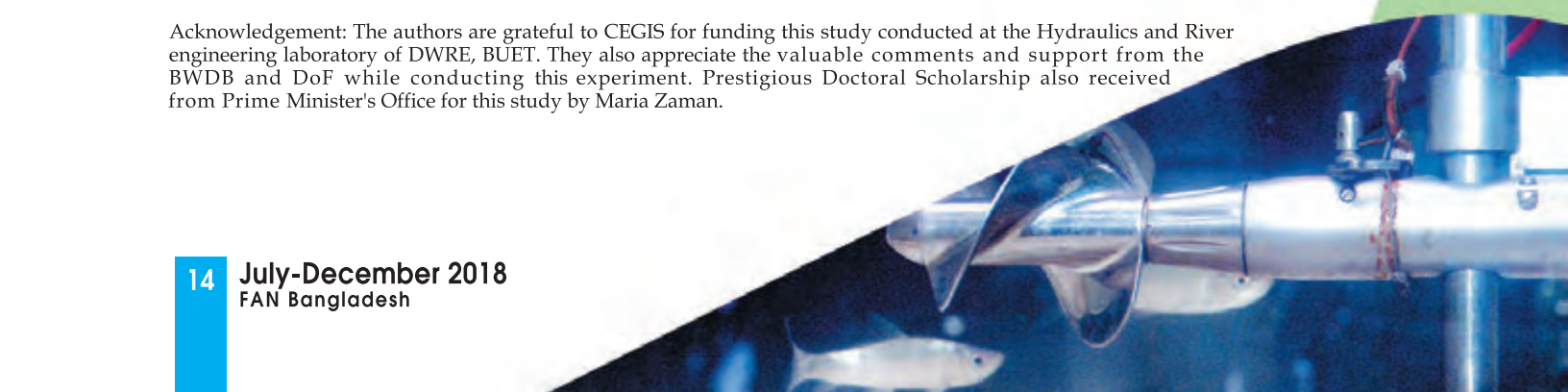
Fig 3. Fish Migratory behavior study in physical model of vertical slot fish pass.

No data were available for native species using fish passes. This area needs intensive research to study migration including behaviour of the fishes and hydraulics of river to design effective fish passes.

Investigation has been conducted with a physical model in the flume of Hydraulics and River Engineering Laboratory, Department of Water Resources Engineering (DWRE), BUET by down scaling the existing prototype at Sariakandi, Bogra, to understand the behaviour of selected species of fishes in a fish friendly structure called 'fish pass' which normally connects a river with a flood plain. The fish pass is constructed on the mild slope which contains four pools. The experiments have been conducted by maintaining upstream water level of 40 cm, 50 cm and 60 cm for different discharges. Fish species (Rui, Catla, Mrigel) of fry, fingerling and juvenile sizes were chosen for the study.

Fish pass model study has shown that carps and catfishes behave differently in the water turbulence created during the rainy season. The migration exercise improve the condition factors of the carps using fish passes. Fish usually take rest in the non-turbulence pockets to rest and meet its physiological conditions.

Acknowledgement: The authors are grateful to CEGIS for funding this study conducted at the Hydraulics and River engineering laboratory of DWRE, BUET. They also appreciate the valuable comments and support from the BWDB and DoF while conducting this experiment. Prestigious Doctoral Scholarship also received from Prime Minister's Office for this study by Maria Zaman.



Fish, Fishers and Fishing in the Meghna River Basin

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The Ganges-Brahmaputra-Meghna (GBM) Delta is the largest and one of the most major deltas in the globe. The delta is built up during the Pleistocene and Holocene time when large volume of sediments was laid down in the delta Complex by the forceful rivers. It is a greatly fertile land with high bio-diversity and the world's largest contiguous mangrove forest 'Sundarbans'. A number of mighty rivers flow through the GBM Delta and terminated at the coast of Bay of Bengal (a northern extended arm of the Indian Ocean)creating an active estuary system.

The coastal region of Bangladesh is a mixture of very old settlements and new land development. Along the coast in east-western directions, the physical features change, as well as the social makeup. The western part is a moribund delta (the largest mangrove forest, Sundarban), the middle part (the Meghna River Basin) is an active delta and the eastern part (Chittagong coast) is a stable landmass. The summer monsoons blow warm, moisture-laden marine air (from Bay of Bengal) over Bangladesh, dousing the land with heavy rainfall. The ensuing floods overflow the major river basins - Padma, Meghna, Brhmaputra and their many distributaries, destroying crops, landscape, houses, valuable livelihood assets, thousands of people annually. But they nourish, too. They carry sediments (alluvium) to farms, enriching their soils and ensure livelihood for hundreds of people living by the river basins.

MRB: The Meghna River Basin (MRB) is one of the largest and the most important river basin of Bangladesh, which carries 79% of total fresh water flow to the Bay of Bengal. The total length of the basin is 87 km. The average seasonal water flow is 91% in August, 74% in December and 59% in April. Discharge rate of the Meghna estuary is massive 86,992 m^3/s in August, 18,639 m^3/s in December and 9,415 m^3/s in April. The peak flow over last 10 year period has been estimated to be 123,000 m^3/s at Chandpur. The total annual volume of water passes the basin is enormous 1200 km^2. Sediments, fine sand and silt in the Meghna basin are carried by the major river systems, and are transported within the estuary mainly by tidal flows. The river is characterized by a highly dynamic morphology, with flow channels shifting their course over the years, and with intermittent erosion and accretion of islands and tidal plains.

Fishes of MRB

The fish assemblage in the MRB is highly divers and composed of a number of freshwater, estuarine and marine species. The major freshwater fishes available in the upstream of the estuary are barbs (*Puntius* sp.), tank goby (*Glosssogobius giuris*), bagrid catfishes (*Mystus* spp.), snakeheads (*Channa* spp.) and climbing perch (*Anabas testudineus*). Many of these species and taxonomically close ones are euryhaline and thrive on water with salinity between 0-15 ppt in Meghna Estuary like mullet (*Mugil/Liza* spp.), croaker (*Johnius* spp.), Pangasid (*Pangasius pangasius*), clupeid (*Gudusia* sp., *Corica* sp., *Olua* sp., *Thryssa* sp. and *Sertipinna* sp.), gobies (*Glossogobius* sp.) and threadfins (*Polynemus* spp.). Further down the Meghna estuary, fish like, bhetki (*Lates calcarifer*), paira (*Scatophagus argus*) and chhuri (*Lepturacanthus* sp.), estuarine eel (*Ophisternon* sp., *Congresox* sp.) and a number of flounders are available. A number of prawn and shrimp species including golda and bagda are also found in the MRB.

Hilsa & MRB

The MRB also attracts a welcome visitor to Bangladesh's rivers: the Hilsa shad (Tenualosa ilisha) and a number of other related clupeids. With one of the highest population densities of any country in the world, a rising birth rate, insolvency, and hunger, Bangladesh desperately depends on this fish. Among all the fish found in the Indian sub-continent and neighboring countries, hilsa holds a special position in the hearts as well as in the diets of people living in the region. Hilsa has the honor of being the national fish of Bangladesh. People in Bangladesh and Indian state of West Bengal - adore hilsa as Machher raja Ilish (Ilish is king of all fishes) and believe the taste of hilsa surpasses nectar.

The hilsa population in the Meghna River basin is affected more by fishing mortality than natural mortality, indicating a trend towards over-exploitation. Further deterioration of the hilsa population due to over-

fishing of adults and increased harvest of juveniles will further diminish the hilsa shad fishery unless measures are taken immediately. Their proper management, based on a sound understanding of their life history, is therefore vital.

Meghna Fishers

Most of the fishers are professional fishermen and depend essentially on fishing or as fishing labour. More than 70 % hilsa fishers fish in MRB. Nearly half a million fishers and an additional 2.5 million people are involved in hilsa value chain. From the ever-increasing numbers of mechanized and non-mechanized fishing crafts engaged in the marine artisanal hilsa gill net fishery, it can be concluded that the number of hilsa fishers in the marine sector has increased many fold in the last decade and continues to increase to date. The number of hilsa fishermen from the inland sector might have decreased as the riverine catch reduced significantly.

The fishing ban on hilsa is effective from 1 March to 30 April. The food incentive is available in the hilsa districts but as the supply is limited, Government presently cannot provide incentive to every hilsa fisher, however, plan to include gradually more fishers in the coming years. The food incentive of 40 kg rice a month no way meets the demand of a family of hilsa fishers, let alone the fisher families who are not included in the incentive list. Therefore, both groups who receive and who don't, often continue fishing defying the ban and occasionally caught by the police, pay fine/go to jail for a few months, their catches are destroyed and nets are burned. One might ask, what the food incentive is doing then, well, it is reducing the trend gradually and number of defiant fishers is decreasing. Both the groups - who receive food incentive and who don't, are increasingly being more aware and looking for alternate livelihood strategies.

Population pressure, low income, lack of alternative employment opportunities, extortion, pirate attacks, loan problem, etc. are the common socio-economic constraints for the MRB fishers

Fishing Craft & Gears in Meghna

Fshermen mainly use Chandi, Khosa, Dingi and mechanized boats for fishing in the Meghna. A large number of fishing gears are operated in the MRB for commercial and sustenance exploitation of the fishery resources. Various materials are used to make the gears include netting, twine, plastic structural and fasteners, clips and swivels, ropes, steel wire ropes, combination wire ropes, purse rings, polyester, polyethylene, nylon, cotton, polypropylene, mixed fibers, floats and sinkers, bamboo, wood etc. Of the total, five gill nets (Punti Jal, Bata Jal, Ilish Jal/Chandi Jal, Poa Jal and Fash Jal), two seine nets (Shatting Jal/Jagat Ber Jal and Gosi Jal/Khoti Jal) , , two drag/Push (Moi Jal and Thela Jal), fixed purse net (Behundi Jal) , cast net (Jakhi Jal/Khapla Jal), dip net (Khara Jal) , and lift (Dharma Jal), six traps (Vair, Kholsun, Unta/Icha Chai, Bitte, Banar Ghop and Pangus Chai), seven hooks and lines (Sip or Barshi, Borsha, Daun, Maita Daun, Tana Barshi, Chara Basrhi and Jomka Barshi) and three wounding gears (Juti, Konch and Teta) are common. Some of the gears are selective for a particular species, whereas others account for a number of species caught during operation giving multispecies nature of the fishing.

The hilsa fishers generally use set gill net (Chandi jal) and drift gill nets (Gulti, Kona, Current jal). Small meshed gears viz. current jal, behundi jal (set bag net), moshari ber jal and Char ghera jal are harmful gears, used for killing juvenile hilsa (jatka) indiscriminately in the particular regions. A number of the fishing gears are found to catch fish irrespective of their size or species and destroy the habitats of the wild species thus causing multiple harms to the biodiversity of the MRB.

End Note

Recent studies have indicated that the most fish species in the MRB are exploited at a high level and this exhaustive level of exploitation is facilitated by use of certain fishing gears. The estuary set bag nets are particularly destructive. Though the use of several types of fishing gear is banned under the national fishery acts, these are still widely used. The basic objective of responsible fishing is to maximize economic returns from the fishery without affecting its long-term sustainability ensuring minimum impact on the ecosystem. Therefore, MRB fishery should be developed, with the objective of stabilizing fish biodiversity at a sustainable stage rather than of increasing production of a few species. Such a development will incorporate, awareness building, and a number of other extension and dissemination activities, supported by training and befitting credit programmes. This is the need of the time to take the necessary measures and appropriate actions to stop indiscriminate fishing of gravid female and undersized fish. The spawning grounds of all major fish species like IMCs, hilsa, pangas, sea catfishes, threadfins, mullets, scats, snakeheads and prawn should be properly identified to allow for the establishment of fish sanctuaries and to promote recruitment of fish.

Environmental education is directly relevant to improved natural resources management in MRB and there is an urgent need for awareness development programmes among all the stakeholders. As the poor living in and around the MRB are the key actors in resource management, it is imperative to seek their cooperation and involvement in sustainable development programme. The mass media can be very effective in disseminating information on functions and values of MRB environment and the resources within. As women play a crucial role in the environmental management, the social participation by women in any initiatives should be encouraged. As the livelihood of the people is closely knit with the MRB, they should be made aware of the impacts of development programmes before implementing them.

Innovative Agro-Aquaculture in Bangladesh

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Agriculture and Aquaculture play a crucial and pivotal role in providing food security, livelihood and export earnings in Bangladesh. The two sectors run side by side very often with same physical and biological resources. With increased demand and resource constraints, it is time to maximize profit through rational utilization of common resources, resource recycling and remodelling of production cycles. Bangladesh, with its thirty agro-ecological zones, agro-aquaculture suits in very many ways. New and more innovative ideas come into play in these sectors which, in turn help boost primary production.

Innovative agro-aquaculture (IAA) in Bangladesh is in practice in some twelve major forms:

i. integrated rice-aquaculture;
ii. alternate rice-aquaculture;
iii. sorjan (homestead fruit garden)-ditch aquaculture;
iv. pond dyke vegetables- aquaculture;
v. aquaponic vegetable-aquaculture;
vi. water recycled agro-aquaculture;
vii. floodplain and riverine pen aquaculture;
viii. floodplain floating net cage aquaculture;
ix. floating bed agro-aquaculture;
x. floodplain fish nursery;
xi. Daudkandi Model agro-aquaculture; and
xii. Vabadaha Model agro-aquaculture.

Past and current status of Integrated Agro-Aquaculture in Bangladesh

Integrated innovative agro-aquaculture in Bangladesh dates back in the last century through introduction of fish culture along with paddy in paddy fields which is popularly known as paddy-cum-fish culture in Meghna-Dhanagoda Irrigation Project, Chandpur(Central Bangladesh) under Bangladesh Water Development Board (BWDB, the then WAPDA, Government of Bangladesh, GoB). People did this practice as an additional income generating activity with rice major crop and fish as a subsidiary one. The fish species were mainly catfishes- *H. fossilis* and *C. batrachus.* The same practice was introduced in adjoining areas and as far as Northern Bangladesh as an induction effect.

BWDB built some polders[1] in Southern Bangladesh in order to protect agricultural lands from flood and salinity intrusion from the sea with no concern with fisheries. But within a short time people find polders non-functional and their land got water-logged. They found a big catch of estuarine fish and shrimp in the water-logged polders without any investment. Having found no other alternatives to agriculture, they gradually moved from agriculture to aquaculture at varying degrees

[1]Polders are protected areas for agriculture encircled with heavy earthen embankments made in the coastal vulnerable region of Southern Bangladesh to control flood, tide and tidal surges with sluice gate facilities.

They changed their cropping pattern from exclusive agriculture to agro-aquaculture. They find it most suitable and more profitable for aquaculture than agriculture with this saline water where they found excellent production of shrimps (*M. rosenbergii* and *P. monodon*) and later on other salinity tolerant fishes like *Rhinomugil corsula, Mugil cephalus, Sicamugil cascasia, Mugil parsia, Mystus gulio, Cyprinu carpio* and the like with salinity level 5-20 ppt. They used to allow tidal water to come into the polder and then close the outlet. Thus entrapping fry and fingerlings of natural fish fauna these are allowed to grow there in natural condition with neither any artificial stocking of fry nor any supplemental feeding. This type of practice continued since middle of eighties and it was gradually converted from extensive to improved-extensive where some selective fry were stocked and some supplementary feed applied. Now in Southern Bangladesh, aquaculture has become major practice and agriculture a secondary option in consideration of people's adoption and return. But agriculture continued in rest of the country as dominant practice with aquaculture minor in low land paddy fields and floodplains in the Central, Northern and Eastern Bangladesh with suitable freshwater species of Indian and Chinese major carps and other fin fishes especially *Labeo rohita, Cirrhinus mrigala, Catla catla, Anabas testudineus, Heteropneustes fossilis, Clarias batrachus, Mylopharyngodon piceus, Barbodes gonionotus, Aristichthys nobilis, Hypophthalmichthys molitrix* and *Cyprinus carpio* and tilapia.

Agro-aquacultural succession and adaptation to climate change

Bangladesh is an agrarian country with prime production of rice and other cereals and pulses. The country has experienced a major breakthrough in rice production. The rice production has tripled since the independence of the country in 1971 and the production reached to 35 million metric tons in 2016 from 10 million metric tons in 1971[2]. While Bangladesh has achieved self-sufficiency in food grain it also faces uncertainty due to adverse climate. With negative impacts of increased climate change and natural disorders, people are moving from exclusive agriculture to inclusive agro-aquaculture for their mere existence and better return, for aquaculture is more resilient to climate change than agriculture, more supportive and highly priced locally and globally. On the other hand, shrimp aquaculture has become the major thrust for export earnings from polders of southern Bangladesh, for polders and sluice gates no longer support agricultural land on account of salinity intrusion, destruction of embankment, siltation and blockade of water exchange ways compounded with permanent water logging and frequent tidal surges. Same case happens with vast areas of Southern Bangladesh named Vabadaha water logged zone with an area of 12,000 ha in two Upazilas of Khulna (Fultala, Dumuria) and three Upazilas of Jessore District (Keshobpur, Monirampur and Avoynagar).

Present status of agro-aquaculture in Bangladesh

Bangladesh, one of the world's leading fish producing countries with a total production of 3.88 million metric tons, aquaculture contributes 56.82% to total production. Since independence in 1971 fish production has increased 5.5fold in general and aquaculture as much as 20 fold. The diversified fisheries resources of the country are divided into three major groups, i.e., inland capture fishery, inland aquaculture and marine capture fishery. Inland aquaculture includes mainly pond/ditch, baor, shrimp/prawn farm, seasonal cultured water-body etc. covering an area of about 0.80 million ha. In view of agro-aquaculture, annual fish production of Bangladesh is given in Table 1 which shows that open water agro-aquaculture and closed water agro-aquaculture contribute 21.75% and 11.54 % respectively to the total fish production of Bangladesh. Agro-aquaculture contributes around 40% of total inland fish production (Table 1).

Table 1. Annual fish production (metric ton) and yield (metric ton/ha) by production ecosystem(FRSS, 2017)

Production ecosystem	Area (ha)	Production (M.T)	Contribution (%)	Yield (Kg/ha)
Exclusive open water fisheries	1100,363	204,917	5.28	186.23
Open water agro-aquaculture	2818,245	843,325	21.75	299.24
Total open water	3918,608	1048,242	27.03	2675
Exclusive closed water fisheries*	404,864	1756,098	45.28	4437.50
Closed water agro-aquaculture	410,385	447,456	11.54	1090.33
Total closed water	4714,449	3251,796	56.82	689.75
Exclusive marine fisheries	-	626,528	16.15	
Grand total	-	3878,324	100.00	

*Exclusive open water fisheries: rivers, estuaries, Sundarbans, Kaptai lake; open water agro-aquaculture: beels, floodplains; exclusive closed water fisheries: ponds, oxbow lakes, pens, cages; closed water agro-aquaculture: paddy fields fish culture, prawn ghers ; exclusive marine fisheries: the Bay of Bengal

Practice and prospect of innovative integrated agro-aquaculture lies mainly in introducing aquaculture in low-lying paddy fields and shrimp ghers, polders and water-logged Vabadaha area and plain lands of Daudkandi region with Daudkandi agro-aquaculture model. People do paddy-cum-fish culture traditionally running with the basic concept of maximizing profit through minimum, planned and recycled investment. People found polders beneficial in early days for agriculture when national policy prioritized agriculture for Green Revolution in the sixties. But soon people found polders a hazard and detrimental to even their agriculture and livelihood. To get rid of detrimental effects of polders people went back to culture their indigenous knowledge of Austamasi - a locally evolved coastal tidal water management which is popularly known as Tidal River Management (TRM).

[2]Total farm holding 15.18 million ha, cultivable land 8.56 million ha and irrigated land 7.41 million ha, cropping intensity being 192 %.Triple cropped area is 1.72 million ha, double cropped area 3.85 million ha and single cropped area 2.35 million ha. In 2015-2016, area under rice cultivation was 1.13 million ha, production was 35 million MT, average yield 3.103 MT/ha. Wheat was with 0.49 million ha, production 1.36 million MT, average yield 2.78 MT/ha, Maize with 0.40 million ha, production 2.76 million MT and average yield was 6.98 MT/ha. Potato with 0.50 million ha, production 0.10 million MT, average yield 20.77 MT/ha.

Tidal river management and Vabadaha agro-aquaculture Model

It is a hundreds-of-years old practice of the farmers of the coastal Southwest Bangladesh. Farmers used to embank around their land in a specific time of the year (austamasi- means aeight month cycle) to protect their land from tidal saline water. With this, they cultivate their land for a period and then cut the embankment after harvesting the crop and allow the tide to flow in. They made this embankment in November-December and cut off in July-August when the rain water comes. It thus helps people to cultivate their land and also make their land fertile. But BWDB made embankments across the river basins with sluice gates through polder project. Primarily this project yielded good results but soon it ceased to continue with the inception of Farakka Barrage in 1975 and withdrawal of upstream fresh water. Saline water and tidal effect continued to reach high above sluice gate of Vabadaha with huge clay which were accumulated in the river bed and blocked sluice gate mouths. In 1980s, the upstream connecting rivers *viz.*, Kubadak, Betna, Chitra, Nabaganga, Begboti, Mukteswari, Horihor, Vadra, Sri, etc. started to die. River beds in some cases became higher than the beels .Thus the entire system became collapsed and resulted a heavy and acute human devastation compounded with water logging of rain water in the rainy season.

Vhabadaha is the central place of this water logging problem of coastal Southern Bangladesh where sluice gate was erected in 1961in the upstream of River Sri. It had 21 regulators to drain the water flow so it is locally called '21 Fhukon gate'. It contributed profoundly in 1960s and 1970s to drain the upland water flow of Avoynagar, Monirampur, Keshabpur and Jessore sadar Upazilas under Jessore district through Mukteswari-Teka-Sri river way, but it started to cease in 1980s and causing immense sufferings in their livelihood and food security due to water logging. BWDB tried in very many ways to keep up flow of the rivers but in vain. BWDB took Khulna Jessore Drainage and Rehabilitation (KJDR) project in 1993 to get rid of this water logging. But it also brought no fruitful result. People claimed to remove all the structures and claimed for Austamasi. The government paid attention to people's call and now BWDB is implementing the TRM officially. TRM allows a certain coastal beel to take tidal flow in and discharge the clays and the settled clay-free water passes through the river. After three to four years, another beel is selected for the same and it will continue. Thus 50 such beels would support the system for two hundred years. The benefit of this system is that planned land reclamation through tidal upcoming sand deposition and lifting of beel basin in one hand and flow of clay-free tidal water to downward ebb-tide through river basin without unwanted sand deposition and blocking of river mouth. The community or authority compensates the farmers of the beel for that period for getting no crops.

TRM in southern Bangladesh paved a way for a unique innovative integrated agro-aquaculture there. A case study made with 13 such randomly selected cooperative projects in Vabadaha area shows a surprising result. People changed their cropping pattern with diverse sectoral investment and more profitable gains. Table 2 shows that out of 313.89 ha none do exclusive agriculture there. Only three cooperatives go with exclusive aquaculture and all the 13 firms run agro-aquaculture. Table 3 shows sectoral cropping diversity and income where in 13 firms paddy caters for Tk. 287.08 million and other agro products Tk 1.95 million total Tk 289.03 million whereas aquaculture Tk 666.36 million and other fishery Tk 52.35 million totallingTk 718.70 million. The grand total being Tk 1468.80 million.

Table 2. A case study of agro-aquaculture at Vabadaha by area coverage (ha) in 2016

Upazila	Name and location of the firm/project	Exclusive agriculture	Exclusive aquaculture	Agri-aquaculture	Others	Total (ha)
Keshabpur	Gonogher	-	-	22.0	12.00	23.80
	Nutongher	-	-	19.0	09.00	21.25
	Gumgher	-	-	17.0	14.25	18.20
	Auriakhaligher	-	-	15.0	03.50	17.0
	Busto tulagher	-	-	8.0	10.50	9.4
	Khalargher	-	-	3.0	0.5	3.5
Monirampur	Purbashaagro-fisheries Society	0	0	34.34	0	34.34
	Nehalpur-Lakhaidanga Agro-fisheries Society	0	0	51.00	0	51.00
	Lakhaidanga Agro-fisheries Society	0	0	85.00	0	85.00
	Paddabon Agro-fisheries	0	0	7.65	0	7.65
	Bilkedaria-I Agro-fisheries	0	30.0	0	0	30
	Pattargher	0	34.00	0	0	
	BeelKedaria–II agro - fisheries	0	12.75	0	0	12.75
Total		0	76.75	261.99	49.75	313.89

Table 3. A case study of agri-aquaculture at Vabadaha by sectoral cropping diversity and income (million Taka), Mongolkot, Keshabpur, Jessore in 2016

Name of Upazila	Name of the Project	Area (ha)	Production by income (million Taka)						
			Agriculture			Aquaculture			GT
			Paddy	others	Total	Aquaculture	Fishery	Total	
Keshabpur	Gonogher	23.8	1.8	0.40	2.2	7.3	1.0	8.3	10.5
	Nutongher	21.25	1.6	0.50	2.1	6.0	0.6	6.6	8.7
	Gumgher	18.2	1.3	0.40	1.7	5.3	0.5	5.8	7.5
	Auriakhaligher	17.0	1.2	0.30	1.5	5.0	0.7	5.7	7.2
	Busto tulagher	9.4	0.75	0.25	1.0	3.0	0.2	3.2	4.2
	Khalargher	3.5	0.30	0.10	0.40	1.2	0.1	1.3	1.7
Monirampur	PurbashaAgro-fisheries	34.34	64.60	-	64.60	108.00	12.00	120.00	184.6
	Nehalpur-Lakhaidanga Agro-fisheries	51.00	73.75	-	73.75	157.50	09.00	166.50	240.2
	LakhaidangaAgro-fisheries	85.00	124.9	-	124.9	250.81	14.25	265.05	390
	PaddabonAgro-fisheries	7.65	16.83	-	16.83	30.90	03.50	34.40	512.3
	Bilkedaria-I agro-fisheries	30.00	-	-	-	91.35	10.50	101.85	101.8
Total		301.14	287.1	1.95	289.0	666.36	52.35	718.70	1468.

[8] Department of Agriculture Extension (DAE), Draft National Agriculture Extension Policy (2015)para 8.5.

Government Interventions

The Govt. owned Water body Management Policy 2009 also emphasized integrated use of agricultural lands and includes Agriculture and Fisheries Departments' representatives in decision making process for leasing out government owned water bodies.

Bangladesh Water Act 2013 limits the use of water resources beyond critical limit for ensuring the availability of water for agriculture and aquaculture. Coastal Zone Policy 2005 also promotes integrated development of crop, fisheries and livestock sub-sectors for equitable use of scarce water resources in coastal zone of Bangladesh. The Law on Protection of playground, open space, park and water body 2000 also enunciates the restriction of filling up of these establishments that also promotes ecosystem conservation and integrated cultivation of crops and fish in low lying areas. National water policy of Bangladesh prioritizes use of water in agriculture and fisheries sector. It empowers National Water Resources Council to co-ordinate all water resources management activities in the country. Likewise, the ministry also formulated Coastal Zone Policy 2005 in order to harmonize and coordinate all development activities in the coastal zone. As a signatory country Bangladesh follows Code of Conduct for Responsible Fisheries for Fisheries Resources Management, aquaculture development and integration of fisheries into Coastal Area Management. Government of Bangladesh formulated National Fisheries Policy 1998 which focuses on policies on conservation, management and harvest of open water fisheries, aquaculture and management of inland closed water fisheries, coastal water shrimp aquaculture, fish conservation and management of marine fisheries, fisheries training, extension and research with due emphasis on employment, quality control and foreign exchange earnings. The Government has also formulated National Shrimp Policy 2014 to protect and promote environment-friendly and socially acceptable shrimp aquaculture with zone and land allocation.

Individual adoption

There are two types of rice-fish farming systems in Bangladesh: capture and culture. In the capture system, wild fish enter the rice fields from adjacent floodplains during the monsoon, however, in the culture system, rice fields are deliberately stocked with fish. Fish culture in rice fields is broadly classified as alternate (rotational) and integrated (concurrent) and it has been identified in a study that regardless of the farming system employed, the majority of rice-fish farmers produce fish in rice fields for income generation, while 34% and 12% did so for household consumption and suitable bio-physical conditions. According to this study, 54% of rice-fish farmers were involved inintegrated rice-fish farming while 46% practised alternate farming. Integrated farming was found under both rain-fed and irrigated conditions. However, because of poor irrigation facilities, only a few farmers 12% were involved in irrigated rice-fish farming.

Cost-benefit analysis of IAA

According to the survey conducted by Ahmed et al., the highest average annual variable costs usually incurred from alternate farming owing to costs associated with fish fingerlings and feed, while the lowest were from rice monoculture. Labour costs generally constituted the highest single operational cost, accounting for 29%, 43% and 51% of total variable costs in alternate, integrated and rice monoculture respectively. However, annual fertiliser cost becomes the highest in rice monoculture and similar for alternate and integrated rice-fish farming. It was noted that the costs for fish feed were only about twice as high for alternate farming than for integrated farming although the input was much higher.

Fixed costs included depreciation (i.e. ploughing and pesticide spray equipment, fish net and rice threshing machine), interest on operating capital and land-use cost or lease money. The largest single fixed cost for rice and rice-fish farmers was cost of land. Fixed costs accounted for 28%, 30% and 34% of total costs in alternate, integrated and rice monoculture respectively.

The average annual net return is higher in integrated farming, compared to rice monoculture and alternate farming. Integrated farmers obtain the highest net return because of a combination of two rice crops and fish production. Although there is higher fish production in alternate farming, the average annual net return is lowest for alternate farmers because, for a single crop, they had the highest production costs and the lowest rice production.

Revenue and Food Security Impact of IAA

While the IAA enhances on-farm resource-use efficiency and productivity via the integration of resource flows between terrestrial and aquatic subsystems, it moves to a whole-farm perspective, utilizing aquaculture in paddy fields by optimizing management of on-farm resources. It has been concluded by some studies based on the experimental design of before- and-after and with-and-without basis that if farmers adopt IAA they would be better off in terms of outcomes such as productivity, income, and food security.

The production of a fish crop between the two rice crops provides the farmer with an off-season job. This can increase the income without increasing expenses. The combined culture leads to a reduction of labour in weeding and an increase in the yield of paddy by 5 to 15%. The increased rice production in the rice-fish integration is attributed to various factors, such as reduction in the number of harmful insects, reduction in rat population due to increase in the water level, increase in organic fertilization by fish excreta and remains of artificial feed, and better tilling of the rice seedlings due to the activity of the fish. The introduction of IAA reduces poverty for IAA adopters, as the poverty rates fall an average of 16%. Investment in IAA improves incomes beyond simply income from fish. Adoption also results in significantly increased fish consumption.

IAA is a smart solution of the day when resources of primary production are getting scarce day by day with increased demand of outputs against decreased input supply compounded with climate change. Selection of hydro-ecological zone-specific best practices, climate-resilient adaptive species with vale chain development are three most important requirements in this regard. It is time to explore all good practices already developed elsewhere in the word for the betterment of the world humanity for safe, sufficient and quality-ensured food security with due respect to water quality, soil health, natural conservation and biodiversity protection. Bangladesh is ready to extend her all- round support and cooperation for any future endeavour for promotion of IAA locally and globally.

Traditional fermented fishery products of North-eastern Bangladesh: First report on process, constraints, storage and consumption of Hidol of Sylhet

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In our program of exploring traditional fishery products in Bangladesh, we found two very specialized fermented fish products: one is "Shidhil tikia" of Rangpur and the other is "Hidol "paste of Sylhet. The process and constraints, storage and consumptrion of "Shidhil" of Rangpur was reported elsewhere. The present paper deals with the details of the origin, raw materials, process, storage, distribution, consumption and constraints of a traditional fishery product- "Hidol" paste of Sylhet in Bangladesh.

Hidol Paste of Moulvibazar, Sylhet

A particular type of semi-fermented fish paste, also called "Hidol", is prepared by anaerobic degradation in closed bamboo pipes or earthen/plastic pots and popularly consumed in Sylhet and Moulvibazar areas of Bangladesh. Small low-priced haor fishes at glut harvest are crushed into paste and kept in closed bamboo or other containers for couple of months to allow partial anaerobic fermentation.

Processing area

Since the time immemorial, plenty of small fishes like punti, chanda, mola, chela, etc. have been harvested from the haor, baor, beel, canals and low lying water bodies of Sylhet and Moulvibazar districts. To utilize plentiful catch of these low-priced species, in addition to plain sun-drying, a very effective traditional endemic method of partial fermentation has been developed in this region, which is practiced at peak fishing of haor, during the mid-August to mid-October. Hidol has traditionally been produced as delicacy, only for home consumption by the local communities in the haor areas of Moulvibazar, Sylhet and other north-eastern districts.

Species for Hidol

Considering the family aspiration and local demand, availability and price, most of the households prefer to make this fish paste from two particular fish species, viz., punti (*Puntius sophore*) and batashi (*Batasio batasio*). Some other species popularly used are chanda (*Chanda nama*), mola (*Amblypharyngodon mola*) and chirka baim (*Mastacembelus pancalus/armatus*). These species are used either individually or as mixed group. Fermented paste prepared from mixed species generally gives a taste quite different from the pastes made of individual species. Therefore, "Hidol" paste of individual fish are highly preferred and sold at higher price.

Traditional processing method

During the mid-August to mid-October when the water body ceases to narrow pits, huge quantity of small fishes like punti, chanda, mola, chela, batashi, baim, etc. are captured by draining out of the water in haor and low lying paddy fields. The fishes are cleaned and spread on the split-bamboo mat, locally called "chatai" for sun-drying. No salt is generally added. But, sometimes a very little amount of salt (25-30 g per 1-2kg fish) and turmeric (2-5 g) are used. After partial sun drying, the raw material fish becomes ready to prepare "Hidol".

At first the dried fishes are washed by rubbing in the water and spread in the air for surface drying. The raw material is then kept in a mortar made of wood or green bamboo, where they are crushed into paste by a wooden/bamboo pestle.

A little amount of salt is used during crushing. Turmeric, chili and other spices are often used as per family taste preference. The paste is then kept in closed containers for aging or fermentation and mouth of the container is finely blocked by banana leaves. In Moulvibazar, the processors preferably use green bamboo pipes (keeping one node closed and the next node cut to open the mouth, in order to make a pipe-like container) for such aging of the paste. Green bamboo imparts extra flavor to the product, which is highly preferred by the local consumers. Other containers used are earthen pot, strong plastic pot, glass pot, etc. The paste is tightly inserted into the pots by adequate pressure from the top, so that no empty space or air pocket remains, as it may hamper the product quality.

How to eat Hidol in Moulvibazar

The local people, specially fisher's family use this product either in the curry with red pepper or in vorta with hot spice, onion and chili. The people consume the product almost throughout the year, but preferably during non-fish season. After taking out a portion, the original container can be sealed again and kept at room temperature for successive use. On an average, the product is kept for one year until the next processing in the next peak fishing season. People particularly prefer its strong characteristic flavor. Many affluent people produce this product at home and eat as delicacy during special celebration, family gathering, valued guest entertainment etc.

Constrains of existing process

- The quality of harvested fish is not properly maintained. Very often the raw material fish are spoiled.
- Unwashed fish are kept piled on the soil or sand, on unclean bamboo mat or chatai.
- Local processors or fishermen are not aware about sanitation and public health.
- Unavailability of raw fish and high price of fish.
- Lack of commercial entrepreneurship, because of local peoples' taboo (mainly Muslim fishermen/producers) on selling fishery products in the market.

Measures to overcome constraints

- Adequate handling and icing of fish should be done to maintain raw material quality.
- Because of huge demand of this traditional product, local entrepreneurship can be developed and promoted by the GO/NGO agencies.
- Fish drying process should be started from middle of September to ensure at least 4 to 5 production cycles within the season.
- Improved tunnel can be used for sun drying of fish.
- The walls of the container, bamboo or earthen, should be polished by mastered oil to avoid adherence of the final products to the wall.
- Insulation of the containers can be improved to maintain true anaerobic conditions favourable for fermentation.
- Standards along with code of practice for quality and personnel hygiene should be ensured throughout the process from raw material collection, product preparation and storage to distribution and marketing.
- Fermented "Hidol" paste should be packaged in alumimium laminated high density polyethylene, polystyrene coated polypropylene packet for storage and for long time use.
- Packaged products should be stored in clean, dry and cool place.

Conclusions

"Hidol" paste is a home-made delicious food item of Sylhet and Moulvibazar, used mainly as condiment or taste enhancer. It is also a good source of protein that plays a vital role in providing many essential micro- and macro-nutrients for the poor as well as socially disadvantaged people during lean fishing season. Due to scarcity of fish and less interest shown by the new generation, these types of traditional produces are becoming extinct day by day. On the other hand, most of the preparations are confined at household level, commercial production is almost lacking. Therefore, adequate entrepreneurship should be promoted to keep this important traditional product alive in the country.

Ditrema viridae (Oshima, 1940) : an unique fish carries developing young

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Ditrema is a genus of surf perches native to the northwestern Pacific Ocean. *Ditrema viride* (common name is Aotanago in Japanese)is one recognized species in this genus. The surfperch characterized by a silvery, dorsally yellowish-green body when fresh. It has a very few information on its biology and ecology. It has a dark triangular marking on the anterior suborbital area, the spinous portion of the dorsal fin with a black distal margin, a longitudinal black line along the anal-fin base and the pelvic fin slightly darkish, and lacking a black spot anteriorly on the base. Adults inhabit shallow Zostera marina beds .It is viviparous, number of embryos about 30. Young born from April through July. Female carries the developing young. Short description of Ditrema viride are: Dorsal spines (total): 9 - 11; Dorsal soft rays (total): 19-21; Anal spines: 3; Anal soft rays: 25 - 28. It has maximum length: 19.0 cm SL male/unsexed. Its distribution occurred in Northwest Pacific: Japan and South Korea mainly along the Japan coasts southward from Aomori Pref., the southern coast of the Korean Peninsula and Yellow Sea. Often inhabits Zostera marina beds on sandy bottoms. It is Marine, demersal and found in temperate region. Very few information is available regarding this species.

Collection and counting of young individuals of *Ditrema viride*

An adult *Ditrema viride* (Female)

An adult Ditrema viride (Female) with young individuals

Traditional fermented fishery products of Northern Bangladesh: First report on process, constraints, storage and consumption of Shidhil of Rangpur

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Fermentation has been a popular technology for the preservation of fish in Southeast Asian countries from time immemorial. Fermentation of fish takes place as a result of the action of exogenic and endogenic enzymes, the latter being naturally present in the guts and intestine of fish. It is a process of transformation of muscular organic substances into simpler compounds by the action of enzymes and microorganisms. Digestive enzymes are highly proteolytic and active at low pH, but visceral and digestive tract enzymes are active at near neutral pH. Various cereals and plant materials are added during production of several fermented fishery products in Southeast Asia. Fermentation is one of the best ways of preserving fish particularly in the tropical countries and specially in glut seasons. In Bangladesh, a few very popular semi-fermented fish products are produced, like Shidhal or Chepa, made from small freshwater silver barb, Puntius shophore and Nga-pi from small marine shrimp (Acetes sp., Mycid sp., etc) and juveniles of small marine fishes. The method of fermentation is also applied in the process of various salted fish products like salt-fermented hilsa, faissha, fatra, sardine, etc. Very recently two other semi-fermented fish products have been identified, one is "Shidhil" tikia of Rangpur and "Hidol" paste of Moulvibazar. The "Shidhil" tikia of Rangpur was first reported and described in a textbook in 2007, but the Hidol" paste of Moulvibazar has not been reported elsewhere yet, except some photos were released by the author online in the social media. The present paper deals with the details of the origin, raw materials, process, storage, distribution, consumption and constraints of a first product- "Shidhil" tikia of Rangpur in Bangladesh.

Shidhil tikia (cake) of Rangpur

Shidhil, in rural areas of greater Rangpur, often pronounced alike 'Shidhol' or Chepa, but is completely a different product than Chepa, made by grinding of dried small fish and esculent stems or leaves and then fermenting. The product is shaped into round flattened ball or dried powder, with slightly blackish or ashy navy-blue in color. Shidhil is very popularly produced and eaten in Rangpur, Nilfamari, Kurigram, Lalmonirhat and greater Dinajpur districts. In Rangpur it is eaten as delicious spicy paste, locally called vorta. Vorta is taken as condiment with boiled rice. While cooking "Shole-mach" (a snake-head curry), shidhil is often dissolved in its fluid to improve the thickness, taste and flavor of the gravy (curry-juice). Shidhil has unique magic flavor and taste to attract the consumer. Such attraction is hardly observed in other food-stuffs.

Fish species used for the preparation of shidhil in Rangpur

For the preparation of shidhil, the small fishes used mainly are tit puti, punti, kajoli, darkina, taki, tengra, meni, boicha, shole taki, kholisa, etc. In was noticed that almost all of the small fishes available in the area during the peak fishing season are used in shidhil.

Season of shidhil preparation

Mainly October to March (Bangla month of Kartik to Chaitra), when small fishes are plentiful, is the season of shidhil preparation, but October to January (Kartik-Poush) is the best time, because of dry weather and low temperature, that allow rapid drying and optimum fermentation of fish.

Source of fish: Small fishes are obtained by draining out of the water of the ditches, ponds, beels, canals, low lying water bodies and depressions. Fishes obtained from the ponds and river and sold in the market are also used.

Processing area: The exclusive shidhil processing area is greater Rangpur district. But it is also prepared in some sub-districts of greater Dinajpur. In greater Rangpur district, people in most of the upazilas produce and eat shidhil. Shidhil is found to be prepared by the households in the local towns also.

Raw materials and tools needed for production: Major raw materials for shidhil are small fish and esculents stems or leaves. Tools used are bamboo mat, wooden mortar and pastel, cotton cloth or towel, mosquito net, earthen pot, sieve and winnowing fan.

Production Process of Shidhil

The most common process of shidhil manufacture in greater Rangpur region is given below.

Drying of raw materials: At first, small fish (most often mixed species if plenty of single species is not available) are spread on bamboo mat (locally called dhara) without washing, then they are fully dried in the sun. Mosquito net is used to protect from insect infestation and/or animal, bird or rodent attack. At a time, wild esculent (Colocasia esculentum) leaves or stems (locally called kachu data) are also semi-dried in the sun; drying time varies because of heating rates of the sun. Before drying, esculent leaves or stems are cut into small pieces, peeled out the barks and boiled in water to soften and remove water and anti-nutrients (for e.g. calcium oxalate, etc).

Crushing, mixing and further drying: The preferred ratio of cut-pieces of semi-dried esculent stems and fully dried fishes used are 2:1, but a ratio of 3:1 is often used due to scarcity of fish. Semi-dried esculent stems/leaves and fully dried fish are crushed together in a wooden mortar and pestle (mortar is called urun and pestle is gayein locally). During crushing, garlic, zinger, pepper, salt and different spices are added according to consumers' preference or family's choice. Some consumers love to eat hot-spicy and somebody favors little or non-spice. Onion is not used during crushing because it accelerates spoilage or off-flavor formation in the final product. The mixture is screened if needed, while the screening is done by a sieve made of split bamboo (locally called jhapa). The mixture is then finally ground into finer paste.

The ground paste is shaped into small round cake or flattened ball by hands. Turmeric powder and mustard oil are mixed together in a bowl and the shidhil balls or cakes are soaked in this mixture, or often the spice-oil mixture is polished over the surface of the ball by hand. The cakes/balls are wrapped with cotton cloth and then semi-dried under the sun or in the earthen oven for 1-2 days. The people of Rangpur called the product shidhil when the cakes or balls are made by hands. Turmeric powder and mustard oil mixture protect the cake from blowfly, beetle or other insect attack.

Fermentation and storage: At first, cool ash of burned wood (locally called "sai") is taken in an earthen pot. Semi-dried shidhil cakes are placed one by one inside the ash. Keeping more ash on or around the cakes up to the mouth, the pot is tightly closed, allowing a controlled fermentation. Sometimes, shidhil tikias or cakes are wrapped by small thin cloth and then kept inside the ash. Without wrapping, shidhil processing seems to be unhygienic, since ash may adhere with the final product. Shidhil cakes are generally kept in air-tight earthen pots for 2-3 months at room temperature. This combined controlled fermentation and storage add desired flavor and taste to the product. Carbohydrates of esculent root, leaves or steams serve as media for fermentation bacteria to grow and draw their metabolic energy. But less-moist dry anaerobic condition due to ash-mixing allows a semi-controlled fermentation, the texture and flavor thus developed are acceptable by the local consumers. If it is kept for long time in the pot, the product will become harder in texture and

desired flavor will be lost. House-hold people consume the products from the pot within limited time period. It is better to eat shidhal as early as possible, as soon as aging/ fermentation is complete. Wood-burnt ash has bactericidal and pesticidal properties, while semi-fermentation allows a stable product capable of protecting bacterial, fungal, insect or pest attacks. Shidhil thus prepared supply protein nutrition to the people during lean season or food scarcity in monga-striken Rangpur.

Another specialized preparation of shidhil: In another specialized process of manufacture of shidhil, the small fishes like punti, darkina, taki, tengra, meni, baicha, shol, kholisa etc. are dried in the sun during the winter. Wild esculent leaves, stems or roots are also dried at a time. Dried fish and esculents are crushed together into powder in a wooden mortar and pestle. Crushed powder is screened if needed. During crushing, dried turmeric, chilli, other spices and salt are added. The mixture is further dried for several hours and preserved in porcelain or glass jar.

How to eat shidhil

Shidhils are eaten in two ways, as vorta and with fish curry.

Shidhil as vorta: Shidhil cake is taken out from the earthen pot. If ash are adhered with it, quick wash with water or quick dip into water to remove the ash is necessary. After washing, cakes are wrapped by banana leaf and placed on burning wood having no flame or in the burnt charcoal. Within few minutes, desired flavor (locally called "Bashna") comes out from the wrapped shidhil. Soon it is taken out from the oven, ground in stone mortar with either fried onion and/or green chili, salt and mustard oil to make a delicious paste, locally called vorta. Ingredients are used based on consumer's choice. Vorta is taken as condiment with boiled rice. In case of powdered shidhil, a portion is soaked in a cup of water, mixed with hot-spices, onion and other spices and make a pasty vorta to eat with freshly boiled rice.

Shidhil with fish curry: Using the same process of grilling with the burning wood, flavor is developed in the wrapped shidhil. After unwrapping, shidhil is ground with little water to make a paste or slurry. The paste is then put into the gravy of boiling fish curry, preferably of shole fish curry (Channa striata). After incorporation of the paste, cooking is continued for further 2-5 minutes. Shidhil is dissolved in curry-juice to enhance the thickness, taste and flavor of curry. Excellent and magic flavor comes out from the fish curry.

Nutritive value of Shidhil

Fish: "Shidhil is made from small fishes, which contains high quantity of vitamin-A and minerals like calcium, phosphorus, iron, magnesium, etc. It provides significant quality of protein, lipid and other macro-nutrients.

Esculent

- Esculent stem is a rich source of calorie than potato.
- Its calorie value chiefly comes from complex carbohydrates, amylose and amylopectin.
- It carries high quality of phyto-nutrients.
- It is also the finest source of fibers.
- Esculent contains valuable vitamins, such as pyridoxine, folates, riboflavin, pantothenic acid and thiamin. It provides highest content of vitamin A, so far, nearly 1800 IU/g.
- It also contains high amount of essential minerals like zinc, magnesium, copper, iron and manganese. That helps to regulate heart rate and blood pressure, as well as bowl movement.

Problems associated with traditional shidhil processing

- Sun-drying of small fish for shidhil is performed mainly by traditional methods. Processors have lack of knowledge on sanitation and public health.
- Very often spoiled raw materials are used.
- Esculents stems are not properly peeled its bark and boiled to remove anti-nutrients.
- Fish is not adequately washed and dressed before drying. This problem is very much associated with the small fish, which are sun-dried by spreading on the mat or sand without washing, sorting or dressing.
- Traditional processors do not have knowledge on public health and sanitation. Dried fish may carry pathogen, dust and dirt. Therefore, fish is spoiled during the process and the product is contaminated.
- Ashes are adhered with shidhil during fermentation process and storage, while packaging is not appropriate, which lead to unhygienic product.
- During storage, earthen pot is not properly cleaned or washed, that contains dirt and ash adhered.

Conclusion

Shidhil has a very special type of characteristic flavor and used to eat as condiment with fish curry or as vorta. It has an unique magic power to attract the consumers. Such attraction is never observed in any other traditional food-stuffs. Shidhil production is reducing day by day due to several factors.

Seaweed and SDGs: Bangladesh perspective

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If someone asks me what is the greatest achievement of Bangladesh last decade? My answer will be "winning sea border dispute with Myanmar and India". We have achieved almost another Bangladesh (118,813 sq.km) in terms of area by this winning and it opens a new door exploring numerous resources such as different types of mines, renewable food items (fish, shellfish, seaweed, etc.) and what not. To explore this resources government of Bangladesh is now focusing on Blue Economy for sustainable development. Bangladesh amongst the coastal countries has targeted the preparatory process leading up to the first International Workshop on Blue Economy in Sep 1-2, 2014 in Dhaka. During the workshop honorable Prime Minister emphasized that Blue Economy could play an important role in the economic upliftment of the country in the context of poverty alleviation, ensuring food and nutrition security, combating climate change impacts. Underlining Blue Economy as a window of opportunity for development, the Prime Minister expressed her resolve to turn the Bay of Bengal to a hub of economic development and prosperity; and observed that marine resources and services could significantly contribute to development of potential sectors like pharmaceuticals and agro-based industry and could also enhance foreign trade and foreign exchange.

Actually "Blue Economy" is a widely used term meaning the overall economic contribution of the oceans and coasts to the national economy and the need to address the sustainability of these natural resources. It includes all things like fish, shellfish, seaweed, algae other vertebrates and invertebrates found in sea. It is now a buzz issue in the world because for attaining sustainable development. The Bay of Bengal is hotspot of biodiversity. As of now 442 species of fish, 19 species of shrimp, 336 species of mollusks and 193 species of seaweed are found in Bay of Bengal. Though marine food items are enriched in nutrients and minerals but it is yet not popular in Bangladesh. People of China, South Korea, Japan and other Asian countries are using seafood as their staple food item due to its high quality of nutrition and other beneficial substances. Bangladesh should explore its marine resources properly because it is one of the most overcrowded country in the world. Ensuring food and nutritional security is a big challenge for Bangladesh. Each and every year we loses cultivable agricultural land. In this regard, searching alternative renewable food source is of prime importance. Therefore, exploring of marine food materials would be the most important options to ensure the food and nutritional security as well as for the fulfillment of Sustainable Development Goals (SDGs) for large number people

Let's see how seaweed helps us to achieve SDGs.

in Bangladesh. Among the marine food resources, seaweeds have recently been attracted as valuable food in many parts of the world including Asia, Africa and western part of the globes. As I have mentioned 193 seaweeds are identified in which 19 seaweeds are commercially important. Seaweed is considered as super food for its nutritional quality. It contains proteins, vitamins minerals, bioactive compounds, antioxidants, trace elements and so on. Seaweed may be used as a good source of food that also reduce the pressure on rice and wheat and indirectly on land. Bangladesh has already met several targets of the MDGs like reducing poverty gap ratio, attaining gender parity at primary and secondary education, under-five mortality rate reduction, containing HIV infection with access to antiretroviral drugs, children under five sleeping under insecticide treated bed nets, detection and cure rate of tuberculosis under directly observed treatment short course and others. Now government's dire need is to achieve SDGs. Actually the Sustainable Development Goals (SDGs), officially known as Transforming our world: the 2030 Agenda for Sustainable Development is a set of 17 "Global Goals" that must be achieved considering the rights of the human being to a healthy and productive environment. Ultimately a better world for living. Surprisingly 6 of those goals can be achieved by proper utilization of seaweed.

Goal 2 and Seaweeds: Food security and improved nutrition are the major concerning issues of zero hunger. As Bangladesh is now struggling in food production stability for decreasing land and increasing population. So, we could use seaweed as an important tool against hunger as seaweed is the limitless source of food and considered as the Super food and capsule of nutrients as well.

Goal 3 and Seaweeds: Seaweed contains lots of bioactive compounds (phenolic and non-phenolic compound, carotenoid, glycoprotein etc., minerals, anti-oxidants, PUFA, HUFA and so on. Seaweed also has antioxidant, antiflammatory, anti-Alzheimer's activity. In recent years it has been used for medicinal ingredients for diabetes, cancer and hypertension.

Goal 6 and Seaweeds: Seaweed has large affinity for nutrients; this allows the seaweed to be used purposely to remove undesired nutrients from water. Nutrients such as ammonia, ammonium nitrate, nitrite, phosphate, iron, copper, as well as CO_2 are rapidly consumed by growing seaweed. Reefs and lakes are naturally filtered this way. Seaweed is a perfect bio purifier.

Goal 7 and Seaweeds: Many biofuels are produced from food crops, such as corn and sugar, which drives up global prices in a world where a billion people are already hungry. Biofuel production also consumes increasingly scarce freshwater and the worst examples - those from palm oil - can produce more carbon dioxide than diesel. So that's why many millions of pounds are being invested in seaweed research from Vietnam to Israel to Chile because producing biofuels in the sea removes at a stroke many of the serious problems with conventional biofuels. The Scottish Association for Marine Science (Sams), with parallel projects in Ireland and Norway, has already produced biofuels which is cost effective, affordable as well as environmental-friendly. So, in Bangladesh we can give concern production of biofuel from seaweed.

Goal 13 and Seaweeds: High level of CO_2 emission and consequently global warming are the main challenge of climate action now at this moment. Bangladesh is much more prone at the result of climate change. In this aspect seaweed can be the best solution as its CO_2 absorption capacity is two times higher than terrestrial plants.

Goal 14 and Seaweeds: The oceans cover 71% of the earth surface. The world's ocean is essential for all life on earth making earth livable.

Over 3 billion people depend on marine life as their livelihood and oceans absorb 30% of all carbon dioxide produced by human. Seaweed is one of the most important life below water.

Apart from this, recently a research report on seaweed identifying hydrocolloids and bio functional activity with chemical compositional analysis has been found. However, huge research in seaweed is of paramount importance to explore this resources for human food, hydrocolloids, pharmaceutical application, bioactive compound, fish and animal feed, growth elicitor for plants etc. Some organizations in Bangladesh like Bangladesh Fisheries Research Institution (BFRI), Bangladesh Agricultural Research Council (BARC), Chittagong Veterinary and Animal Sciences University (CVASU), Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Chittagong University (CU) are doing some research to explore seaweed resources. BFRI, CU and BARC has developed the culture technique of seaweed. BFRI is trying to develop a herbarium and exploring compositional analysis of different seaweed. BSMRAU has developed the low cost technology for extracting carrageenan from *Hypnea* sp. (Seaweed) and found 48% yield which is comparatively much higher than the other country's *Hypnea* sp. Not only this but also BSMRAU trying to find out alternative utilization of seaweed as fish feed supplement and growth elicitor for rice. Results of this research so far have indicated higher growth and immunized Tilapia.

It's pretty clear that seaweed is one of the best option for achieving significant no of SDGs. However marine resources of Bangladesh is yet to be explored and very few research have been conducted on it. Though many organizations and institutions are working on this but more research work should be done in comprehensively. So all the entity working on seaweed should come together under the single umbrella for greater betterment. If Bangladesh can explore its marine resources properly where seaweed is one of the leading part it will be able to achieve these 6 SDGs that ultimately will hit its economy. Now question is that is Bangladesh ready for doing this?

Ready to Cook Fish: A Best Choice of Modern Consumers

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Bangladesh is a land of delta where fisheries resources are the opportunity thus leads economic growth. According to the World Health Organization, Bangladesh belong 4th position in the world by producing fishes. In 2015-16, Bangladesh produces 3.6 million metric tons fishes. Almost all of the fishes are purchased as a whole and processed it at home or unhealthy place of market. Our consumers have purchase fishes from market either in frozen, dead or alive condition and process it at normal temperature without maintaining safety and quality system. Fish is a highly perishable food items and in tropical country spoilage activity is faster than cold country. Most of the time our consumers does not have good quality fishes in their dinning due to post purchase mishandling and wrong processing. Consumers are wasting their valuable time only to prepare fishes for cooking.

Lives of Bangladeshi people are too fast and expensive than previous. Female are successfully performing their duties in their working arena along side of male to earn more money for uplifting livelihood. At the same time, new couples are losing interest towards combined family system. They want to live with single family. House assistances (maid) are not available. Traffic jam is another issue that has cut minimum 2/3 hours per day from people lives. All these factors are significantly affecting human food habit and have been reducing purchase of un-dressed (whole) fish. Most of the parents have avoided fishes as food for their children due to presence of bones. Even children's become fear to eat fish. So, they are depending on chicken and meat. As a results, obesity, anxiety, bone problems, dull brain child, heart disease, high cholesterol are common problems in our society.

Sea fish is a food that contains all the essential minerals (including iodine, calcium, etc.), fatty acid (including Omega-3 & Omega-6), vitamins, protein, iodine, micronutrients, etc. According to the USDA-Dietary Guidelines for Americans-2011, every people should eat 230 gms variety of sea fish meat/week and pregnant women/breast feeding mother should eat 230-300 gms variety of sea fish meat/week to get significant amount (250 mg) of EPA (Eicosa Pentaenoic acid) and DHA (Docosa Hexaenoic Acid) that helps to develop brain of a child and reduce risk of heart diseases.

Considering all the aspects, ASAP Healthy Food Ltd. and Deep Sea Fishers Ltd. have started to produce Ready to Cook sea fish products as a social commitment of their business. They have been doing their processing by fresh caught fishes at onboard into deep sea using their own fishing trawlers. They have developed four formed of fisheries ready to cook products like Steak, Fillet, Cleaned Head On, Cleaned Head Less and selling it as BEST CHOICE brand. They have made frozen block by potable water for the ready to cook fishes using quick freezing system where product core temperature meet international standard. Frozen block help to protect rancidity, denaturation of proteins, enzymes & minerals and also keep the taste remain same as fresh caught.

Year round availability of different species as well as different value added forms will lead to fulfill the needs and wants of today's consumers. Value added ready to cook fishes will help to bring back the consumers for eating fishes. It will help consumers to save time and money. Consumers will buy the fishes, bring home, defrosting it and finally cook it using his/her own recipe or can visit www.asapfood-bd.com to have delicious recipe. During defrosting period he/she can be refreshed, spent time with children, assist them to prepare school home work, etc. Consumers can easily make school Tiffin for their children afternoon snacks or snacks for entertaining gust using "Ready to Eat" "BEST CHOICE" products that helps to keep all the family members in good health.

Usually "A" grade quality 'ready to cook' product is prepared by fresh caught/harvested fishes. For this, fish processing, packaging and storing activities have done in fishing vessel at Deep Sea. 'Ready to cook' fish products does not contain viscera (intestine), scale, gills and blood. Bacteria are the most important cause of seafood spoilage. Millions of bacteria are present in the surface slime, on the gills, and in the gut of living seafood species. When seafood species die, bacteria, or the enzymes they produce, invade the flesh through the gills, along blood vessels, and directly through the skin and belly cavity lining. If food poisoning bacteria are present, they can multiply and cause illness when the seafood is eaten. To prepare the best quality and safe 'Ready to Cook' products, processing activities starts in the Deep Sea immediate after catching of fishes. Since 'Ready to cook' fish is prepared by fresh fish, it taste and nutritional value remain same and shelf life of the products is increase up to two years.

Swimming Crabs: Prospects for Mariculture in Bangladesh Coast

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Swimming crabs are belong to the Portunidae family, which also includes other large, edible crabs like mud crabs. These crabs can usually be recognized by their flat, disc shaped hind legs, used as paddles for swimming and by the nine spikes, called horns, along their carapace, either side of their eyes. Swimming crabs vary in color from brown through blue to purple with pale mottling. They live in a wide range of inshore and continental shelf areas, including sandy, muddy or algal and sea grass habitats from the intertidal zone to at least 50 meters in depth. They move to deeper water as they age and in response to changes in water temperature and inshore salinity.

Swimming crabs are costly and high demand in the international market for its sweet meat and high quality food value. The high price and increased demands resulted over-exploitation of blue swimming crabs from seas. In Bangladesh 2011, total landings for swimming crabs was increased from 75 m. tons to about 130 m. tons during 2011 to 2017. Most of the swimming crabs from Bangladesh goes to markets of China

In the Bay of Bengal, Bangladesh coast, mainly three crab species (mud crabs, *Scylla* spp.; three spot swimming crabs, *Portunus sanguinolentus* and blue swimming crabs, *Portunus pelagicus* are abundant. Another swimming crab know as coral crab, Charybdis feriatus is also available in our coast. Among them mud crabs are cultured/fattened in coastal areas of Bangladesh and they now used in soft-shell crab culture practices. Among the total landed marine crabs more than 80% are blue swimming crab.

Swimming crabs occur mostly during March to August months in Bangladesh coast and mainly harvested as by-catch in the Elephant point areas. They are harvested with the jew or croaker fish catch nets and some are fished incidentally by trawl fishing and marine set bag net also.

Due to their fast growth rates to market size, the mariculture interest of swimming crab is growing in many countries. The blue swimming crab, *P. pelagicus* is becoming a commercially important species in many Asia countries. The expanding export market for crabs has led to intensified collection and has threatened the wild stocks. This threat has prompted the need for proper management of the resources, and interest in the establishment of hatchery facilities to produce crablets for aquaculture.

Threatened fishes and other aquatic animals of the Bay of Bengal

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The Bay of Bengal (BoB) is the north-eastern extended part of the Indian Ocean, lies north of 6°N latitude and west of about 95°E longitude, the Andaman Sea and Andaman Islands excluded. BoB, is being located in the tropics, indicates that the bay is low in productivity, but rich in biodiversity. The bay is blessed with a wide range of biodiversity, such as fishes, shrimps, molluscs, crabs, mammals, seaweeds, etc. Reduced water flow in the Ganges rivers basin has resulted in depleted biodiversity in river mouths, estuaries sand in the Bay of Bengal. Indeed, there may be nowhere in the world where effects of climate change and other natural/anthropogenic activities on fish biodiversity are more apparent than in Bangladesh.

According to IUCN Red List, we found a total of 57 marine animals - 15 bony fish (mainly grouper, tuna and seahorse), 34 cartilaginous fish (sharks, rays, guitarfish and sawfish), 5 reptiles (turtle) and 3 mammals (dolphin and porpoise) inhabiting Bay of Bengal are under different threatened categories (Tables 1). Among the bony fishes, three are data deficient (DD), one is near threatened (NT), eight are vulnerable (VU) and three are endangered (EN). Among the sharks and rays, nineteen are vulnerable (VU), nine are endangered (EN) and six are critically endangered (CR). Three vulnerable (VU), one endangered (EN) and one critically endangered (CR) turtles are found in the Bay of Bengal along with two vulnerable (VU) and one endangered (EN) mammals.

ETP (Endangered, Threatened & Protected) species of Bay of Bengal, Bangladesh

The distribution of ETP species in the Bay of Bengal is reasonably well known. ETP species likely to interact with fisheries in the Bay of Bengal are listed in Table 1 which has been populated based on vulnerability assessed by IUCN Red List and the range of the species.

A risk assessment in the Bay of Bengal indicates that sharks are the highest risk group in purse seines. Sharks and rays are by nature slow growing, low fecundity species and thus are particularly vulnerable to over-exploitation. The Bay of Bengal is rich in cetacean diversity and abundance with over 30 species of whales, dolphins and porpoises throughout the region. Accidental entangling in gill and mesh nets or traps set by fishers is considered a major, but largely unquantified, cause of dolphins mortality.

Six, out of the seven species of marine turtle in the world, are found in the Bay of Bengal: green, hawksbill, flatback, leatherback, loggerhead and olive Ridley turtles. All species are known to nest on the beaches of one or more of the Bay of Bengal countries. The principle threat to turtles is shore based due to illegal poaching and egg harvesting, but they are also incidentally caught in fishing activities notably by demersal trawling, but also gill netting.
Management

There are a number of specific management actions taken by countries throughout the BOB area to protect ETP species. The International Plan of Action for the Conservation and Management of Sharks (IPOA Sharks), developed by FAO's Technical Working Group on the Conservation and Management of Sharks in 1999, is a voluntary agreement to promote the conservation and sustainable management of sharks and their long-term sustainable use. As a result of this National Plans of Action for the Conservation of Sharks (NPOA-Sharks) are being developed on a country basis.

All species of marine turtles are protected from domestic consumption and trade by national laws and from international trade through being a party to CITES. In addition there are a number of country specific measures in place to protect turtles, for example Bangladesh, Myanmar has closed areas in inshore locations specifically to protect turtles when they are returning to breed. Bangladesh also implementing Turtle Exclusion Device enforcement.

Table 1. Common English name, scientific name and IUCN Red List status (ver. 3.1) of the threatened animals of the Bay of Bengal with the reference

	Common English name	Scientific name	IUCN RedList Status	Reference
		Bony Fish		
1	Humphead Wrasse	*Cheilinus undulatus*	Endangered A2bd+3bd	Russell 2004
2	Redmouth Grouper	*Aethaloperca rogaa*	Data Deficient	Heemstra et al. 2008a
3	Cloudy Grouper	*Epinephelus erythrurus*	Data Deficient	Heemstra et al. 2008b
4	Barred-chest Grouper	*Epinephelus faveatus*	Data Deficient	Russell et al. 2008
5	Giant Grouper	*Epinephelus lanceolatus*	Vulnerable A2d	Shuk Man & Ng Wai 2006
6	Dusky Grouper	*Epinephelus marginatus*	Endangered A2d	Cornish & Harmelin-Vivien 2004
7	Humpback Grouper	*Cromileptes altivelis*	Vulnerable A4cd	Sadovy et al. 2008
8	Squaretail Coral Grouper	*Plectropomus areolatus*	Vulnerable A4d	Thierry et al. 2008
9	Ocean Sunfish	*Mola mola*	Vulnerable A4bd	Liu et al. 2015
10	Bigeye Tuna	*Thunnu sobesus*	Vulnerable A2bd	Collette et al. 2011
11	Queen Triggerfish	*Balistes vetula*	Near Threatened	Liu et al. 2016
12	Madagascar Kob, Southern Meagre	*Argyrosomus hololepidotus*	Endangered B1ab(ii,iii,v)+2ab(ii,iii,v)	Heemstra 2007
13	Brick Seamoth	*Pegasus laternarius*	Vulnerable A2cd	Vincent 1996
14	Spotted Seahorse	*Hippocampus kuda*	Vulnerable A2cd+3cd+4cd	Aylesworth 2014
15	Three-spot Seahorse	*Hippocampus trimaculatus*	Vulnerable A2bcd+4bcd	Wiswedel 2015
		Cartilaginous Fish		
16	Narrow Sawfish	*Anoxypristis cuspidata*	Endangered A2cd	D'Anastasi et al. 2013
17	Smalltooth Sawfish	*Pristis pectinata*	Critically Endangered A2cd	Carlson et al. 2013
18	Largetooth Sawfish	*Pristis pristis*	Critically Endangered A2cd	Kyne et al. 2013
19	Green Sawfish	*Pristis zijsron*	Critically Endangered A2cd	Simpfendorfer 2013
20	Tawny Nurse Shark	*Nebrius ferrugineus*	Vulnerable A2abcd+3cd+4abcd	Pillans 2003
21	Zebra Shark	*Stegostoma fasciatum*	Endangered A2bd+3bd	Dudgeon et al. 2017
22	Common Thresher Shark	*Alopias vulpinus*	Vulnerable A2bd+3bd+4bd	Goldman et al. 2009
23	Silky Shark	*Carcharhinus falciformis*	Vulnerable A2bd	Rigby et al. 2017
24	Pondicherry Shark	*Carcharhinus hemiodon*	Critically Endangered A2acd; C2a(i)	Compagno et al. 2003
25	Oceanic Whitetip Shark	*Carcharhinus longimanus*	Vulnerable A2ad+3d+4ad	Baum et al. 2015
26	Sand Tiger Shark	*Carcharias taurus*	Vulnerable A2ab+3d	Pollard & Smith 2009
27	Sharptooth Lemon Shark, Sicklefin Lemon Shark	*Negaprion acutidens*	Vulnerable A2abcd+3bcd+4abcd	Pillans 2003
28	Whale Shark	*Rhincodon typus*	Endangered A2bd+4bd	Pierce & Norman 2016
29	Scalloped Hammerhead	*Sphyrna lewini*	Endangered A2bd+4bd	Baum et al. 2009
30	Great Hammerhead	*Sphyrna mokarran*	Endangered A2bd+4bd	Denham et al. 2007
31	Smalleye Hammerhead	*Sphyrna tudes*	Vulnerable A2ad+3d+4ad	Mycock et al. 2006
32	Winghead Shark	*Eusphyra blochii*	Endangered A2d+3d	Smart & Simpfendorfer 2016
33	Ganges Shark	*Glyphis gangeticus*	Critically Endangered A2cde; C2b	Compagno 2007
34	Irrawaddy River Shark	*Glyphis siamensis*	Critically Endangered B1ab(iii,v)	Barnett et al. 2009
35	Shortfin Mako	*Isurus oxyrinchus*	Vulnerable A2abd+3bd+4abd	Cailliet et al. 2009
36	Broadfin Shark	*Lamiopsis temminckii*	Endangered A2d+3d	White et al. 2009
37	Longhead Eagle Ray	*Aetobatus flagellum*	Endangered A2d+3d+4d	White 2006
38	Mottled Eagle Ray	*Aetomylaeus maculatus*	Endangered A2d+3d+4d	White 2006
39	Banded Eagle Ray	*Aetomylaeus nichofii*	Vulnerable A2bd	Kyne et al. 2016
40	Giant Devil Ray	*Mobula mobular*	Endangered A2d	Notarbartolo di Sciara et al. 2015
41	Porcupine Ray	*Urogymnus asperrimus*	Vulnerable A2bd	Chin & Compagno 2016
42	Blotched Fantail Ray	*Taeniurops meyeni*	Vulnerable A2d	Kyne & White 2015
43	Zonetail Butterfly Ray	*Gymnura zonura*	Vulnerable A2d+3d+4d	White 2006
44	Javanese Cownose Ray	*Rhinoptera javanica*	Vulnerable A2d+3cd+4cd	Dudley et al. 2006
45	Honeycomb Stingray, Reticulate Whipray	*Himantura uarnak*	Vulnerable A2bd	Manjaji et al. 2016
46	Bowmouth Guitarfish	*Rhina ancylostoma*	Vulnerable A2bd+3bd+4bd	McAuley et al. 2016
47	Widenose Guitarfish	*Glaucostegus obtusus*	Vulnerable A2bd+3d+4d	Compagno & Marshall 2016
48	Common Shovelnose Ray	*Rhinobatos typus*	Vulnerable A2bd+3bd+4bd	White et al. 2016
49	Giant Guitarfish, Bottlenose Wedgefish	*Rhynchobatus australiae*	Vulnerable A2bd+3bd+4bd	White & McAuley 2003

Reptiles				
50	Hawksbill Turtle	*Eretmochelys imbricata*	Critically Endangered A2bd	Mortimer & Donnelly 2008
51	Loggerhead Turtle	*Caretta caretta*	Vulnerable A2b	Casale & Tucker 2017
52	Green Turtle	*Chelonia mydas*	Endangered A2bd	Seminoff 2004
53	Olive Ridley	*Lepidochelys olivacea*	Vulnerable A2bd	Abreu-Grobois & Plotkin 2008
54	Leatherback	*Dermochelys coriacea*	Vulnerable A2bd	Wallace et al. 2013
Marine mammals				
55	Finless Porpoise	*Neophocaena phocaenoides*	Vulnerable A2cde+3cde+4cde	Wang & Reeves 2017
56	Irrawaddy Dolphin	*Orcaella brevirostris*	Endangered A2cd+3cd+4cd	Minton et al. 2017
57	Indo-pacific Hump-Backed Dolphin	*Sousa chinensis*	Vulnerable A3cd+4cd	Jefferson et al. 2017

In the IUCN Fish Red List of Bangladesh, 2015, only inland fishes along with a few coastal fish were assessed for their biodiversity status. Almost all the marine fish both bony and cartilaginous fish, reptiles and mammals were not assessed. We used the IUCN global red list and found that 57 of the aquatic animals from the Bay of Bengal are under different threat categories with the hope that in future red list assessment of Bangladesh these important animals will be included and based on their present global threat categories, appropriate management measures will be taken to conserve their biodiversity like - regulating fishing intensity at sustainable level, controlling gear selectivity, gear type and size of fish, spatial and temporal ban on fishing, prohibition of destructive fishing, and allocation of resources to different types of fisheries.

Role of Bacterial Biofilms as oral vaccine vehicle in aquaculture

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Aquaculture is a steadily growing industry world over. The number species and new technologies are increasing in aquaculture industry for rising production. Intensification has come up as a boon to meet the increasing food demand. However, diseases are stumbling block, causing huge economic loss in millions each year world over. To control bacterial and parasitic diseases, antibiotics and drugs were used indiscriminately. Antibiotic has already raised lots of criticism over its negative impact on living biota may lead to antibiotic-resistant pathogen. In this prospect, vaccinations against the bacterial and viral diseases play a vital role in finfish and shellfish aquafarming.

Importance of oral vaccines in aquaculture

Depending on the age and size of the fish, commercial vaccines are administered either orally (by mixing with the feed), by immersion (dip or bath) or by injection through the intraperitoneal (i.p.) or intramuscular (i.m.) route. Vaccine by injection route although very effective in terms of immune response and long term protection but it has some side effects including tissue inflammation, adhesion and necrosis. On the other immersion vaccination required high production costs. Oral vaccines are an attractive alternative to reduce the stress on the fish during immunization. Due to the ease, simplicity and practical applicability oral vaccination became the choice of antigen delivery. However, attempts to orally vaccinate against different bacterial diseases have either yielded mild and short lived or inadequate responses. One of the important factors for the inconsistency and poor response to oral vaccination is the digestive degradation of antigens in the foregut, before the vaccine reaches immune-responsive areas in the hind-gut and other lymphoid organs.

Need for biofilm oral vaccines in aquaculture

To protect oral antigens from the gastric destruction several strategies were evaluated, such as encapsulated antigen microspheres, enteric coated vaccine and bioencapsulation of vaccine in live feed, these are complex, costly and impractical method. In this respect biofilm vaccines would be the best alternative way for oral route of vaccination. Biofilm cell produce adhesive exopolymeric substance, which is called glycocalyx, offer protection to antigen from gastric destruction.

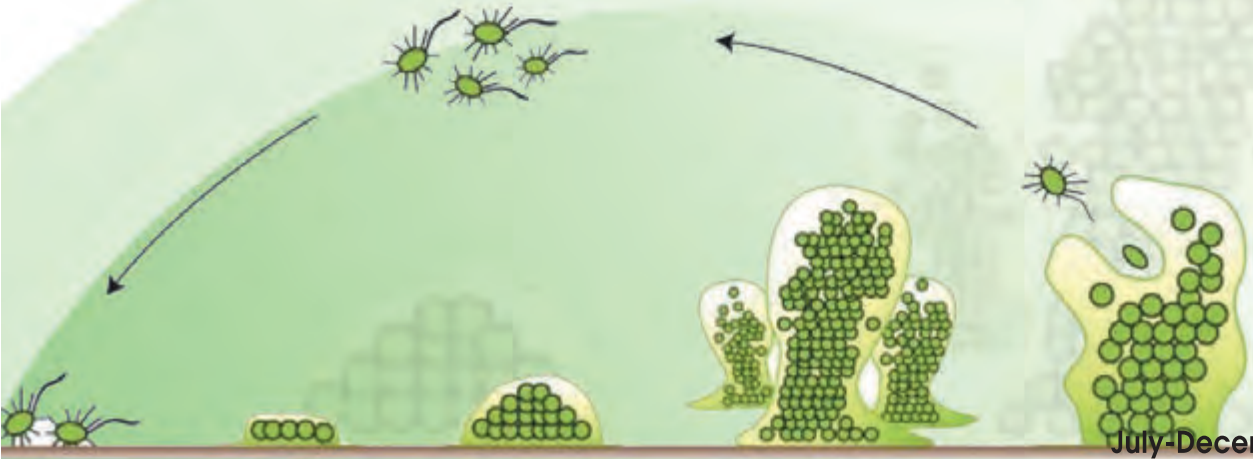
Designing of biofilm-based vaccines

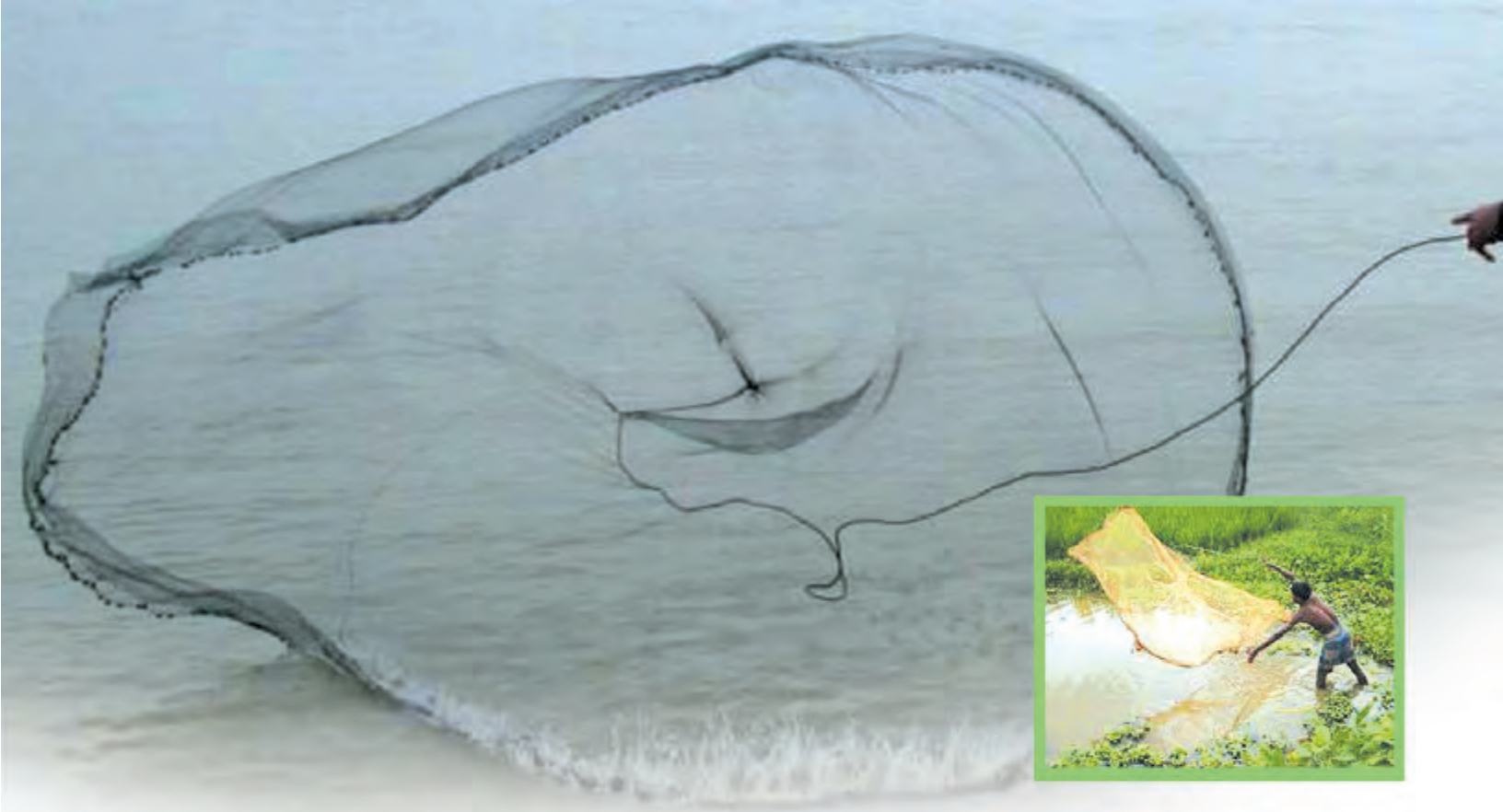
Unlike in natural environment, here in laboratory condition bacteria was forced to go into biofilm mode by providing them with minimum of media (0.225% TSB+ 0.3% Chitin flakes) and harsh environment in the form of shaking 120 strokes/min. Biofilm was produced on the chitin flakes later the supernatant was decanted and the chitin flakes were washed thrice in the same flask with sterile phosphate buffer saline (PBS, pH 7.2) to remove free cells. Biofilm cells on chitin were then heat inactivated at 100^0C for 50 min before incorporating in the feed.

Efficacy of biofilm vaccines in aquaculture

Over the 20 years, the vaccine research has been oriented towards safer and more effective vaccine preparation from a normal inactivated bacterial vaccine to the biofilm vaccine (Azad et al., 1997). Various researches conducted in the preparation of biofilm of Aeromonas hydrophila and Vibrio alginolyticus and its use as oral vaccine under the direct supervision of renowned Indian scientist and ICAR (Indian Council of Agriculture Research) Emeritus Professor Dr. K.M Shankar at the Laboratory of Aquatic Health Management, College of Fisheries, Mangalore have shown promising outcome in teleost fishes like catla, rohu, common carp, catfishes like *C. batrachus, C. striatus* and also from crustaceans tiger shrimp (*P. monodon*). The hypothesis was proposed and substantiated first by Azad et al. (1997, 1999). They promoted a virulent A. hydrophila isolate to form biofilm on chitin flakes and successfully utilized it as oral vaccine in catla, rohu and common carp. Biofilm vaccinated carps had significantly higher antibody titre and protection than free cell vaccinated fishes. Advantage of biofilm and free cell vaccines when studied by antigen localization employing monoclonal antibody based immunefluorescence, indicated that biofilm antigen compared to free cell antigen retained for longer time in larger quantities in gut and other lymphoid organs like kidney and spleen. The protective nature of glycocalx was believed to be protecting biofilm from gastric hydrolysis as free cells showed a quicker clearance from lumen of hindgut within 6h of vaccine uptake compared to biofilm, which remained for 48h following oral delivery. In addition to that, biofilm might represent a more immunogenic material as seen to have induced higher antibody and protective immunity, altogether making it as a better vaccine carrier in oral immunization regime, keeping this background biofilm of *A. hydrophila* was evaluated for oral vaccination of walking catfish (*Clarius batrachus*). Serum agglutinating antibody titre and relative percent survival (RPS) following challenge were found to be significantly higher in catfish fed with BF vaccine compared to that with free cell vaccine. Another study with C. striatus, a carnivorous fish model, fed with biofilm (BF) and free cell (FC) of A. hydrophila with the dose of 1010 cfu/fish/day and 20 duration. They observed BF vaccinated fish upon challenge had significantly higher relative per cent survival (88) than that with FC (29.6). Biofilm of V. alginolyticus to study preliminary immune response in tiger shrimp (Penaeus monodon) and the study showed that biofilm cells were superior to free cell in stimulating the non-specific immune response of Penaeus monodon.

Biofilm cells probed to be effective as oral vaccination of fin and shellfishes. It can be considered as simple, cheap and ideal oral vaccination technique for bulk administration. Production of Biofilm vaccines and its efficacy has been proven in institutional research experiments and it is expected that the biofilm vaccine will available in the market by 2019 in South Asian countries as commercial production was undertaken by the aqua drug company.





Exploration of fishing gears and crafts in the Agunmukha River, Patuakhali

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Bangladesh is very rich with extensive inland open water, coastal and marine water resources, which mainly consists of floodplains, haors, baors, beels, rivers, estuaries, coastal belt and vast sea waters. Along with potential water resources, Bangladesh is also rich in the diversity of various fish species and other important aquatic species. About 700 rivers including tributaries flow through the country constituting a waterway of total length around 22,155 km which bears a huge potential for fisheries sector. Fishing is a widespread practice for pastoral community to sustain their sources of revenue and to fulfill nutrition demand. Due to the heavy demand on freshwaters fishes, different types of illegal, restricted and small mesh size gears are placed on different rivers throughout the last decade which causes indiscriminate killing of all aquatic species.

Galachipa upazila in Patuakhali district of Bangladesh is close to the Bay of Bengal south-west part and its center lies in between 21°48' and 22°21'N latitudes and in between 90°15' and 90°37'E longitudes. Agunmukha River is one of the vital river of Galachipa upazila as an important fisheries resource. The river is situated at the side of Panpatty Union which is the meet-point of several rivers. There is a sluice-gate of 15 doors at Panpatty border makes it very special place in rainy season and it is known as "Beauty with Danger".

Due to its remote geographical location, the available fishing gears, fishing crafts, catch composition of gears, fish diversity, occurrence and conservation of fish in the Agunmukha river are still unexplored. Considering all the current issues, the attempt was worth to identify fishing gears including their mesh size, market price, catch composition, fishing crafts and the fisheries diversity in the Agunmukha river of Patuakhali district, Bangladesh.

Fishing gears

Generally fishing gears are those equipments which mainly used for capturing of aquatic organisms especially fishes. Different types of fishing gears including their mesh size, shape, price, major species caught and average catch composition recorded from Agunmukha River are presented in Table 1 and Figure 2. From the survey, total nineteen (19) different types of fishing gears were listed under 9 major groups described

Fig. 1. (A) Position in the map of Bangladesh, (B) geographical position of Agunmukha River, (C) a representative part of Agunmukha River

as Gill/ Drift nets (Poa jal, Current jal, Ilish/ Chandi jal, Pocket jal and Sutar jal), Seine net (Jagat ber jal), Fixed purse nets (Behundi jal and Badha jal), Cast nets (Jhaki jal and Bachari jal), Lift nets/Dip nets (Dharma jal), Drag/ Push nets (Moia jal and Thela jal), Traps (Pangus Chai and Anta), Hook and line (Chhara Barshi, Chingri Barshi, Cast Barshi) and Wounding gears (Koach).

Among the different 9 groups of fishing gear, Drift/Gill net, Seine net and Fixed purse net were larger in size, mesh size, higher price and catch composition than other gear identified in the studyh area. Mesh size of the gears fluctuated depending on target fish species. But a ready to use fishing gear price varied depending on size of the net, water body, season and the personnel engaged to operate the gear. The maximum size and price of Current net and Ilish net was correlated with the maximum catch composition (20 kg/day). The result suggested that Gill net/ Drift net, Seine net and Purse net considered as commercial fishing and Cast net, Lift net, Drag/ Push net, fish trap and Wounding gear considered as economic/subsistence fishing gear.

Maximum (10 cm) and minimum (0.5 cm) mesh size was found in case of Ilish jal and Moia jal under the group of gill/drift net and drag/push net, respectively.

The highest price was for Current jal (447.43-1022.7 $) followed by Ilish jal (447.43 $) and the lowest price were for Koach (1.92 $).

The highest catch composition was found for both Current jal and Ilish jal was 20 kg/day. The catch composition of Sutar jal, Pocket jal, Poa jal, Jagat ber jal, Badha jal and Behundi jal was 15 kg/day, 13 kg/day, 12 kg/ day, 12 kg/ day, 10 kg/day and 5 kg/ day, respectively which was lower value than gillnet/drift net and higher value than any other gear used in the Agunmukha River. The lower catch composition was observed for Moia jal and Pangus chai (3 kg/day), Bachari jal and Dharma jal (2 kg/day), Jhaki jal, Thela jal, Chhara Barshi, Cast Barshi and Koach (1 kg/day for each) and Chingri Barshi (0.5 kg/day). The result revealed the lower catch composition influenced lower uses of those respective fishing gear by the fishermen (Figure 3). On the other hand, maximum uses of Gill net/ Drift net (Current jal and Ilish jal) were correlated with the maximum catch composition of net. Most of the fishermen exploited fish by Ilish jal and Current jal due to the availability of Ilish fish all the year round as well as highest catch composition.

Fig. 2. Representative figures of fishing gears (A. Jhaki jal, B. Sutar jal, C. Current jal and D. Pangus chai) found in the Agunmukha River.

Table 1. llustration of fishing gears with their mesh size, shape, price, major species caught and average catch composition recorded from the Agunmukha river

Gear types	Local name	Mesh size (cm)	Shape of net	Price of net ($)	Major species caught	CC/day/ Gear (Kg)
Gill/Drift nets	Poa jal	3-5	RS	127.84	*Otolithoides pama*, *Setipinna phasa*, *Thryssa purava*, *Labeo bata*	12
	Current jal	6	RS	447.43-1022.7	*Tenualosa ilisha*, *Glossogobius giuris*, *Pangasius pangasius*, *Sperata aor*, *Otolithoides pama*, *Thryssa purava*, *Ompok pabda*, *Labeo rohita*, *Osteobrama cotio*	20
	Ilish/ Chandi jal	10	RS	447.43	*Tenualosa ilisha*, *Otolithoides pama*, *Setipinna phasa*	20
	Pocket jal	7.5	RS	255.67-767.02	*Tenualosa ilisha*, *Otolithoides pama*	13
	Sutar jal	6	RS	++	*Tenualosa ilisha*, *Otolithoides pama*	15
Seine net	Jagat ber jal	0.5-1	RS	255.67	*Chitala chitala*, *Lates calcarifer*, *Glossogobius giuris*, *Silonia silondia*, *Colisa fasciata*, *Gudusia chapra*, *Taenioides cirratus*, *Macrobrachium* sp., *Puntius* sp., *Xenentodon cancila*	12
Fixed purse nets	Behundi jal	0.5-1	CS	102.27-319.59	*Otolithoides pama*, *Labeo bata*, *Anabas testudineus*, *Lates calcarifer*, *Pseudapocryptes elongatus*, *Macrobrachium* sp., *Salmostoma bacaila*, *Gudusia chapra*	5
	Badha jal	0.5-1	RS	127.84-319.59	*Macrobrachium* sp., *Mystus* sp., *Nandus nandus*	10
Cast nets	Jhaki jal	0.5-1	CS	38.35-51.13	*Anabas testudineus*, *Sperata aor*, *Mystus vittatus*, *Puntius* sp., *Macrobrachium* sp.,	1
	Bachari jal	2.5	CS	25.57-51.13	*Macrobrachium* sp., *Scylla serrata*, *Chitala chitala*	2
Lift nets/ Dip nets	Dharma jal	0.5-1	SS	15.34-25.57	*Macrobrachium* sp., *Glossogobius giuris*, *Puntius* sp., *Mastacembelus armatus*	2
Drag/ push nets	Moia jal	0.5	RS	12.78	*Macrobrachium* sp., *Taenioides cirratus*, *Puntius* sp., *Gudusia*, *chapra, Pseudapocryptes elongates*,	3
	Thela jal	0.5-1	TS	6.39	*Macrobrachium* sp., *Colisa fasciata*, *Chanda nama*	1
Traps	Pangus chai	MO: 20 cm	DS	6.39	*Pangasius pangasius*, *Monopterus cuchia*	3
	Anta	MO: 2.5 cm	RS	3.84	*Anabas testudineus*, *Otolithoides pama*, *Puntius* sp.	1
Hook and line	Chhara Barshi	-	-	2.56-6.39	*Otolithoides pama*, *Channa* sp., *Anabas testudineus*, *Lates calcarifer*,	1
	Chingri Barshi	-	-	2.56	*Macrobrachium* sp., *Puntius* sp.	0.5
	Cast Barshi	-	-	5.11	*Lates calcarifer*, *Chitala chitala*, *Channa* sp.	1
Wounding gears	Koach	-	-	1.92	*Macrobrachium* sp., *Channa* sp.	1

Jal = Fishing Net, MO = Mouth Opening, RS = Rectangular Shape, SS = Square Shape, CS = Conical Shape, DS = Drum-Shape, TS = Triangular shaped, + + = Government Approved, CC = Catch

Composition

On the basis of use, Ilish jal was the highest used by the fishermen constituting 17.86% followed by Current jal 13.39%. The result revealed that gillnets/driftnet was the most dominant use by the fishermen in the study area. The fishermen in the area of Agunmukha River were also used Jagat ber jal, Poa jal, Trap, Pocket jal, Sutar jal, Barshi, Bachari jal and Wounding gear at the rate of 9.82%, 8.93%, 6.25%, 6.14%, 6.14%, 3.41%, 2.68% and 1.05%, respectively. Another 4 types of gears viz., Moia jal, Behundi jal, Badha jal and Jhaki jal were similar used by the fishermen comprising 5.36% of each. The lowest used was observed for Dharma jal and Thela jal at same percentage as 1.79% (Fig. 3).

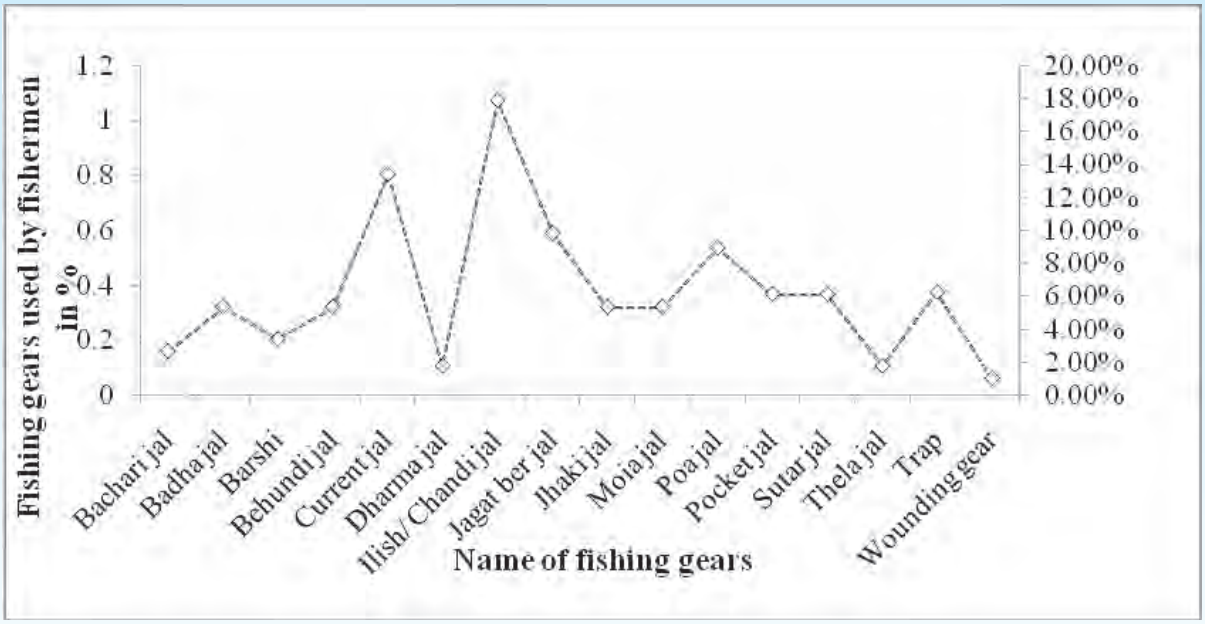

Fig. 3. Gears used by fishermen (percentage) in the Agunmukha River.

Fishing crafts

Total three types of fishing crafts were documented from the study area namely fishing trawler, Dingi nouka and Vhela (raft) listed in Table 2. Among the fishing crafts used for operating different fishing gears in the Agunmukha River, the trawler is a mechanical vessel and used for commercial purpose. The fishing trawler found has a length of 15-40m and breath 12-15m. Different native trees were used to prepare these trawlers, having durability about 5-7 years. Numerous net like gill net, seine net are operated by this crafts. Another fishing craft is Dingi nauka, a commonly used craft having smaller size hull and bottom. The bottom is curved like structure rather than flat. The deck is generally made of splinted bamboo, wooden plank or splinted betel nut trees. A large number of fishing gears like Current jal, Poa jal, Sutar jal etc. are operated by using this craft. The last one but important craft is Raft (locally called Vhela), made by banana tree or of wooden floating log, bamboo etc. It is usually 2-4m wide and about 3-8m long driven by a bamboo made log. 8-10 banana trees are used to prepare raft in which bamboo splits are used to join them together. The front portion of the craft is pointed so that it can move easily. A long bamboo pole (locally called logi) is used to operate the vessel. Jhaki jal, Line fishing are done by this fishing craft.

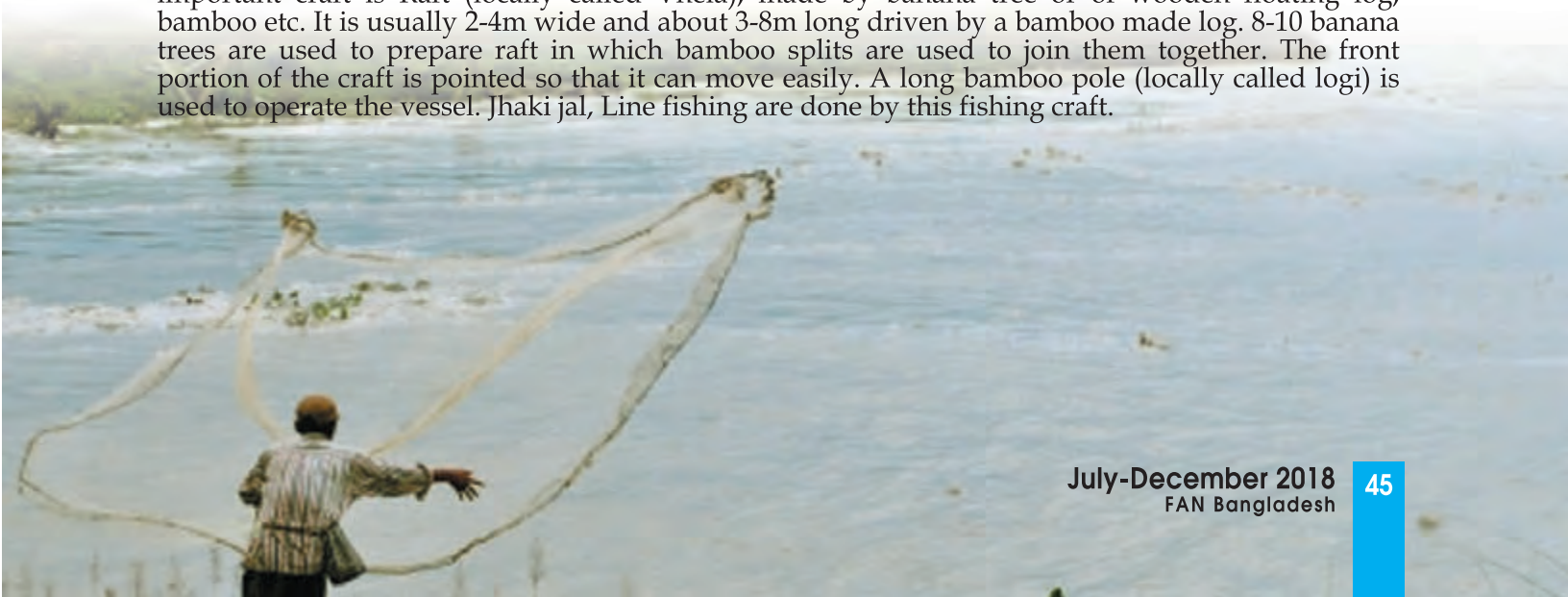

Table 2. List of fishing crafts with size, construction materials, durability and major used in the Agunmukha River

Name of the crafts	Size	Construction materials	Durability	Purpose
Trawler	Length: 15-40 m, Breath: 12-15 m.	Wood of breadfruit, crape myrtle, white teak, rock dammar, looking glass mangrove and bamboo etc. are used.	5-7 years	To handle Behundi jal, Gill net and Seine net etc.
Dingi nauka	Length: 3 to 7m, Breadth: 2 to 4m.	Mainly native tress like big leaf mahogany, rain tree, blackberry etc.	3-4 years	Jhaki jal, Moiya jal, Poa jal, Dharma jal, Pangus chai, Anta, Cast Barshi, Chai, Hooks and lines etc.
Vhela (raft)	Length: 3-5m, Breadth: 0.7-1.2m, Height: 0.2- 0.4m.	Banana trees, bamboo splits.	2-6 months	To operate Chingri barshi, Cast barshi, Koach, Long line, Trap, Jhaki jal, Dharma jal etc.

The Agunmukha River is very important fisheries resources in the southern part of Bangladesh. The river is playing a vital role for the maintaining the fisheries diversity in the southern district of Bangladesh. Among the fishing gear existed, gill net/drift net grouped Current jal and Ilish jal was most available and prominent use due to their maximum catch composition. However, different smaller mesh size and non-selected fishing gears especially Current jal, Jagat ber jal and Badha jal responsible for indiscriminate fish catch leads to destroying fishing habitat in the river. As a consequence, aquatic biodiversity of the Agunmukha River is decreasing gradually. Proper initiatives should be taken into consideration for effective fisheries diversity management of the Agumukha River in Southern district of Bangladesh.

Tilapia cage culture in haor: A new horizon for booming inland aquaculture in Bangladesh

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In Bangladesh, haors and floodplains are left mostly for capturing natural stocks of fish and remain un-utilized for aquaculture. The haors and floodplains, characterized with inundation for 5-6 months by flood water and deep narrow pit or canal in dry season, can be comfortably managed for boosting up fish production. Wise use of the potential vast haor waters by culturing fish could assist fulfilling the demand of national protein intake as in other Asian countries. Cage culture could be the most suitable aquaculture technique to optimally utilize the productivity of floodplains in monsoon and rainy season (Beverage, 1987). Average fish production in the floodplains including haors in Bangladesh is extremely low, only about 500 kg /ha, which can easily be increased to 2 to 5 MT/ha by community based operation of cage culture of fast growing popular species. Considering this backdrop, an extensive trial on monosex tilapia culture in cages was done for three years in Sutarpara haor of Karimganj under Kishoreganj district with the financial assistance of Krishi Gobeshona Foundation.

Sutarpara Haor in Sutarpara Union under Karimganj Upazila of Kishoreganj district is potentially important for seasonal catch of hoar fishery (Banglapedia, 2003). Huge number of poor fisher families living in adjacent villages earns their livelihood from this haor. Innovative community based aquaculture approach for fish production round the year based on monosex tilapia cage culture in this seasonal floodplain, followed by nursing, rearing and over-wintering of spawn, fries and fingerlings of other fast growing fish species in hapas, pens and cages to supply seed round the year increased the production multifold, improved the livelihood of the hardcore poor resource users of haor and used as a

model system to replicate in other floodplain areas for boosting up aquaculture production of the country. Adequate post-harvest handling and marketing of the harvested fish reduced post-harvest loss, shortened value-chain, increased profit and provided alternative income to fishers/fisher women for improved livelihood. The over-wintered tilapia in hapas set inside the cages made the optimal sized fingerling available for cage pond culture in neighbouring villages, thus ensured quality seed supply continually for year round aquaculture.

Approach and methods

The cage culture innovations were addressed by 3 collaborating partners: BAU Faculty of Fisheries (BAU-FF), Krishibid Fisheries Ltd. (KFL) and Organization for Rural Advancement (ORA). The Department of Fisheries (DFO of Kishoreganj and SUFO of Karimganj) were involved in facilitating technology adaptation, monitoring and evaluation, regulation, law enforcement and compliance improvement process. Local administration facilitated access to water resource, monitoring and law enforcement. A model cage culture system for floodplain, based on DoF (2010), for boosting up aquaculture production was developed through community based operation and management involving primary resource users of Ujandhanu Nadi Jolmohal (Chong Noagaon Matsayajibi Samabaya Samiti) and Raijanidai Jolmohal (Sutarpara Matsayajibi Samabaya Samiti).

Cage culture groups (CCGs) led the innovation process with facilitation from NGO, BAU-FF, KFL and DoF. Central involvement of CCG along with fishers in this innovation process facilitated wider uptake of the culture system, with initial community partners working with NGO to inform future communities about the improved fish production opportunities. This initiative placed all partners at the same level, with the aim of increasing fish production and at the same time, improving the livelihoods of poor resource users involving women, mostly coming from a disadvantaged ethnic low-caste Hindu and Muslim fisher communities of Chong Noagaon and Uttar Sutarpara of Sutarpara Union, Karimganj. Two PhD and 3 MS students conducted the field and lab research. The cages were jointly operated by the project and HH families of the target community, as one cage one HH, under cost-sharing basis. Although most of the community people were very marginally poor, they developed ownership and came under an unique production system through contribution both in terms of physical and monitory involvement. In addition to cage construction, maintenance and management including surveillance, a 20% of the cost of seed and feed were borne by the target community.

A good number of studies were conducted in nursery ponds, hapas, cages and laboratory aquaria with specific targets and statistically sound designs. Chemical and microbiological quality analyses of the fishes were done using appropriate methods. All data were statistically analyzed.

Results/Outputs

Community-based tilapia cage culture, community empowerment and motivational and up-scaling researches were conducted in Sutarpara haor of Karimganj, by the BAU Faculty of Fisheries as the lead organization. Mono-sex tilapia production in haor water cages was found to be very profitable. Nursing and over-wintering for fries and fingerlings of tilapia, common carp and Vietnamese koi, along with their cultures in cages under mono- and poly-culture were also found profitable. An innovative fry nursing and over-wintering technique was developed, where fish fries were nursed in hapas set inside the cages, due to the scarcity of ponds in the haor areas. The growth of tilapia in cages in haor waters within a growing period of 4.5 months was found to be very significant. The fish attained an average weight gain of 600 g against the FCR of 1.1 with CP feed. It was the first published record of the highest growth performance and maximum FCR so far in Bangladesh in tilapia cage culture venture.

An improved fish handling and marketing was developed for the cage-raised tilapia and other fish. To compare the shelf life and quality of tilapia raised in different ecological conditions, a new quality index method (QIM) was developed. QIM was found to be an effective functional tool to determine quality and shelf life, as well as the source of tilapia. In terms of shelf life and quality, pond raised tilapia was better compared to cage raised tilapia.

The efficiency of an essential amino acid, DL-methionine, on the growth of mono-sex tilapia in aquarium conditions was tested. The result showed that complete replacement of fish meal by DL-methionine gave significantly higher growth of fish with reduced feed cost by Tk.4 per kg. Based on the results, a new low-cost feed for tilapia for cages was developed.

Several entrepreneurs were developed from the beneficiaries on cage culture, fry nursing, hapa nursing and improved fish trading. Since tilapia farming was found to be profitable in cages in Karimganj haor, many interested entrepreneurs from Mithamoin, Austogram, Nikly and Tarakanda haor upazilas received training on cage culture from the project beneficiaries. Several private entrepreneurs set new cages in different sites of haor and now have been profitably operating tilapia cage culture independently.

A drama highlighting the benefit of cage culture innovation in haor waters and a documentary film narrating the entire cage culture ventures were prepared. The drama has been launched in air through BTV and being telecasted 4 to 5 times every day.

Benefit/Outcomes

The outputs in the project have been achieved by the direct involvement of project beneficiaries. The field researches were done using community-based approach where the beneficiaries under several cage culture groups (CCGs) of men and women worked together with the field research team of the project. So, the people were directly involved in cage construction, cage repair, fry nursing, hapa construction and setting in cages, pond preparation, feeding, nursing, over-wintering, fry transportation and trade, cage and hapa management, harvesting, handling, transportation and selling of fish. Thus, they knew the technical know-how and improved knowledge of all sort of cage culture operations including post-harvest handling and marketing. Moreover, many new enterprises were developed where the CCGs operated several fishery related business like fry nursing, fry transportation and selling, hapa nursery, cage culture, fish marketing etc. The practical knowledge on all sort of these aqua-ventures were quite clear to them now as they are now able to apply those in any new ventures to generate income or improve livelihood. They have been continuing cage culture in haor waters. Moreover, many new cage culture enterprises have been developed by this time by the secondary beneficiary groups. Primary beneficiaries trained the secondary adapters from at least 5 nearby haor upazilas of Kishoreganj. By these way they have been benefitting with cage operation and profitable fishery trade and business management.

Conclusions and Recommendations

Out of the field experiments, cage culture has been proved to be the most suitable aquaculture venture for haor waters. The new innovations have brought out tremendous changes in the attitude and activities for socio-economic upliftment of haor people in Karimganj and adjacent upazilas. Haor people do not have any aquaculture knowledge before, because of lack of aquaculture resource and facilitates like scarcity of ponds, seasonality of water bodies, remote and isolated locations, etc. Owing the cage culture as only possible aquaculture opportunity in seasonal haor waters, haor people now find it as a means of getting livelihood in lean period, boosting up fish production and receiving adequate nutrition. Most of the fishing communities lay idle all around since no fish or limited fish catch from natural harvest. Through cage culture, they have found new hopes to thrive upon with cages to run families comfortably. Benefit of cage culture has made huge sensitization in the neighboring areas and upazilas. Successful cage culture innovations have come up as a complete aquaculture package in hoar with many forward and backward linkage opportunities, viz., spawn/fry nursing and rearing, over-wintering, fry transportation and trade, fish handling, transportation and marketing, value-addition in fish, etc.

Therefore, the success of the project needs to be made available to the entire floodplain areas of the country, especially to all haor areas to bring such waters under cage culture. Policy makers and regulatory bodies should come forward to assist interested fishing communities to setup cages in haor, in terms of facilitating access to waters by leasing for short-term and/or long term basis, protecting them from vested groups and resolving conflicts of other interest groups. From now-on, no leasing of haor rivers or any water bodies should be given to any non-fisher powerful people.

Comparative shelf life assessment of haor-cage and pond reared tilapia *(Oreochromis niloticus)* applying quality index method

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Bangladesh has emerged as one of the leading nations in freshwater aquaculture production during recent years. In order to meet the soaring demand for food, there is a huge potential of tilapia farming in Bangladesh both in pond and cage. Tilapia is a world wide fish of great commercial importance and it is recognized as one of the most important aquaculture species of the 21st century. Tilapia is currently ranked second only to carps in global production. About one-third of the world's food production is lost annually as a result of microbial spoilage. Shelf life of fresh and frozen fish is very important criteria for marketing, as it allows a processor or a retailer to plan the length of time a set fish can be held, allowing control of the market. Consumers demand for high-quality, safe, and healthy foods is increasing on a global scale. Besides, in order to secure the food safety, it is important to keep the quality of fishes at a high level in each link of the whole complex chain from catch to consumer. Adding one or two days to the shelf life allows the market to get good profitability and assure repeat sales.

A quality index method (QIM) is a scaling method that establishes robust data reflecting the different quality levels of fish in a simple and well-documented way, by plotting quality score against storage time to get shelf life or defect point. The remaining shelf life can be calculated based on correlation between the QI and storage time. The QIM developed by Okeyo, 2009 for evaluating the freshness and shelf life for tilapia (O. niloticus) was applied in the present study.

Tilapia reared in ponds and in haor cages might be different in quality, shelf life and taste than those of pond reared one. Therefore, shelf life and quality of tilapia reared in haor cages and ponds should be compared. The aim of this study was to evaluate the freshness and shelf life of haor-cage and pond reared tilapia by applying QIM. In order to gain further information about the environmental effect (farming cages) on postmortem changes tilapia differences in sensory properties, proximate composition, biochemical parameters and microbial growth between haor-cage and pond reared tilapia were compared.

The quality and shelf life of cage and pond reared ice stored tilapia was assessed by using a) sensory assessment i.e. quality index method; b) biochemical parameters (pH, TVBN) and c) microbiological changes which are briefly described below:

Sensory assessment

The sensory scores increased with storage time with a strong correlation (R2 = 0.991 and 0.992) indicating the increased rejection of the fish by the panellists with time (Fig. 1).

Time dependent regression analysis: The quality index method (QIM) is based upon objective evaluation of certain attributes of raw fish using a point scoring system. The score for all attributes are added to give an overall sensory score, called quality index (QI), which increases linearly with keeping time on ice. The calculated QI evolved linearly with storage time on ice (QIcage = 1.079x - 0.213, R2 = 0.991; QIpond = 0.937x - 0.387, R2 = 0.992). The demerit points were calculated for each interval of three days storage where the index increases with the storage time. A significant increase ($p<0.05$) in the QI scores was noticed as the storage on ice progressed. The highest QI scores of all the parameters for haor-cage and pond reared tilapia fish samples exceeded the acceptability limit on day 18 and 21 days of storage and reaches to maximum QI score 18.67 and 18.83 out of 20, respectively. It was found that on day 18, the haor-cage fish samples and on day 21, the pond reared fish samples were unfit for human consumption. According to the sensory score it was recorded that the QI score of haor-cage and pond reared tilapia fish were in acceptable limit and reaches to QI score 16.50 and 16.67 out of 20 on day 15 and 18, respectively. The results of the present studies showed that O. niloticus was found in edible condition for 15 days of haor-cage and 18 days for pond fish sapmples respectively, in ice storage.

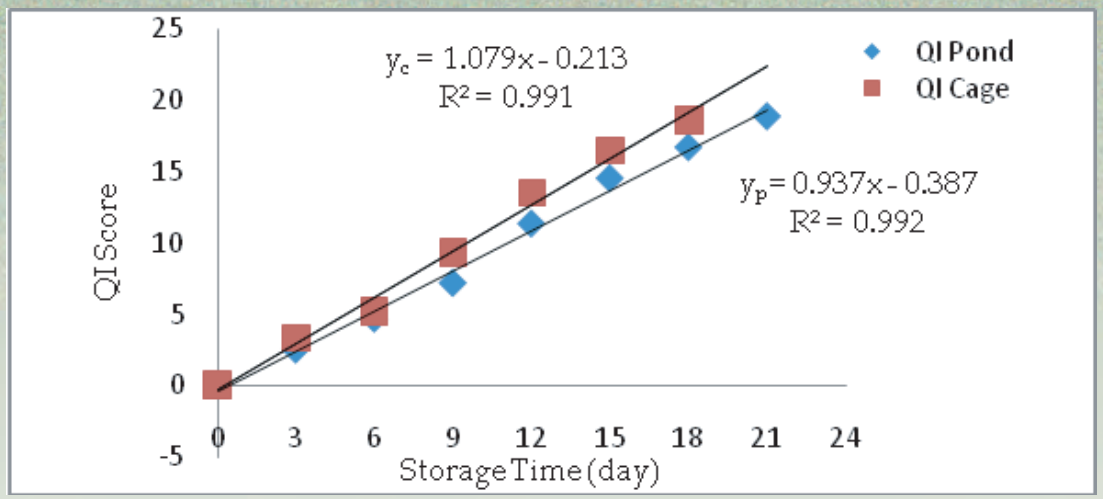

Fig. 1. Quality index (QI) score of tilapia samples caught from populations in haor-cage and pond reared against storage time on ice. Each point represents the mean of 6 fish evaluated by individual assessor.

Biochemical parameters pH: In most species, the post mortem pH is between 6.0 and 6.8. EOS (2005) stated that the maximum acceptable limit of pH value in fish and fish products would be 6.5. In the present study, the initial pH values of haor-cage and pond reared fish samples were 5.94 and 5.74 respectively. A gradual increase in pH values with storage time was recorded. The initial pH 5.94± 0.02, and 5.74 ± 0.03 in cage and pond at day zero were observed to reach 6.53±0.03 and 6.53±0.03 at the end of the storage period on day 18 and 21 respectively.

Total volatile base nitrogen (TVBN): A significant ($p<0.05$) gradual increase in TVB-N was observed throughout the storage period. The initial TVBN value of haor-cage and pond fish on day '0' was 7.35±0.07 mg/100g and 7.21±0.11 mg/100g which increased to a final value of 30.12±0.57 mg/100g and 30.31±0.95 mg/100g of haor-cage and pond fish, respectively. TVB-N value for ice-stored haor-cage and pond fish samples increased from 7.21 mg/100g and 7.35 mg/100g on day '0' to an acceptable value of 24.60 mg/100g and 24.55 mg/100g on day 15 and 18 and finally to a rejection value of 30.12±0.57 mg/100g and 30.31±0.95 at the end of 18 and 21 days of storage period, respectively.

Microbial changes: The total viable counts (TVC) of O. niloticus samples stored in ice undertaken on day 0, 3, 6, 9, 12, 15, 18 and 21. A gradual significant ($p<0.05$) increase in total viable count (TVC) was observed throughout the storage period. The initial value of total viable count of haor-cage and pond fish of 4.18 log10 CFU/g and 4.17 log10 CFU/g was gradually increased with storage period and finally reached to 7.23 log10 CFU/g and 7.16 log10CFU/g on day 18 and 21, respectively. The microbial level rose to exceed 107 CFU/g which exceeded the maximum microbiological limit for fresh fish recommended by the International Commission of Microbiological Standards for Foods (ICMSF 1986). The microbial load was in acceptable condition up to 15 and 18 days of storage of cage and pond reared fish samples respectively.

Plate: Microbiological activities for comparing the shelf life of cage and pond reared tilapia.

Canonical Discrimination Analysis: The proximate composition, biochemical parameters and microbial changes measurements on the average, among the haor-cage tilapia, are higher than the pond reared one. The canonical discriminate function is

F = -223.481 + 0.501 (Moisture) + 4.241 (Protein) + 5.621 (Lipid) + 13.703 (Ash) + 0.086 (TVB-N) +11.020 (pH) + 2.320 (TVC).

The Eigen value is 6.757 (>1). Canonical correlation, rc = 0.933. Wilks' Lamda = 0.129 ($p < 0.01$). Thus, the Function F explains the variation significantly well.

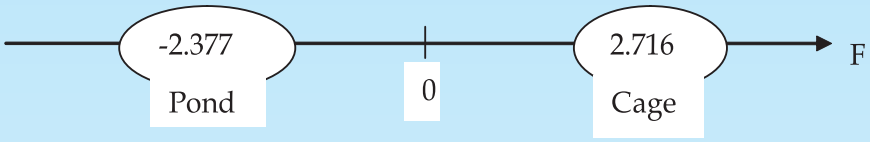

Fig. 2. Classification Centroids.

The function F can then be applied to new samples that have sensory, proximate composition, chemical composition, and microbial load measurements for the predictor variables but have unknown group membership, either cage reared or pond reared. The classification rule is if F > 0 then the new sample is classified as cage reared otherwise pond reared. The classification showed overall, 100% of the samples are classified correctly. The cross-validation result also supported our conclusions.

Principal Component Analysis (PCA)

From Fig. 3, the PCA analyses showed distinct separation of cage and pond reared fish samples in terms of proximate, biochemical and microbiological changes. The results of PCA were supported by Canonical Discriminant Analysis.

The implementation of QIM method for all the key supply/value chain as tilapia for evaluating the quality freshness of the fishes would help the industry to supply safe, high-quality and health promoting tilapia fish-products, giving a unique value to it. Results of sensory, biochemical (pH, TVBN) and microbial (TVC) assessment are good criteria to study shelf life of tilapia (O. niloticus). QI scores resulting from sensory evaluation of tilapia with the QIM scheme was correlated highly with storage time in ice. The high correlation between QI and storage time in ice made it possible to predict the past storage time in ice. This technique has also been found equally effective in comparing freshness quality of tilapia reared in cage and pond. The results of the present study showed that O. niloticus of cage and pond reared was found to be edible on day 15 and 18, respectively in ice storage. Results of pH, TVB-N and microbial analysis supported those of sensory evaluation, in which values were within the recommended limit of acceptability within 15 and 18 days in ice storage. As the maximum storage time in ice of tilapia (O. niloticus) of cage and pond reared was determined as 15 and 18 days, this information may be utilized directly for assessment with the QIM for cage and pond reared tilapia to predict remaining storage time in ice assuming optimum storage conditions and used in production and quality management. For consumers, we recommend a conservation of whole tilapia up to 15 days for cage and 18 days for pond reared to avoid any food intoxication.

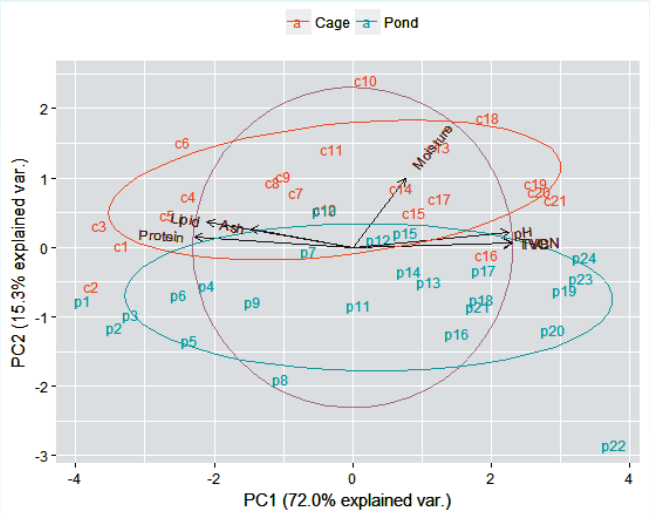

Fig. 3. Biplot of principal component 1 versus principal component 2.

Fisheries education through open and distance learning in Bangladesh

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The fisheries sector in Bangladesh plays a very important role in the national economy, contributing 3.61% to the Gross Domestic Product (GDP) of the country and 24.41% to the agricultural GDP. Fish supplements about 60% of Bangladeshi people's daily animal protein intake. Though Bangladesh is gifted with long coastline, large freshwater and marine water bodies, fisheries are underdeveloped compared to other industry sectors. With the rising population and consequent depletion of fisheries resources for agriculture and other purposes, development of an institutional set-up for fisheries education and research is keenly needed to ensure technological improvement in fisheries sector. Though a number of educational institutes have been established in different areas of Bangladesh and every year a certain number of graduates are coming out from these institutes, this is not adequate. Therefore, it is utmost requisite to establish similar types of institutes for challenging future worse situation in the fisheries sector of Bangladesh.

In Bangladesh majority people are mostly deprived from privilege of study in traditional institutes in appropriate time due to poverty, adversity, shortage of educational institutes and also lack of proper guideline from their families. In conventional teaching technique, teachers teach face-to-face in front of the students formally in a specific class room which in many cases become difficult for the students. Fortunately, distance education allows the learners to get their education by sitting at home in working period and at any age and thereby provides the majority of our education deprived people a scope to receive required institutional knowledge. In addition, in distance education learners get education with the mentioned materials specially designed for them; learning time and place are mainly selected considering learners advantage and learners accept teaching aids provided by the tutors as per their demand.

In Bangladesh the demand for higher education is high with seat limitations in institutions; only 4-5% of students get the chance to enroll in public universities after their HSC. As a result, a large number of these young students are forced to give up their dreams for higher education and a major proportion of them remain unemployed. Distance education is considered an important alternative to offer these aspirant young students an opportunity for higher education. Due to easy access and flexibility in age, gender, geographical locations, and regular attendance in class, many students find BOU as an alternative to the conventional universities for higher education. The degree/diploma/certificate of BOU is accepted by all as equivalent to those of conventional public universities. As a result number of students per teacher at BOU is several hundred folds higher than those of the conventional universities. Distance education in Bangladesh is very cost-effective and thus demand of this alternative system is increasing very fast.

Bangladesh Open University is offering a programme entitled "Certificate in Pisciculture and Fish Processing (CPFP)" since 1999 in order to disseminate knowledge of fisheries for all categories of people of Bangladesh at any age and discipline, including unemployed youth. The programme is operated by different fisheries training centers, training academics, Bangladesh Fisheries Research Institute, Youth Training Center as study centers. Thus it opens scope for students of different areas of the country to get admitted into nearest study center and acquire knowledge of fisheries. Teaching to the students is done through the use of various technologies including the provision of telecommunication services during the course of admission and later on providing tutorial services.

The outline of the CPFP programme is as follows:
Duration: one semester (six months).
Registration validity: One and half years.
Admission requirement: Minimum SSC or equivalent.
Credit: Total 15 credit. Each credit consists of 15 to 20 lessons. Each lesson will need approximately 45 minutes to 1 hour study.

Courses in the Programme

SL.	Course Code	Name of Course	Credit
1	CPFP 1301	Pisciculture	3
2	CPFP 1202	Fish Nutrition and Feed Technology	2
3	CPFP 1303	Integrated Fish Farm Management	3
4	CPFP 1204	Fish Diseases and Control	2
5	CPFP 1305	Fish Hatchery Management	3
6	CPFP 1206	Harvesting and Processing of Fish	2
		Total Credit	15

Bangladesh Open University is also offering a programme entitled Bachelor of Agricultural Education (BAgEd) since 1998 in order to disseminate knowledge of Agricultural Sciences for all categories of students who have minimum HSC or Equivalent degree at any age including unemployed youth. The programme is offered for three years (6 semesters) and each semester is 06 months. In this programme following four courses for Fisheries Sciences are offered.

1. BAE 1305, Aquaculture and Management, Credit 3
2. BAE 2202, Fish Feed and Nutrition, Credit 2
3. BAE 5203, Fish Health Care, Credit 2
4. BAE 6203, Fish Harvesting and Preservation, Credit 2

Bangladesh Open University has started another programme entitled Masters in Aquaculture (MS in Aquaculture) from 2018 for the students of any age who have minimum B.Sc. Fisheries (Hons.) or Equivalent degree from any recognized university and either employed or unemployed. The programme is offered for one and half years with total 3 semesters and each semester is of 06 months. The programme has 12 theoretical courses and one semester for research, and a total of 40 credit hours.

Courses of M.S. in Aquaculture are as follows**:**

Semester	Course Code	Course Name	Credit
January-June		Compulsory Courses	
	MSAQ 1201	Advanced Freshwater Aquaculture	2
	MSAQ 1202	Aquatic Animal Health Management	2
	MSAQ 1203	Aquafarm Operation	2
	MSAQ 1204	Advanced Aquaculture Feed Technology	2
	MSAQ 1205	Mariculture	2
	MSAQ 1206	Cilture of Fish Food Organisms	2
		Total	12
July-December		Compulsory Courses	
	MSAQ 2201	Advanced Coastal Aquaculture	2
	MSAQ 2202	Integrated Aquaculture	2
	MSAQ 2203	Aquaculture Nutrition	2
	MSAQ 2204	Advanced Fish Pathology	2
	MSAQ 2205	Aquarium Fish Culture	2
	MSAQ 2206	Mangrove Aquaculture	2
		Total	12
	Thesis		12
Research Semester	Thesis Defense		4
		Grand Total	40

In addition, BOU has set up a programme entitled Masters in Sustainable Agriculture and Rural Livelihood (MS in SARL) which will start very soon and in that programme Fisheries courses have been also included for BAgEd graduates of BOU and other disciplines, including unemployed youth. The duration of that programme will be 2 years with each semester of 06 months. In that programme there are 12 courses as Theory and one semester for research and total credit hour is 40.

Education is a necessary prerequisite for economic growth within the knowledge-based economies for our country. Importance of education has been emphasized through fundamental rights, principles, and statutes/acts in a number of countries including Bangladesh. Fisheries sector is making valuable contribution to livelihood development and nutrition of people of Bangladesh, especially rural people. However, the immense potential of this sector is still underutilized due to the ignorance and lack of technical knowledge in this respect. Thus for the people who want to get involved in fisheries activities can be benefited from the wide opportunity provided by BOU Fisheries education programmes through distant learning to gain sufficient and effective knowledge to achieve technological advancement in this sector when opportunity from other universities or institutions have been blocked.

News in brief...

Dr. Md. Kabir Ikramul Haque

Appointed as Executive Chairman
Bangladesh Agricultural Research Council (BARC), Dhaka

Dr. Md. Kabir Ikramul Haque joined Bangladesh Agricultural Research Council (BARC) on December 28, 2017 as Executive Chairman. Earlier he served as the Member Director (Fisheries) and Director, Project Implementation Unit (PIU), National Agricultural Technology Program (NATP) in the same organization.

Dr. Md. Kabir Ikramul Haque was born in Dhaka in 1961. He began his career as Scientific Officer at Bangladesh Fisheries Research Institute (BFRI), Mymensingh in 1987 and subsequently joined BARC as Principal Scientific Officer (Fisheries) in 2007. Dr, Kabir obtained B.Sc. in Fisheries (Honours) in 1984 and M. S. in Fisheries Biology and Limnology in 1985 from Bangladesh Agricultural University, Mymensingh. He did his PhD in Hydro Biology (Fisheries) in 1995 from Kharkov State University, Ukraine.

Dr. Md. Kabir Ikramul Haque has 31 years work experience in the field of agricultural research, research management, project management and agricultural policy development. Dr. Kabir also contributed in developing many agricultural technologies.

He visited many countries including USA, Germany, Ukraine, China, Thailand and India for research and training programs. He has 35 scientific publications in different esteemed journals at home and abroad.

Dr. Md. Kabir Ikramul Haque was involved another organization as vital position: Chairman, Governing Board: SAARC Agricultural Center; General Secretary Bangladesh Fisheries Research Forum (BFRF); and Member Krishibid Institution of Bangladesh (KIB).

Peer Reviewed Papers (2018-19)

- Abigail, B., Patil, P., Kleisner, K., Rader, D., Virdin, J. and Basurto, X. 2018. Contribution of fisheries to food and nutrition security: current knowledge, policy, and research. NI Report, 18-02. Durham, NC: Duke University.
- Ahamed, F. Saha, N., Ahmed Z.F., Hossain, M.Y. and Ohtomi, J. 2018. Reproductive biology of Apocryptes bato (Gobiidae) in the Payra River, Southern Bangladesh. J Appl. Ichthyol., 34(5): 1169-1175
- Ahmed, M.S., Chowdhury, M.M.K. and Nahar, L. 2019. Molecular characterization of small indigenous fish species (SIS) of Bangladesh through DNA barcodes. Gene, 684: 53-57.
- Ahmed, N., Thompson, S. and Glaser, M. 2018. Transforming organic prawn farming in Bangladesh: Potentials and challenges. J. Cleaner Production, 172: 3806-3816.
- Akash, M., Sabah, F.A. and Hossain, M.A.R. 2018. A Southeast Asian species in the Ganges Delta: on spreading extent of non-native croaking gourami Trichopsis vittata (Cuvier, 1831) in Bangladesh. Bio. Invasion Records, 7(4): 447-450.
- Alam, M.J., Andriyono, S., Eunus, A.T.M., Rahman, M.M. and Kim, H.W. 2019. Mitigenome announcement mitochondrial genome of Molacarplet, Amblypharyngodon mola (Hamilton, 1822) and its evolutional relationship in subfamily Danioninae. Mitochondrial DNA Part B 4(1): 650-651.
- Alam, M.J., Andriyono, S., Sektiana, S.P. Rahman, M.M. and Kim, H.W. 2019. The molecular characterization of complete mitochondrial genome of spotted snakehead fish, Channa punctata (Bloch 1793). Mitochondrial DNA Part B 4(1): 547-548.
- Alam, M.M., Haque, M.M., Aziz, M.S.B. and Mondol. M.M.R. 2019. Development of pangasius-carp polyculture in Bangladesh: Understanding farm characteristics by, and association between, socio-economic and biological variables. Aquaculture, (in press)
- Ali, H., Rahman, M.M., Rico, A., Jaman, A., Basak, S.K., Islam, M.M., Khan, N., Keus, H.J., Mohan, C.V. 2018. An assessment of health management practices and occupational health hazards in tiger shrimp (Penaeus monodon) and freshwater prawn (Macrobrachium rosenbergii) aquaculture in Bangladesh. Veterinary and Animal Science, 5: 10-19.
- Ando, H., Shahjahan, M. and Kitahashi, T. 2018. Periodic regulation of expression of genes for kisspeptin, gonadotropin-inhibitory hormone and their receptors in the grass puffer: Implications in seasonal, daily and lunar rhythms of reproduction. General and Comparative Endocrinology, 265: 149-153.
- Azad, M.A.K., Islam, S.S., Sithi, I.N., Ghosh, A.K., Banu, G.R., Bir, J. and Huq K.A. 2019. Effect of probiotics on immune competence of giant freshwater prawn Macrobrachium rosenbergii. Aquaculture Research, 50(2): 644-657.
- Baki, M.A., Hossain, M.M., Akter, J., Quraishi, S.B., Shojib, M.F.H., Ullah, A.K.M.A. and Khan M.F. 2018. Concentration of heavy metals in seafood (fishes, shrimp, lobster and crabs) and human health assessment in Saint Martin Island, Bangladesh. Ecotoxicology and Environmental Safety, 159: 153-163.
- Barange M., Fernandes, J.A., Kay, S., Hossain, M.A.R., Ahmed, M. and Lauria, V. 2018. Marine Ecosystems and Fisheries: Trends and Prospects. 469-488 pp. In: Nicholls R., Hutton C., Adger W., Hanson S., Rahman M., Salehin M. (eds) Ecosystem Services for Well-Being in Deltas. Palgrave Macmillan, Cham.
- Bayazid, Y., Umetsu, C., Hamasaki, H. and Miyanishi, T. 2019. Measuring the efficiency of collective floodplain aquaculture of Bangladesh using Data Envelopment Analysis. Aquaculture, 503: 537-549.
- Bremer, S., Haque, M.M., Aziz, S.B. and Kvamme, S. 2019. 'My new routine': Assessing the impact of citizen science on climate adaptation in Bangladesh. Environmental Science & Policy, 94: 245-257.
- Brown, S., Nicholls, R.J., Lázár, A.N., Hornby, D.D., Hill, C., Hazra, S., Addo, K.A., Haque, A., Caesar J. and Tompkins, E.L. 2018. What are the implications of sea-level rise for a 1.5, 2 and 3 °C rise in global mean temperatures in the Ganges-Brahmaputra-Meghna and other vulnerable deltas? Regional Environmental Change, 18(6): 1829-1842.
- Brugere, C., Aguilar-Manjarrez, J., Beveridge, M.C.M. and Soto, D. 2018. The ecosystem approach to aquaculture 10 years on - a critical review and consideration of its future role in blue growth. Reviews in Aquaculture, 1-22.
- Bush, S.R., Belton, B., Little, D.C. and Islam, M.S. 2018. Emerging trends in aquaculture value chain research. Aquaculture, 498: 428-434.
- Chowdhury, M.S.N., Wijsman, J.W.M., Hossain, M.S., Ysebaert, T. and Smaal, A.C. 2019. Growth potential of rock oyster (Sacosstrea cucullata) exposed to dynamic environmental conditions simulated by a Dynamic Energy Budget model. J. Sea Research, 147: 19-27.
- Chowdhury, M.S.N., Wijsman, J.W.M., Hossain, M.S., Ysebaert, T. and. Smaala, A.C. 2018. DEB parameter estimation for Saccostrea cucullata (Born), an intertidal rock oyster in the Northern Bay of Bengal. J. Sea Research, 142: 180-190.

- Das, A., Ianakiev, P., Baten, A., Nehleen, R., Ehsan, T., Ahmed, O., Islam, M.R., Naser, M.N., Marma, M. S. and Khan, H. 2018. Genome of Tenualosa ilisha from the river Padma, Bangladesh. BMC Res Notes, 11: 921.
- Dhar, A.R., Islam, M.M., Jannat, A. and Ahmed, J.U. 2018. Wetland agribusiness aspects and potential in Bangladesh. Data in Brief, 16: 617-621.
- Fernandes, J.A. 2018. Climate change impacts, vulnerabilities and adaptations: Southern Asian fisheries in the Arabian Sea, Bay of Bengal and East Indian Ocean. 281-303 pp. In Barange, M. et al. (Eds) Impacts of climate change on fisheries and aquaculture: synthesis of current knowledge,adaptation and mitigation options. FAO Fisheries and Aquaculture Technical Paper No. 627. Rome, FAO. 628 pp.
- Filipski, M. and Belton, B. 2018. Give a Man a Fish Pond: Modeling the Impacts of Aquaculture in the Rural Economy. World Development, 110: 205-223.
- Gupta, D., Dwivedi, A.K. and Tripathi, M. 2018. Taxonomic validation of five fish species of subfamily Barbinae from the Ganga river system of northern India using traditional and truss analyses. PLoS ONE, 13(10): e0206031.
- Hernandez, R., Belton, B., Reardon, T., Hu, C., Zhang X. and Ahmed, A. 2018. The "quiet revolution" in the aquaculture value chain in Bangladesh. Aquaculture, 493:456-468.
- Hoque, M. S., Jacxsens, L., Rahman, M.B., Alam A.K.M.N. and Rahman, M. 2018. Evaluation of artificially contaminated fish with formaldehyde under laboratory conditions and exposure assessment in freshwater fish in Southern Bangladesh. Chemosphere, 195: 702-712.
- Hossain, M.A.R., Ahmed, M., Fernandes, J.A. and Ojea, E. 2018. Impacts and responses to environmental change in coastal livelihoods of south-west Bangladesh. Science of the Total Environment, 637: 954-970.
- Hossain, M.A.R., Das, I., Genevier, L., Hazra, S., Rahman, M., Barange, M. and Fernandes, J.A. 2019. Biology and fisheries of Hilsa shad in Bay of Bengal. Science of the Total Environment, 651: 1720-1734.
- Hossain, M.I., Rahman, M.S., Amin, A.K.M.R., Ahmed, S.I and Shahjahan, M. 2019. Effects of Sumithion on Growth and Production of Phytoplankton and Zooplankton in Aquaculture Pond. Iranian J. Fish. Sci., (in press)
- Hossain, M.S., Sharifuzzaman, S.M., Rouf, M.A., Pomeroy, R.S., Hossain, M.D., Chowdhury, S.R. and Uddin, S.A. 2019. Tropical hilsa shad (Tenualosa ilisha): Biology, fishery and management. Fish and Fisheries, 20 (1): 44-65.
- Huq, N., Bruns, A. and Ribbe, L. 2019. Interactions between freshwater ecosystem services and land cover changes in southern Bangladesh: A perspective from short-term (seasonal) and long-term (1973-2014) scale. Science of The Total Environment, 650(1): 132-143.
- Islam, M. M. and Shamsuddoha, M. 2018. Coastal and marine conservation strategy for Bangladesh in the context of achieving blue growth and sustainable development goals (SDGs). Environmental Science & Policy, 87: 45-54.
- Islam, M.M. and Jentoft, S. 2019. Creating an enabling environment to support disaster risk reduction in the context of the SSF Guidelines: a case study from Bangladesh 87-106 pp. In: Westlund & Zelasney. eds. Securing sustainable small-scale fisheries: sharing good practices from around the world. FAO Fisheries and Aquaculture Technical Paper No. 644. Rome. 184 pp. Licence: CC BY-NC-SA 3.0 IGO.
- Islam, M.S. and Hoq M.E. 2019. Vulnerability of Aquaculture-Based Fish Production Systems to the Impacts of Climate Change: Insights from Inland Waters in Bangladesh. In: Islam M., van Amstel A. (eds) Bangladesh I: Climate Change Impacts, Mitigation and Adaptation in Developing Countries. Springer Climate. Springer, Cham: 67-97.
- Kais, S.M. and Islam, M.A. 2018. Impacts of and resilience to climate change at the bottom of the shrimp commodity chain in Bangladesh: A preliminary investigation. Aquaculture, 493: 406-415.
- Kamal, A.S.M.M., Shamsudduha, M., Ahmed, B., Hassan, S.M.K., Islam, M.S., Kelman, I. and Fordham, M. 2018. Resilience to flash floods in wetland communities of northeastern Bangladesh. International J. Disaster Risk Reduction, 31: 478-488.
- Karim, E., Liu, Q., Sun, M., Barman, P.P., Hasan, S.J. and Hoq, M.E. 2019. Assessing recent gradual upsurge of marine captured Hilsa stock (Tenualosa ilisha) in Bangladesh. Aquaculture and Fisheries (in press)
- Karim, E., Qun, L., Khatun, M.H., Rahman, M.F., Memon, A.M., Hoq, M.E. and Mahmud, Y. 2018. Estimation of the marine Pomfret fishery status of the Bay of Bengal, Bangladesh: Sustainable retained. Indian J. Geo Mar. Sci., 47(3): 686-693.
- Karim, Ehsanul, Liu, Q., Xue, Y., Liao, E., Hasan, S.J., Hoq, M.E. and Mahmud, Y. 2018. Ecosystem modeling of the resettled maritime area of the Bay of Bengal, Bangladesh through well-adjusted Ecopath approach. Applied Eco. Environ. Res., 16(3): 3171-3196.
- Khan, M.A.R., Ara, M.H. and Mamun, M.S.A. 2018. Fatty Acid Composition and Chemical Parameters of Liza parsia. J. Basic. Appl. Chem., 8(3): 1-8.
- Kibria, A.S.M. and Haque, M.M. 2018. Potentials of integrated multi-trophic aquaculture (IMTA) in freshwater ponds in Bangladesh. Aquaculture Reports, 11: 8-16.
- Kullander, S.O., Rahman, M.M., Norén, M. and Mollah, A.R. 2018. Laubuka tenella, a new species of cyprinid fish from southeastern Bangladesh and southwestern Myanmar (Teleostei, Cyprinidae, Danioninae). Zoo Keys, 742: 105-126.
- Kumar, P., Biswas, G., Ghoshal, T.K., Kailasam, M. and Vijayan, K.K. 2018. Embryonic and larval developments of brackishwater catfish, Mystus gulio (Hamilton and Buchanan, 1822) induced with human chorionic gonadotropin and consequent larval rearing. Aquaculture Research, 49(7): 2466-2476.

fishing: Evidence from urban, semi-urban and rural communities. Science of the Total Environment, 637-638: 758-770
Matin, A., Hossain, B., Iqbal, M.M., Billah, M.M. and Abdulla-Al-Asif. 2018. Diversity and abundance of Macrobenthos in a subtropical estuary, Bangladesh. Species, 19: 140-150.

- Mehvar, S., Filatova, T., Sarker, M.H., Dastgheib, A. and Ranasinghe, R. 2019. Climate change-driven losses in ecosystem services of coastal wetlands: A case study in the West coast of Bangladesh. Ocean & Coastal Management, 169: 273-283.
- Molla, M.H.R., Islam, M.S., Rahman, M.A., Lee, S.G., Jahan, B., Iqbal J. and Mamtaz, S. 2018. An assessment of geo-morphology and hydro-biological factors of major wetlands of Bangladesh. Water Science & Technology, 78(3-4): 578-587.
- Mukul, S. A., Alamgir, M., Sohel, M. S. I., Pert, P. L., Herbohn, J., Turton, S. M., Khan, M. S. I., Munima, S. I., Reza, A.H.M. A. and LauranceW. F. 2019. Combined effects of climate change and sea-level rise project dramatic habitat loss of the globally endangered Bengal tiger in the Bangladesh Sundarbans. Science of The Total Environment663: 830-840.
- Murshed-e-Jahan, K., Ali, H., Upraity, V., Gurung, S., Dhar, G. C. and Belton, B. 2018. Making sense of the market: Assessing the participatory market chain approach to aquaculture value chain development in Nepal and Bangladesh. Aquaculture 493: 395-405.
- Nahar, A., Luckstead, J., Wailes, E.J. and Alam, M.J. 2018. An assessment of the potential impact of climate change on rice farmers and markets in Bangladesh. Climatic Change, 150(3-4): 289-304.
- Nesa, N.U., Faroque, A.A., Sarder, M.R.I. and Mollah, M.F.A. 2018. Assessment of genetic structure of wild populations of mrigal carp, Cirrhinus cirrhosus by microsatellite DNA markers. Aquaculture Research, 49(2): 3919-3925.
- Queirós, A.M., Fernandes, J., Genevier, L. and Lynam, C.P. 2018. Climate change alters fish community size-structure, requiring adaptive policy targets. Fish and Fisheries, 19(4): 613-621.
- Rahman, M., Dustegir, M., Karim, R., Haque, A., Nicholls, R.J., Darby, S.E., Nakagawa, H., Hossain, M., Dunn, F.E. and Akter, M. 2018. Recent sediment flux to the Ganges-Brahmaputra-Meghna delta system. Science of the Total Environment, 643: 1054-1064.
- Rahman, M.A., Lee, S.G., Molla, M.H.R., Asare, O.E., Megwalu, F.O., Jahan, B. and Shaikh, M.M. 2018. Fisheries management and governance in Bangladesh. MOJ Eco Environ Sci., 3(6): 381?385.
- Rahman, M.J., Wahab, M.A., Amin, S.M.N., Nahiduzzaman, M. and Romano, N. 2018. Catch trend and stock assessment of Hilsa Tenualosa ilisha using digital image measured length-frequency data. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science, 10: 386-401.
- Rahman, M.S., Hossain, M.S., Ahmed, M.K., Akther, S., Jolly, Y.N., Akhter, S., Kabir, M.J. and Choudhury, T.R. 2019. Assessment of heavy metals contamination in selected tropical marine fish species in Bangladesh and their impact on human health. Environmental Nanotechnology, Monitoring & Management 11: (in press)
- Sanchez, E., Biju, S.D., Islam, M.M., Hasan, M., Ohler, A., Vences, M. and Kurabayashi, A. 2018. Phylogeny and classification of Fejervaryan frogs (Anura: Dicroglossidae). SALAMANDRA 54(2): 109-116
- Sarker, S. Bhuyan, M.A.H., Rahman, M.M., Islam, M.A., Hossain, M.S., Basak, S.C. and Islam,M.M. 2018. From science to action: Exploring the potentials of Blue Economy for enhancing economic sustainability in Bangladesh. Ocean & Coastal Management, 157: 180-192.
- Sarker, S., Rahman, M.M., Yadav, A.K. and Islam, M.M. 2019. Zoning of marine protected areas for biodiversity conservation in Bangladesh through socio-spatial data. Ocean & Coastal Management, 173:114-122.
- Sarowar, M. N., Hossain, M.J., Nasrin, T., Naznin, T., Hossain, Z., Rahman, M. M. 2019. Molecular identification of oomycete species affecting aquaculture in Bangladesh. Aquaculture & Fisheries (in press).
- Shahjahan, M., Uddin, M.H., Bain, V. and Haque, M.M. 2018. Increased water temperature altered hemato-biochemical parameters and structure of peripheral erythrocytes in striped catfish Pangasianodon hypophthalmus. Fish Physiology and Biochemistry, 44(5): 1309-1318.
- Sharifuzzaman, S.M., Hossain, M.S., Chowdhury, S.R., Sarker, S., Chowdhury, M.S.N. and Chowdhury, Z.R. 2018. Elements of fishing community resilience to climate change in the coastal zone of Bangladesh. J. Coastal Conservation., 22(6): 1167-1176.
- Sumon, K. A., Rashid, H., Peeters, E. T. H. M.,Bosma, R. H. and. Van den Brink, P. J. 2018. Environmental monitoring and risk assessment of organophosphate pesticides in aquatic ecosystems of north-west Bangladesh. Chemosphere, 206: 92-100.
- Sumon, K.A., Rashid, H., Peeters, E.T.H.M., Bosma, R.H. and den Brinka, P.J.V. 2018. Environmental monitoring and risk assessment of organophosphate pesticides in aquatic ecosystems of north-west Bangladesh. Chemosphere206: 92-100.
- Sumon, K.A., Ritika, A.K., Peeters, E.T.H.M., Rashid, H., Bosma, R.H., Rahman, M.S., Fatema, M.K. and den Brink, P.J.V. 2018. Effects of imidacloprid on the ecology of sub-tropical freshwater microcosms. Environmental Pollution, 236: 432-441.
- Sunny, A.R., Islam, M.M., Rahman, M., Miah, M.Y., Mostafiz, M., Islam, N., Hossain, M.Z., Chowdhury, M.A., Islam, M.A. and Keus, H.J. 2019. Cost effective aquaponics for food security and income of farming households in coastal Bangladesh. The Egyptian J. Aquatic Res., (in press)
- The, L.C.L., Caddell, R., Allison, E.H., Finkbeiner, E.M., Kittinger, J.N., Nakamura, K.. 2019. The role of human rights in implementing socially responsible seafood. PLoS ONE, 14(1): e0210241.

Upcoming Conferences/Seminars

4th Global Food Security, Food Safety & Sustainability Conference
May 10 -11, 2019, Montreal, Canada
https://globalnutritionreport.org/events/

43rd Annual Larval Fish Conference
May 21-24, 2019, Palma, Balearic Islands, Spain
https://earlylifehistory.fisheries.org/conferences/larval-fish-conference-2019/

Atlantic Salmon Symposium - International Year of the Salmon
June 3 - 4, 2019, ScandicIshavs Hotel, Tromsø, Norway
http://www.nasco.int/pdf/iys/Save%20the%20Date%20 Tromso%20Symposium%20Flyer.pdf

III Iberian Congress on River Restoration
June 12-14, 2019, Murcia, Spain
https://www.restaurarios.es/en/

Asian Pacific Aquaculture 2019
June 19-21, 2019
Chennai Trade Center, Chennai, Tamil Nadu, India
www.was.org/meeting/code/APA2019

5th International Conference on Fish Telemetry
June 24 - 28, 2019, Arendal, Norway
https://www.5thicft.org/

European Conference on Aquaculture and Fisheries
June 27-28, 2019 , Amsterdam, The Netherlands
https://aquaculture.conferenceseries.com/

Congress 2019: Aquatic ecosystem health in a changing environment
June 30 - July 4, 2019, South Africa
http://www.riv.co.za/sasaqs/pdf/1st_SASAQS_Jan2019.pdf

11th Symposium for European Freshwater Sciences
June 30 - July 5, 2019, Zagreb, Croatia
http://www.husek.hr/welcome-to-sefs11-in-croatia/

2nd International Summit on Fisheries & Aquaculture
August 12-13, 2019, Prague, Czech Republic
https://scientificfederation.com/fisheries-aquaculture-2019/index.php

9th International Conference on Diseases of Fish and Shellfish
September 9-12, 2019, Porto, Portugal
https://www.eafp2019.com/

10th International conference on Fisheries & Aquaculture
September 27-28, 2019, Toronto, Canada
https://fisheries.conferenceseries.com/

International River Society Conference
Sept 8-13, 2019, Vienna, Austria
http://isrs2019.info/cms/index.php/home-235.html

EIFAAC International Symposium Food Safety and Conservation in Inland Fisheries and Aquaculture
Sept 9-11, 2019, Dresden, Germany
https://www.bmel.de/SharedDocs/TermineVeranstaltungen/EN/19-09-08-13-EIFAAC.html

8th World Conference on Ecological Restoration
Sept 22-27, 2019, Cape Town, South Africa
https://ser2019.org/

149th American Fisheries Society Annual Meeting
Held jointly with The Wildlife Society
Sept 29 - Oct 3, 2019, Reno, Nevada, USA
http://afstws2019.org/

IFM 50th Annual Conference
Oct 8-10, 2019, Nottingham, England
https://ifm.org.uk/events/ifm-events/

Latin American & Caribbean Aquaculture 2019
Nov 19-22, 2019
Herradura Convention Center (Wyndham) San José, Costa Rica
www.was.org/meeting/code/lacqua19

Aquaculture America 2020
Feb 9-12, 2020
Hawaii Convention Center, Honolulu, Hawaii USA
https://www.was.org

Catfish 2020 - Third International Catfish Symposium
Feb 18 - 20, 2020, Little Rock, Arkansas, USA
http://catfish2020.weebly.com/

World Fish Migration Day 2020
May 16, 2020, Worldwide
https://worldfishmigrationday.com

Aquaculture UK 2020
May 19-21, 2020
Macdonald Aviemore Resort, Scotland, UK
https://www.was.org

Fish Passage 2020
June 29 - July 3, 2020, Lisbon, Portugal
http://fishpassage.umass.edu

8th World Fisheries Congress
Oct 11 - 15, 2020, Adelaide, Australia
https://wfc2020.com.au/
Video: https://youtu.be/xXlM7mvF9n4

22nd International River Symposium
Oct 20-24, 2019, Brisbane, Australia
http://riversymposium.com/

3rd International Catfish Symposium
February 18-20, 2020, Little Rock, Arkansas, USA
https://fisheries.org/events/

World Fisheries Congress 2020 (WFC2020)
October 11-15, 2020, Adelaide, Australia
https://fisheries.org/events/

Aquaculture 2022
Feb 17 - Mar 3, 2022
Town & Country Resort & Convention Center, San Diego, California USA
https://www.was.org

Aquaculture America 2023
Feb 19 - 22, 2023
Marriott New Orleans, New Orleans, Louisiana USA
https://www.was.org

Bangladesh Fisheries Research Forum
Executive Committee 2016-18

	Name and Address	Position
1.	Dr. AKM Nowsad Alam Professor, Department of Fisheries Technology, Bangladesh Agricultural University, Mymensingh 2202	President
2.	Dr. AKM Aminul Haque Director, Department of Fisheries, Matshya Bhaban, Romna, Dhaka 1000	Vice-President
3.	Dr. Md. Khaliur Rahman Director, Bangladesh Fisheries Research Institute Mymensingh 2201	Vice-President
4.	Dr. Md. Kabir Ikramul Haque Executive Chairman, Bangladesh Agricultural Research Council Dhaka 1215	General Secretary
5.	Dr. S M Rafiquzzaman Assoc. Professor, Faculty of Fisheries Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur 1706	Joint Secretary
6.	Dr. Kazi Ahsan Habib Professor, Department of Fisheries, Sher-e-Bangla Agricultural University, Dhaka 1207	Treasurer
7.	Dr. Syed Arif Azad Ex. Director General, Department of Fisheries, Matshya Bhaban, Romna, Dhaka 1000	Member
8.	Dr. Md. Enamul Hoq Principal Scientific Officer, Bangladesh Fisheries Research Institute, Mymensingh	Member
9.	Ms. Khandoker Lutfunnesa Ex. Secretary, Bangladesh Fisheries Development Corporation, Kowran Bazar, Dhaka	Member
10.	Dr. Md. Nahiduzzaman Project Manager, EcoFishBD, WorldFish, Bangladesh and South Asia, Banani, Dhaka	Member
11.	Dr. Md. Shah Alam Sarker Professor (Fisheries), School of Agriculture and Rural Development Bangladesh Open University, Gazipur 1705	Member
12.	Dr. M Shahadat Hossain Professor, Institute of Marine Science and Fisheries Chittagong University, Chittagong	Member
13.	Dr. Md. Asaduzzaman Assistant Professor, Department of Marine Bio-resources Science Chittagong Veterinary and Animal Sciences University, Chittagong	Member

Bangladesh Fisheries Research Forum
Executive Committee 2016-18

	Name and Address	Position
14.	Dr. Kaniz Fatema Professor & Chairman, Department of Fisheries, Dhaka University, Dhaka 1000	Member
15.	Dr. Md. Ferdous Mehbub Associate Professor & Dean, Faculty of Fisheries Hajee Mohammad Danesh Science & Technology University, Dinajpur 5200	Member
16.	Dr. Md. Mer Mosharraf Hossain Associate Professor, Department of Fisheries and Marine Bioscience Jessore University of Science and Technology, Jessore 7408	Member
17.	Dr. Khandaker Anisul Huq Professor FMRT Discipline, Khulna University, Khulna 9208	Member
18.	Dr. Md. Younus Mia Professor, Department of ESRM Mawlana Bhasani Science & Technology University, Tangail 1902	Member
19.	Dr. Md. Jahngir Sarker Associate Professor & Chairman Noakhali Science & Technology University, Noakhali	Member
20.	Dr. Sultan Mahmud Ex. Professor, Faculty of Fisheries Patuakhali Science & Technology University, Patuakhali	Member
21.	Dr. Md. Al-Amin Sarker Associate Professor, Department of Fisheries, Rajshahi University, Rajshahi	Member
22.	Dr. Mrityunjoy Kunda Professor & Chairman, Dept. of Aquatic Resource Management Sylhet Agricultural University, Sylhet	Member
23.	Mr. ABM Shamsul Alam Badal Proprietor, Agro3, 37 Lichu Bagan Akua, Mymensingh	Member
24.	Mr. Syed M Istiak Director, Deep Sea Fisheries Limited, Rangs Bhaban, Dhaka 1215	Member
25.	Md. Abdul Kadir Tarefder Managing Director, Sharnalata Agro Fisheries, 41, Boundary Road, Mymensingh	Member
26.	Dr. Md. Jahangir Alam Professor, Faculty of Fisheries Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur	Member
27.	Dr. Mostafa Ali Reza Hossain Professor, Department of Fish. Biology & Genetics Bangladesh Agricultural University, Mymensingh 2202	Member

Bangladesh Marine Fisheries Capacity Building Project

Department of Fisheries, Bangladesh

Ministry of Fisheries and Livestock

To assess the biomass status and maximum sustainable yield of fisheries resources of the Bay of Bengal Bangladesh part and, to strengthen the overall capacity of DoF officials, the Ministry of Fisheries and Livestock, Government of Bangladesh launched the project entitled 'Bangladesh Marine Fisheries Capacity Building Project' with financial and technical assistance from Islamic Development Bank and Government of Malaysia.

Main Objectives

- To assess the standing stock and Maximum Sustainable Yield (MSY) of estuarine and coastal fisheries resources for management of the artisanal fisheries;
- To undertake census and establish data bank on different types of fishing crafts and gears;
- To strengthen the capacity of the DoF in assessing and managing the marine and coastal fishery resources, and
- To develop mechanism to implement Monitoring, Control and Surveillance (MCS) system to oversee and manage the resources.

Major activities

- Purchase of fisheries research and survey vessel;
- Survey Operation: Land based survey and Vessel based survey;
- Establish & operate vessel tracking monitoring system (VTMS);
- Establishment of integrated fisheries data bank, and
- Local and overseas training to increase efficiency of DoF officials and employees.

জাটকা সংরক্ষণ সপ্তাহ ২০১৯

‘কোনো জাল ফেলবো না  জাটকা ইলিশ ধরবো না’

দেশে ইলিশের উৎপাদন বৃদ্ধির লক্ষ্যে ১৬ হতে ২২ মার্চ জাটকা সংরক্ষণ সপ্তাহ’১৯ উদ্‌যাপিত হচ্ছে

আজকের ছোট জাটকাই আগামী দিনের বড় ইলিশ

- ১০ ইঞ্চি বা ২৫ সেন্টিমিটার দৈর্ঘ্যের চেয়ে ছোট ইলিশকে ‘জাটকা’ বলা হয়;
- ১ নভেম্বর থেকে ৩০ জুন পর্যন্ত জাটকা ধরা, পরিবহন, ক্রয়-বিক্রয় ও মজুদ/হেফাজতে রাখা আইনত দণ্ডনীয় অপরাধ;
- এ আইন অমান্যকারীকে কমপক্ষে ১ বছর থেকে সর্বোচ্চ ২ বছরের সশ্রম কারাদণ্ড অথবা পাঁচ হাজার টাকা পর্যন্ত জরিমানা অথবা উভয় দণ্ডে দণ্ডিত করার বিধান রয়েছে;
- আসুন, আমরা সবাই মিলে জাটকা ধরা, ক্রয়-বিক্রয় ও পরিবহন থেকে বিরত থাকি।

জাটকা রক্ষা করি এবং ইলিশ সম্পদ বৃদ্ধি করি

মৎস্য অধিদপ্তর, বাংলাদেশ

মৎস্য ও প্রাণিসম্পদ মন্ত্রণালয়

নতুন জাতের মাছ লাল তেলাপিয়া

লাল তেলাপিয়ার বৈশিষ্ট্যসমূহ

- ✓ অধিক উৎপাদনশীল
- ✓ খেতে সুস্বাদু ও পুষ্টিকর
- ✓ সহজে পোনা উৎপাদন সম্ভব
- ✓ ৪-৬ মাসের মধ্যেই বিপননযোগ্য
- ✓ রোগ প্রতিরোধ ক্ষমতাসম্পন্ন
- ✓ আন্তর্জাতিক বাজারে অন্যান্য তেলাপিয়ার চেয়ে লাল তেলাপিয়ার চাহিদা বেশী

আগ্রহী হ্যাচারি মালিক ও উদ্যোক্তাগণ লাল তেলাপিয় মাছের পোনা/জার্মপ্লাজম সংগ্রহের জন্য যোগাযোগ করতে পারেন।

বাংলাদেশ মৎস্য গবেষণা ইনস্টিটিউট

স্বাদুপানি কেন্দ্র, ময়মনসিংহ-২২০১

Bangladesh Fisheries Research Forum (BFRF) foresees ahead to be flourished as an organization to provide a platform for scientific collaboration, team work and future horizon of research and development activities in fisheries sector. Major objectives of BFRF are to develop networking among fisheries professionals and institutions; to share knowledge and experience to promote growth of the sector; to initiate discussion and dialogue among different stakeholders; to assist public and private sector, donors and development partners; to secure funding from donors and offer research awards to scientist/s to address demand-led research; to organize workshop, seminar, conference, dialogue and training; and to offer support services to industries, government and private sectors.

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www.bfrf.org