A Report

on

"Catch assessment survey, Net pen culture, Fish conservation, Sanctuary construction, and Awareness building in 6 Polders under CEIP-1" in contract package W-02"

Under
World Bank funded "Coastal Embankment Improvement Project, Phase-1 (CEIP-1)" implementing by Bangladesh Water Development Board (BWDB)

Submitted By

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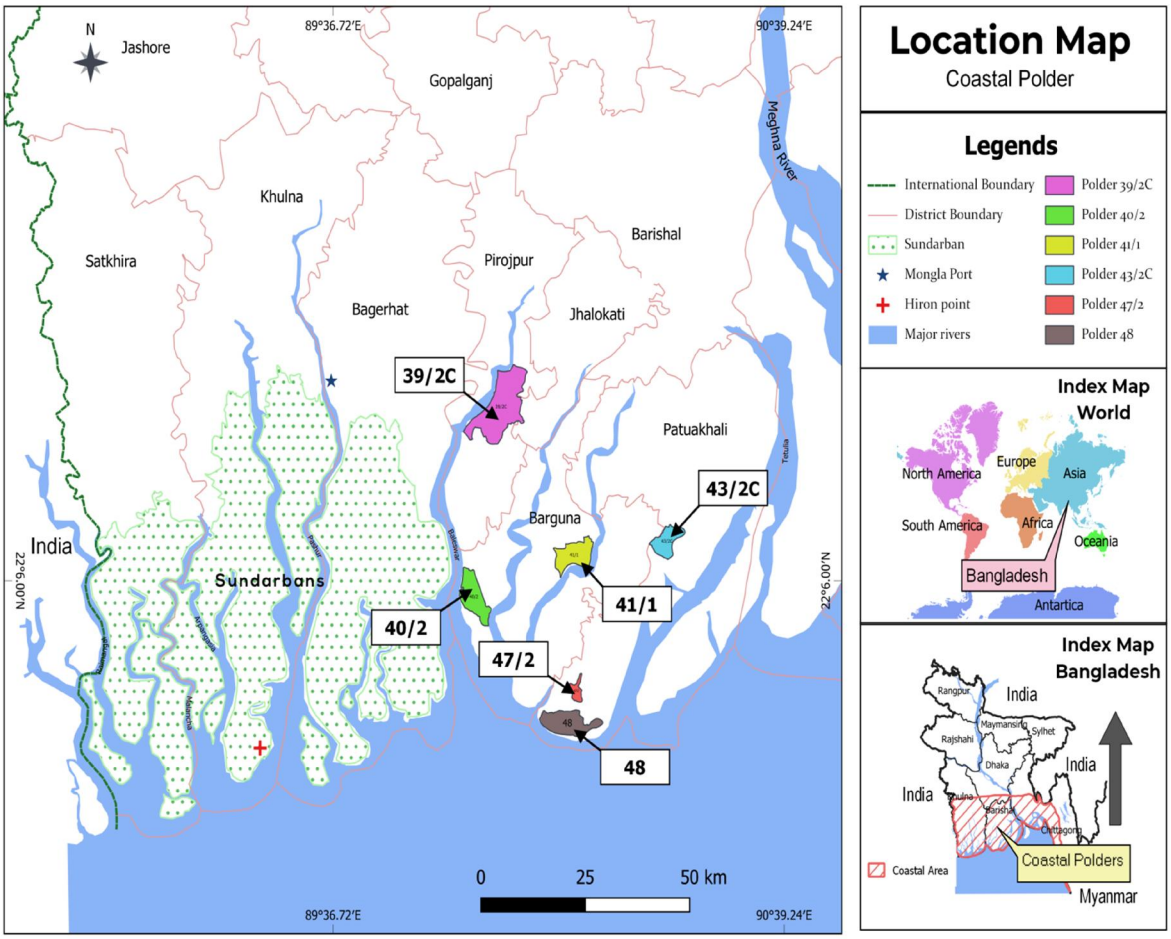

Figure 1. Location map of six polders

Executive Summary

Bangladesh is one of the world leading fish producing country in the world. Fishes and fishery resources play a vital role in improving the socio-economic condition combating malnutrition, earning foreign currency and creating employment opportunities in Bangladesh. The country ranked 3rd in inland open water production and 5th in world aquaculture production. Polders has a wide range of ecological, socio-cultural, economic and commercial importance and values in Bangladesh. These are important habitats for a large variety of flora and fauna of local, national and regional significance. Capture fishery is an important source of employment in the Polder's community and a supply source of animal protein. But due to different environmental and manmade destructive activities, natural fish stocks are declining day by day. A good number of fishes are highly regarded for their taste and nutritive value but these are now critically endangered, endangered and vulnerable. In considerably fish harvest, climatic degradation and numerous anthropogenic causes deleteriously changes fish biodiversity. Several socio-eco-friendly programs are being implemented to increase the productivity of polders water bodies in the recent past months. Such as catch assessment survey, N\net pen culture, fish conservation, sanctuary construction, and awareness building in 6 Polders under CEIP-1" in contract package W-02.Net Pen culture is the new approach to increase the fish production in inland water bodies. To increase the fish production in open water bodies, the installation of netpen offer scope for avoiding more land-based fish farm. Cage culture has been successfully practiced most Asian countries adopting which China, Vietnam, Thailand, Taiwan and Malaysia have increased their national fish production. Fish sanctuary is an adaptive approach for conservation of fish for natural propagation in open water bodies. It is a demarcated protected area, where fishes are not disturbed or captured. It has positive impact in all cases on fish production, biodiversity and socioeconomic condition of fishers. Fish and other aquatic organisms can take shelter, survive, and reproduce without any disturbance which is used worldwide as a fish conservation tool. Public awareness is essential to manage the sanctuary and protect the biodiversity.

The present activities were conducted during April to November 2022 in the southern coastal region of Bangladesh including the polder 39/2C, 40/2, 41/1, 43/2C, 47/2 and 48 were located Bhandaria, Patharghata, Borguna, Galachipa, Kalapara and Kuakata respectivelyin connection of Environmental Mitigation Works under "Coastal Embankment Improvement Project, Phase-1 (CEIP-1). Catch assessment survey, net pen culture, fish conservation, Sanctuary construction, training and awareness building were done in 6 Polders.

Catch Assessment survey: Primary data were collected through structured questionnaires. The questionnaire form was filled in by interviewing from 40 fishermen from each polder area. Total of 240 questionnaire forms were filled up for 6 polders. A total of 48 FGD sessions was conducted on 6 polder area and each polder area covered 8 FGD session where each group size of FGD was 6 to 8 people.

The fish biodiversity in the polder area is declining day by day. The available fish species are Golda Chingri, Horina Chingri, Baila, Tengra, Vetki, Tit Punti, Tengra, Shol, Taki, Shing, Pangas, Ramsus, Poa. Some fish species were available in five years past now they are vulnerable. According to fisherman the endangered fishes were Magur, Veda, Taposi, Bele, Chital, Sarputi, Gojar, pabda, gulsha, baim. It has been found that average 95% fisherman has no any idea about scientific fish culture. They don't maintain proper stocking density and never use artificial diet, proper fertilizer and lime. Only 5% fisherman fisher man use lime, fertilizer and supplementary feeds. Culturable fish species are Catla, Silver Carp, Rui, Grass Carp, Mrigal, Carpio, Golda, Thai Pangus, Tilapia and Thai Punti.

Main constrains in the polders regarding fisheries are using of pesticides and other agrochemicals, little knowledge about fish farming, use of harmful fishing gears, overexploitation of fish, overflow of water during monsoon period, using of power tiller destroy the mollusks species that alter ecological balance.

General recommendation for the development of fisheries sector in the polders were ensure different training programme to increase the knowledge of local people about sustainable fishing, establish fish hatchery, avoid harmful fishing nets, reduce overfishing, use organic fertilizer, use agrochemicals in desirable limit, need financial support to the fishermen, demonstration of aquaculture technology, empowerment of fishing laws and regulations. Moreover, Fish sanctuary should be established to conserve the existing fish stock, preserving biodiversity and increasing fish production.

Net pen culture: Net pen culture were done in 6 polders to ensure the proper utilization of vast water bodies in this polder area without intervening the other uses of those water bodies and to create an alternative livelihood for the polder community. Net pen were setup in different lake such as Nadmula Khal (DS-12) in 39/2C, Charduani Bazar Khal (DS-4) in 40/2, Amajhuri Khal (DS-1) in 41/1, Golkhali Beribadh Khal (DS-3) in 43/2C, Dalbugonj High School Khal (DS-3) in 47/2,Barohar Khal (DS-3/3) in 48. 10 (ten) net pen of 10 ft x 10ft x 6ft were setup in each polder.

The netting materials are purchased from the factory. They cut and sew to the particular shape and size of hapa/cages. The cage frames are attached one another in a series

supported to float by 2-3 exhausted 200L barrels in each gap. The whole structure is then hardened by binding with bamboos around the structure. The setting of frames and barrels was done on the land first and then pushed over the khal water, placed in a suitable place and then tied with anchors in all sides. A finer meshed net of 0.5-meter height is attached to the upper inner side of cages to protect the floating feed pellets escaping out. A larger meshed (5 cm) net is used to cover the cages on top to protect from birds e.g. pelicans, eagles and others. As stocking size of fingerlings is 15-20 grams and stocking density was 500 fish per cage. Tilapia and pangas fish were stock in the cages. Floating feed was used in cage. Feeding was done twice daily to satiation level spreading over the water surface in each cage. During feeding the cages are not disturbed by any other activities.

Water quality parameters of the lake were recorded in every fifteen days' interval throughout the culture period. Physico-chemical parameters, such as water temperature (°C), dissolved oxygen (mg/l), pH, ammonia (mg/l), nitrite (mg/l) and alkalinity (mg/l),hardness(mg/l), salinity (ppt) were measured on the spot. Water quality parameters of Nadmula Khal (DS 12), polder no. 39/2C during the Net Pen Culture showed that pH ranged from 7.2 to 8.2, temperature 26.1-30.9 °C, ammonia 0.1-0.3 mg/L, nitrite 0-0.1 mg/L, DO 5.5-6.7 mg/L, alkalinity 105- 130 mg/L, salinity 0 ppt and hardness 180-195 mg/L. Water quality parameters of Charduani Bazar Khal (DS-4), polder no. 40/2 during the Net Pen Culture showed that pH ranged from 6.2 to 8.2, temperature 26.2-31.7 °C, ammonia 0.5-0.9 mg/L, nitrite 0-0.4 mg/L, DO 4.2-5.9 mg/L, alkalinity 105- 133 mg/L, salinity 0 ppt and hardness 120-148 mg/L. Water quality parameters of Amajhuri Khal (DS-1), polder no. 41/1 during the Net Pen Cultures howed that pH ranged from 7.4 to 8.4, temperature 26.2-30.7 °C, ammonia 0.4-0.8 mg/L, nitrite 0-0.5 mg/L, DO 5.4-6.3 mg/L, alkalinity 112- 141 mg/L, salinity 0 ppt and hardness 181-202 mg/L.Water quality parameters of Golkhali Beribadh Khal (DS-3), polder no. 43/2C during the Net Pen Culture showed that pH ranged from 7.1 to 8.0, temperature 26.2-30.8 °C, ammonia 0.1-0.3 mg/L, nitrite 0-0.1 mg/L, DO 5.5-6.7 mg/L, alkalinity 105- 130 mg/L, salinity 0 ppt and hardness 180-195 mg/L. Water quality parameters of Dalbugonj High School Khal (DS-3), polder no. 47/2 during the Net Pen Cultureshowed that pH ranged from 7.6 to 8.6, temperature 26.7-31.1 °C, ammonia 0.1-0.4 mg/L, nitrite 0-0.2 mg/L, DO 4.7-6.1 mg/L, alkalinity 140- 165 mg/L, salinity 0-2 ppt and hardness 164-181 mg/L. Water quality parameters of Barohar Khal (DS-3/3), polder no. 48 during the Net Pen Culture showed that pH ranged from 7.5 to 8.7, temperature 26.2-31.6 °C, ammonia 0.2-0.6 mg/L, nitrite 0-0.4 mg/L, DO 4.3-5.4 mg/L, alkalinity 140- 172 mg/L, salinity 0-3 ppt and hardness 154-176 mg/L.

A slight variation founded in yield parameters of tilapia among different polders.The mean weight gain obtained in polder39/2C , 40/2, 41/1, 43/2C and 47/2 was 205g, 165g, 175g, 185g and 175g respectively. The specific growth rate (SGR) obtained in polder 39/2C, 40/2, 41/1, 43/2C and 47/2 was 2.98% day^{-1}, 2.76% day^{-1}, 2.82 % day^{-1}, 2.87 % $day^{-1}$and 2.82 % day^{-1}respectively. The calculated survival rate of tilapia was 93%, 94%, 92%, 95% and 95% inpolder39/2C, 40/2, 41/1, 43/2C and 47/2respectively. The average food conversion ratios (FCR) was 1.86, 1.88, 1.90, 1.85 and 1.85 for polder 39/2C, 40/2, 41/1, 43/2C and 47/2 respectively. Yield parameters of pangas between two different polders showed some variation. The mean weight gain obtained in polder43/2C and 48 was 650g and 520g respectively. The specific growth rate (SGR) obtained in polder 43/2C and 48 was 2.46% $day^{-1}$and 2.49% day^{-1}respectively. The calculated survival rate of tilapia was 98% and 97% inpolder 43/2C and 48 respectively. The average food conversion ratios (FCR) was1.85 and 1.85 for polder 43/2C and 48 respectively. Excellent fish production in the net pen was done in different polders. Color and growth of fish were impressive. WMA members and farmers were present during results demonstration. After the observation of net pen culture, they became motivated to do net pen culture.

Training: Training is teaching, or developing in oneself or others, any skills and knowledge or fitness that relate to specific useful competencies. Training has specific goals of improving one's capability, capacity, productivity and performance. Smallholder farmers produce far below their potential yields, often due to poor farming practices and poor access to extension services. Training in good aquaculture practices help farmers learn how to capably manage the health of their pond, effectively cultivate their crops, and increase their harvests. Total 12 (Twelve) training programs were organized in different 6 polders viz polder 39/2C, 40/2,41/1, 43/2C,47/2, 48. Six training programs were conducted on importance of scientific fish culture and pond nursery management, fish farming methods through advanced technology, conservation of fish biodiversity and establishment of fish sanctuaries,Rice cum Golda culture,fish and prawn disease management during 17 April to 21 May, 2022. The number of participants in each training program was 25. Total 150 farmers were trained up. Again, six training programs were conducted on net pen culture during1-9October, 2022.Trainees were selected from WMA members, switch gate committee members, fish farmers & fisherman. Training program were started at 9.30 and finished at 3.30. Pen, notebook, folder, breakfast and remuneration (500tk) were provided to all participants.

Fish sanctuary: The abundance and distribution of fishes from different khals of polder area are decreasing day by day due to the environmental degradation and anthropogenic activities such as overfishing, indiscriminate use of chemicals, destruction of natural feeding and breeding ground of fishes etc. Six fish sanctuary were constructed in different perennial khals of six polders to save the existing fish diversity in a water body and in some cases restoration of habitat and also to protect the fish species of polders from further losses. Fish sanctuaries were setup in different lake such as Nadmula Khal (DS-12) in 39/2C, Charduani Bazar Khal (DS-4) in 40/2, Amajhuri Khal (DS-1) in 41/1, Golkhali Beribadh Khal (DS-3) in 43/2C, Dalbugonj High School Khal (DS-3) in 47/2, Barohar Khal (DS-3/3) in 48. 50% of total harvested fish from Net Pen culture was stocked in the sanctuary.

Awareness building: Awareness building activities is an important tool for better management of sanctuary, protection of biodiversity and net pen culture. Total six awareness building program were organized in six different polders to aware people about aquatic biodiversity conservation, enhance and preserving aquatic biodiversity, increasing the abundance of threatened fish species, protect many other aquatic fauna and flora and increase production of all kind of fish in the polder area. Various type of awareness building activities was discussed in the training and meeting, such as overfishing, harmful effect of poison fishing, katha fishing, fishing by dewatering, catching of fry from wild habitat, water pollution, etc. Importance of sanctuary with buffer zone and contribution of sanctuary for increasing aquatic biodiversity and fish production was also discussed. Awareness building was done using motivational speech, rally and human chain.

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ABBREVIATIONS

BoB	:	Bay of Bengal
BWDB	:	Bangladesh Water Development Board
CEIP-I	:	Coastal Embankment Improvement Project, Phase I
EIAs	:	Environmental Impact Assessments
FGD	:	Focus group Discussion
GoB	:	Government of Bangladesh
GBM	:	Ganges, Brahmaputra and Meghna
H.S.C	:	Higher Secondary Certificate
NGO	:	Non-Government Organization
PRA	:	Participatory Rural Appraisal
S.S.C	:	Secondary School Certificate
SUFO	:	Senior Upazila Fisheries Officer
TSP	:	Triple Super Phosphate
UFO	:	Upazila Fisheries Officer
WMA	:	Water Management Association

GLOSSARY

Pen culture: Pen culture is defined as raising of fish in a volume of water enclosed on all sides except bottom, permitting the free circulation of water at least from one side. This system can be considered a hybrid between pond culture and cage culture. Mostly shallow regions along shores and banks of the lakes and reservoirs are used in making pen/enclosure using net/wooden materials where fish can be raised.

Net pen/Cage Culture: A cage or net pen is a system that confines the fish or shellfish in a mesh enclosure. By strict definition, a cage and a net pen differ based on their construction. A cage has a completely rigid frame (on all sides) and a net pen has a rigid frame only around the top. However, the terms "cage" and "net pen" are often used interchangeably.

Fish Sanctuary: Fish sanctuary is a particular form of protected area in waters and is considered to be an important and efficient managing tool for the protection, conservation, and management of fisheries resources. Fish sanctuary means to establish and maintain a particular area in the water body as a permanent shelter for protection of fish for natural propagation.

Result demonstration: One of the most effective educational tools for transferring research-based technology to agricultural producers and the general public is the result demonstration.A result demonstration is a trial or exercise conducted to show the public how a practice, variety or technique works.

Participatory Rural Appraisal (PRA): PRA is a participatory method to gather or collect information by involvement of Rural or local communities for decision making and implementation of the development.

Focus Group Discussion (FGD):A focus group discussion (FGD) is a good way to gather together people from similar backgrounds or experiences to discuss a specific topic of interest. The group of participants is guided by a moderator (or group facilitator) who introduces topics for discussion and helps the group to participate in a lively and natural discussion amongst themselves.

Crosscheck Interviews: Crosscheck interviews, which are conversations between a manager and an employee or between team members, invite deeper personal interaction, allowing you to learn more about an employee's perspective: what works, what doesn't and how they can

remain happy at work. Cross-functional interviews look at things objectively.Crosscheck appears to have gained the trust of a large and politically diverse audience.

Environmental Impact Assessment (EIA): Environmental Impact Assessment as a tool used to identify the environmental, social and economic impacts of a project prior to decision-making. It aims to predict environmental impacts at an early stage in project planning and design, find ways and means to reduce adverse impacts, shape projects to suit the local environment and present the predictions and options to decision-makers.

Capture fishery: Capture fishing is collecting fish straight from waterways, such as lakes, seas, ponds etc. Capture fishery refers to all kinds of harvesting of naturally occurring living resources in both marine and freshwater environments.

Culture Fishery: Culture fishery is the type of inland fishery practiced in small water bodies where desired fish is reared and then harvested.Culture fisheries is the cultivation of selected fishes in confined areas with utmost care to get maximum yield. The seed is stocked, nursed and reared in confined waters, then the crop is harvested.

Fish Biodiversity: Fish biodiversity is defined as the number of species and abundance of each species that live in a particular location. Biodiversity is the quantity, variety and distribution across biological scales ranging through genetics and life forms of populations, species, communities and ecosystems. Biodiversity affects the capacity of living systems to respond to changes in the environment, underpins ecosystem function and provides the ecosystem goods and services that support human well-being.

Fish Fingerlings: When the fish have developed to the point where they are capable of feeding by themselves, the fish are called fry. When, in addition, they have developed scales and working fins, the transition to a juvenile fish is complete and it is called a fingerling, so called as they are typically about the size of human fingers. As soon as the fry grow up to 10–15 cm size or roughly equal the size of a finger it is known as fingerling. Fingerling is the proper size for stocking in table fish production ponds. It takes about 30–60 days for the fry to grow up to fingerling size.

Fishing Gears: Fishing Gear is any form of equipment, implement, tool or mechanical device used to catch, collect or harvest fish. Additionally, a single type of gear may also be used in multiple ways. Different target species require different fishing gear to effectively catch the target species.

Liming: Liming is the general term used for the addition of base neutralizing materials to acidic waters and soils. Liming has long been used to increase fish productivity in soft water and acidic ponds, lakes, and streams. Liming may enhance the effect of fertilization. Liming helps prevent wide swings in pH. Liming also adds calcium and magnesium, which are important in animal physiology.

Fertilization: By increasing the availability of major nutrients, fertilizers promote the development of planktonic algae, which provide food for many fish. Fertilization also leads to the development of animals which feed on algae, including some fish such as the Chinese silver carp and the Nile tilapia. Proper fertilization can greatly increase crop yields. Fertilization can increase fish yields three to four times. Also, fish will be in better condition, and the quality of catch by fishermen usually improves. Fertilizers used in ponds stimulate the growth of microscopic plants called algae or plankton. As primary elements of the food web, algae are eaten by microscopic animals called zooplankton and insects which serve as food.

SECTION 1: INTRODUCTION

Bangladesh is one of the world leading fish producing country in the world. Fishes and fishery resources play a vital role in improving the socio-economic condition combating malnutrition, earning foreign currency and creating employment opportunities in Bangladesh (Akter *et al*., 2017). The country ranked 3rd in inland open water production and 5th in world aquaculture production (BER 2020). In 2018-19 total production of fish is 40 3.84 and the growth of last 3 years' production is 6.04% (BER, 2020). About 10% of the population depends directly and indirectly on the fisheries for their living. Fisheries sector contribute and 3.52% to National GDP and around one-fourth (26.37%) to the agriculture sector of GDP. Bangladesh achieved self-sufficiency in fish production with a per capita consumption of 62.58 g/day against set target of 60 g/day (BBS, 2016).

The coastal and marine zone of Bangladesh is one of the world's richest ecosystems having high biodiversity and characterized by higher productivity and unique mangrove influences (Islam, 2003). Coastal fish and fisheries are one of the major parts of the total country fisheries production contributing 60% of our daily animal protein, and also contributing to the economic development (BER, 2016).About 5,08830 people of coastal area are directly dependent on fisheries (FRSS, 2016).About 475coastal and marine species and 36shrimps are available in the BoB (DoF, 2016).The region is characterized by a delicately modified ecosystem of an evolving flat delta subject to high tides, salinity intrusion and frequent cyclones coming from the Bay of Bengal and encountering very large sediment inflows from upstream. In 1960s, polderization started in the coastal areas to convert this area into permanent agricultural lands. The polders in this area are enclosed on all sides by dykes or embankments, separating the land from the main river system and offering protection against tidal floods, salinity intrusion and sedimentation. These polders are equipped with in-and outlet sluice gates to control the water inside the embanked area.

Bangladesh as the third largest aquatic fish biodiversity in Asia, after China and India, enriched with about 800 species in fresh, brackish and marine waters (Hussain and Mazid, 2001). Nearly 253 fish species are found in different freshwaters of Bangladesh (IUCN Bangladesh, 2015). Inland open and closed water bodies are the major sources of fish production in Bangladesh from time immemorial. But due to different environmental and manmade destructive activities, natural fish stocks are declining day by day (Azher *et al*. 2006). A good number of fishes are highly regarded for their taste and nutritive value but

these are now critically endangered, endangered andvulnerable (Hasan *et al*. 2012). Inconsiderably fish harvest, climatic degradation and numerous anthropogenic causes deleteriously changes fish biodiversity (Nagelkerken *et al.,* 2017; Islam *et al*., 2019). From 20th century, many of the freshwater riverine fish species become highly endangered due to habitat degradation as a consequence of extreme anthropogenic intervention (Rahman *et al.,* 2012). However, IUCN enlisted a total of 64 fish species as threatened in Bangladesh (IUCN Bangladesh, 2015).

Cage aquaculture has grown rapidly during the past decades and is presently undergoing swift changes in response to pressures from globalization and an escalating worldwide global demand for aquatic products. There has been a move toward clustering existing cages as well as toward the development and use of more intensive cage-farming systems. In particular, the need for suitable sites has resulted in cage aquaculture accessing and expanding into new untapped open-water culture areas such as lakes, reservoirs, rivers and coastal brackish and marine offshore waters. Cage culture has been successfully practiced most Asian countries adopting which China, Vietnam, Thailand, Taiwan and Malaysia have increased their national fish production by several folds and leading the international tilapia market and producing better sized tilapia whole frozen and fillet (Am. Tilapia Assoc., 2010). The report recognizes the tremendous importance of cage aquaculture today and its key role for the future growth of the aquaculture sector.

Water is harmed profusely all over the country by insane interruption of human beings. For these reasons, diversity of flora and fauna has been decreasing all over the world. Fish sanctuary is an adaptive approach for conservation of fish for natural propagation in open water bodies.It is a demarcated protected area, where fishes are not disturbed or captured. So establishment of sanctuary is a way that carries such facilities and creates opportunities for protection, conservation and breeding of open water fishes in natural way. Fishes assemble in sanctuaries for shelter, lead peaceful life without any disturbance and can move freely towards feeding and breeding grounds. It has positive impact in all cases on fish production, biodiversity and socioeconomic condition of fishers (DoF 2016, Hossain *et al.* 2017). Fish sanctuary is a particular form of protected area in waters and considered to be an important and efficient managing tool for protection, conservation and management of fisheries resources (Islam *et al*., 2016). Generally, it can be defined as a prescribed area of particular waters together with buffer zone where fishing is strictly prohibited. Fish and other aquatic

organisms can take shelter, survive, and reproduce without any disturbance which is used worldwide as a fish conservation tool (Islam and Hossain, 2019). In 1960-1965, DOF established 23 fish sanctuaries in several floodplain waters under the Development and Management Scheme. Another 25 sanctuaries were established by DoF under the same scheme in 1960-1965 bases on the positive outputs of the previously established sanctuaries.

However, an ecosystem-based management approach with local community participation is necessary for the sustainable utilization of the fisheries resource of the polder. Therefore, community managed net pen culture and fish sanctuary was established through the project inversions of "Catch assessment survey, Net pen culture, Fish conservation, Sanctuary construction, and Awareness building in 6 Polders under CEIP-1" in the jurisdiction of Barisal division were implemented by CICO receiving technical supports from the Department of Aquaculture, Patuakhali Science and Technology University for the conservation and restoration of fish biodiversity.

1.1 Specific objectives

The specific objectives of the present acuities are:

- ✓ To collect data regarding catch assessment, aquaculture status, Aquatic mammal movement and aquatic biodiversity.
- ✓ To trained up local fish farmers/fisherman on improve culture practice including rice cum golda farming, pond culture/net pen culture.
- ✓ To establish 6 fish sanctuary including native fish fry release in the perineal khals of 6 polders for conservation of threatened fish species.
- ✓ To build awareness of local community for conservation of threatened fish species.
- ✓ To help community people through net pen culture.

Table-1: Activities performed by consultant regarding Catch assessment survey, Net pen culture, Fish conservation, Sanctuary construction, and Awareness building in 6 Polders under CEIP-1" in contract package W-02.

Sl. no	Date/Month of year	Polder no	Name of the activities	Outputs of the activities
1	27 March, 2022	43/2C	Planning meeting with CICO polder manager as well as WMA team.	Developed work plan on all fisheries activity at different polders.
2	2 April, 2022	41/1	Planning meeting with CICO polder manager as well as WMA team.	Developed work plan on all fisheries activity at different polders.
3	5 April, 2022	48		
4	8 April, 2022	39/2C		
5	14 April, 2022	47/2		
6	15 April, 2022	40/2		
7	17 April, 2022	39/2C	Training on improved fish culture practices and rice cum golda farming	Total 144 WMA members and fish farmers were trained up on improve aquaculture technology.
8	23 April, 2022	40/2		
9	27 April, 2022	48		
10	5 May, 2022	41/1	Training on improved fish culture practices and rice cum golda farming	Total 144 WMA members and fish farmers were trained up on improve aquaculture technology.
11	15 May, 2022	47/2		
12	21 May, 2022	43/2C		
13	27 May, 2022	39/2C	Meeting and field visit with WMA members for site selection due to sanctuary and Net pen culture	Suitable site was selected for sanctuary and Net pen culture
14	28 May, 2022	40/2		
15	3 June, 2022	41/1	Meeting and field visit with WMA members for site selection due to sanctuary and Net pen culture	Suitable site was selected for sanctuary and Net pen culture
16	4 June, 2022	43/2C		
17	10 June, 2022	47/2		
18	11 June, 2022	48		
19	5 August, 2022	39/2C	Transport net pen and banner from PSTU, collect plastic drum, bamboo, rope, cod, brick etc to setup net	Net Pen or cages were setup in the selected lake. Net Pen or cages were setup in the selected lake.
20	6 August, 2022	40/2		
21	16 August, 2022	41/1		
22	17 August, 2022	43/2C		

Sl. no	Date/Month of year	Polder no	Name of the activities	Outputs of the activities
23	18 August, 2022	48	pen in the selected lake.	
24	19 August, 2022	47/2		
25	20 August, 2022	43/2C	Meeting with CICO for fish fry collection	Select fish species and hatchery to release in the net pen.
26	26 August, 2022	Hatchery	Meeting with hatchery owner for fish fry collection	Select fish species and hatchery to release in the net pen.
27	27 August, 2022	39/2C	Collect Tilapia and Pangas fingerlings from hatchery and fish farmers and transport to the polder CICO truck and local transport	Fish fingerlings were stocked in the Net pen.
28	28 August, 2022	40/2		
29	29 August, 2022	41/1		
30	31 August, 2022	43/2C		
31	2 September, 22	48	Collect Tilapia and Pangas fingerlings from hatchery	Fish fingerlings were stocked in the Net pen.
32	3 September, 22	47/2		
33	30 September, 22	43/2C	Meeting with CICO regarding funding of training on net pen culture	Fund collected from CICO for training program.
34	1 October 2022	39/2C	Training on Net Pen culture and awareness building program	Total 148 WMA members and fish farmers were trained up on improve aquaculture technology.
35	2 October 2022	40/2		
36	4 October 2022	48		
37	5 October 2022	47/2		
38	6 October 2022	41/1		
39	9 October 2022	43/2C		
40	15 October 2022	39/2C	Monitoring of net pen culture and results demonstration	Results of net pen culture was demonstration
41	21 October 2022	43/2C	Monitoring of net pen culture and results demonstration	Results of net pen culture was demonstration
42	22 October 2022	39/2C	Sanctuary establishment and Monitoring of net	Establish fish Sanctuary and observation of fish growth.
43	28 October 2022	40/2		

Sl. no	Date/Month of year	Polder no	Name of the activities	Outputs of the activities
			pen culture	
44	4 November, 22	48	Sanctuary establishment and Monitoring of net pen culture	Establish fish Sanctuary and observation of fish growth.
45	5 November, 22	47/2		
46	8 November, 22	41/1		
47	14 November, 22	39/2C	Observe fish health and water quality to find out the causes of mortality.	Causes of fish mortality were identified and give suggestion to WMA member
48	18 November, 22	47/2	Observe fish health and water quality to find out the causes of mortality.	Causes of fish mortality were identified and give suggestion to WMA member

SECTION 2: FINDINGS ON SPECIFIC ACTIVITIES

2.1 Activity Name: Catch Assessment Survey

2.1.1 Aim: The aim of the survey study for CEIP-1 (Package-II) under the Fisheries sector were to identify the causes of decreasing fish biodiversity among the polders area and how these problems can overcome.

The specific objectives of the study were to:

- ✓ Know the past (around 5 year) and present fish and other aquatic animals' biodiversity at selected polders;
- ✓ Identify the fishermen profile including educational, family members, age, fishing experience, regularity of fishing etc.
- ✓ Know the harmful nets which hamper the natural fish production.
- ✓ Know the knowledge of fish sanctuary and farming of fish;
- ✓ Identify and assess the potential environmental and social impacts of the Project;
- ✓ Identify mitigation measures to minimize the negative impacts and enhancement measure to enhance the positive impacts;

2.1.2 Materials and methods:

Study area

The present study was conducted during April to June 2022 in the southern coastal region of Bangladesh including the polder 39/2C, 40/2, 41/1, 43/2C, 47/2 and 48 were located Bhandaria, Patharghata, Borguna, Galachipa, Kalapara and Kuakata respectively (Figure 1)

Methodology

Both primary and secondary data were used during the study. For gathering data, a combination of several survey techniques was adopted are as follows:

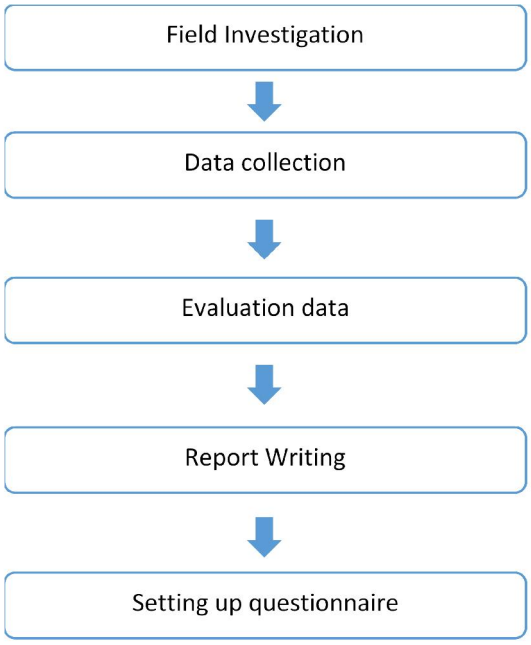


Figure 2. Overall methodology of Catch Assessment Survey

Primary Data Collection

Field surveys were used for the collection of primary data. For the confirmation of the secondary data, primary data was used also. By using questionnaire, interviews and direct observations, primary data were gathered for this survey. Primary data were collected through structured questionnaires. The questionnaire form was filled in by interviewing from 40 fishermen frome ach polder area.

Secondary Data Collection

Secondary source of information consists of published material such as websites, journals, textbooks, newspaper etc.

Focus group discussion (FGD)

For this research one of the PRA (Participatory Rural Appraisal) tool, such as Focus Group Discussion (FGD) was conducted with fish farmers. In this survey, FGD was used to get an overview of the problems and discussed on how to solve the problems as well as shared knowledge on different topics such as sustainable fishing, fish farming, importance of fish sanctuary and cage culture etc. A total of 48 FGD sessions was conducted on 6 polder area and each polder area covered 8 FGD session where each group size of FGD was 6 to 8

people. FGD session was held in front of tea stall, under the shaded area, in the open field, beside khals etc.

Crosscheck interviews

After collecting the data through questionnaire, interviews and FGD, crosscheck interviews were conducted with SUFO (Senior Upazila Fisheries Officer), UFO (Upazila Fisheries Officer), WMA (Water Management Association) president and field Assistant.

Data Processing and Analysis

The collected data were transferred to tabular forms after careful examination and calculation. Data collected from various sources were coded and entered into a data base system using Microsoft office Software. The processed data were transferred to a master sheet from which classified tables were prepared revealing the findings of the study. Finally, these data were analyzed by MS-Excel and then presented in textual, tabular and graphical forms.

Appendix

In annexure section we add the following things:

- ✓ In Appendix 1 we added sample of questionnaires from fish farmers, senior upazila fisheries officer and water management association president or secretary,
- ✓ Appendix 2 we added some photo from all the selected polder, training of research associate on catch assessment survey by BWBD consultant, fishing boat, interview with fishermen etc.

Polder 39/2C

Polder 40/2

Polder 41/1

Polder 43/2C

Polder 47/2

Polder 48

Figure 3. Catch assessment survey at different polders

2.1.3 Results

a) Biodiversity

i) Fishes Found in Polder Now

The fish biodiversity in different polder area is declining day by day. The Polder area comprises an assemblage of both fresh and brackish water fish species. The available fish species are Golda Chingri, Horina Chingri, Baila, Tengra, Vetki, Tit Punti, Tengra, Shol, Taki, Shing, Baim, etc.

Table 2: Availability of fish species in different polder area

Scientific Name	Local Name	Polder No.					
		39/2C	40/2	41/1	43/2C	47/2	48
Metapenaeaus monocerus	Horina Chingri	✓	✓	✓	✓	✓	✓
Leander styliferus	Gura chingri	✓	✓	✓	✓	✓	✓
Pama pama	Poa	✓	✓	✓	✓	✓	✓
Lates calcarifer	Vetki	-	✓	✓	-	✓	-
Polynemus paradiseus	Taposhi	✓	✓	-	✓	-	-
Mystus vitatus	Tengra	✓	✓	✓		✓	✓
Mystus cavasius	Gulsa	✓	-	✓	✓	✓	-
Macrobrachium rosenbergii	Golda	✓	✓	✓	✓	✓	✓
Channa punctatus	Taki	✓	✓	✓	✓	✓	✓
Anabas testudinius	Koi	✓	✓	✓	✓	✓	✓
Heterpnestis fossilis	Shing	-	-	✓	-	-	✓
Mastacembelus spp.	Baim	-	-	✓	✓	✓	-
Mugil corsula	Bata	✓	-	-	✓	-	✓
Xenentodon cancila	Kakila	-	✓	✓	✓	-	✓
Setipinna phasa	Phasa	✓	✓	-	✓	✓	-
Gudusia chapra	Chapila	-	-	✓	-	✓	-
Corica soborna	Kachki	-	✓	-	✓	-	✓
Tenualosa ilisha	Ilish	✓	✓	✓	✓	✓	✓
Devario aequipinnatus	Chebli	-	-	✓	✓	-	-
Esomus danricus	Darkina	-	-	-	✓	✓	✓
Catla catla	Katol	✓	✓	-	✓	-	-

Scientific Name	Local Name	Polder No.					
		39/2C	40/2	41/1	43/2C	47/2	48
Amblypharyngodon microlepis	Mola	✓	✓	-	✓	-	✓
Puntius puntio	Punti	✓	✓	✓	✓	✓	✓
Puntius ticto	Tit punti	✓	-	✓	-	-	✓
Chelon parsia	Parse	✓	✓	-	✓	-	-
Notopterus notopterus	Foli	✓	-	-	✓	-	✓
Parambassis ranga	Ranga chanda	-	✓	-	-	✓	-
Awaous guamensis	Bailla	✓	✓	-	-	✓	-
Channa gachua	Cheng	-	-	✓	-	-	✓
Channa striata	Shol	✓	✓	✓	✓	✓	✓
Pseudapocryptes elongatus	Chewa	✓	✓	✓	✓	✓	-
Brachygobius nunus	Nuna bailla	-	✓	-	-	✓	-
Colisa fasciata	Khailsha	✓	-	-	✓	-	✓
Mystus vittatus	Tengra	✓	✓	-	✓	-	-
Rita rita	Rita	-	✓	-	-	✓	-
Clarias batrachus	Magur	-	-	-	-	-	-
Pangasius pangasius	Pangas	✓	✓	✓	✓	-	✓
Monopterus cuchia	Kuchia	✓	-	✓	✓	-	✓
Tetraodon fluviatilis	Potka	-	✓	-	-	✓	-
Lepidocephalichthys guntea	Gutum	-	-	-	✓	-	-
Pseudeutropius atherinoides	Batasi	✓	✓	-	-	✓	-
Silloginopsis panijus	Tular dandi	-	✓	✓	-	✓	-
Katengus typus	Med	-	✓	-	-	-	✓
Penaeus monodon	Bagda chingri	-	✓	-	-	✓	-

ii) Endangered fishes

An endangered species is a species that is very likely to become extinct in the near future, either worldwide or in a particular place. Endangered species may be at risk due to factors such as habitat loss, poaching and invasive species. Endangered fish species, which are locally rare and unavailable now reported by the local fishermen and concerned elderly people, are given in Table 3. The reason of Endangered fish species in the polder area are agrochemicals and pesticides coming from paddy fields, decline of water depth, obstruction of fish migration route, destruction of fish breeding and spawning grounds, etc.

Table 3: Endangered fish species with their local status

Scientific Name	Local Name	Local Status		
		Rare	Unavailable	Locally Extinct
Rohtee cotio	Dhela	✓		
Tenualosa toli	Chondona	✓		
Sperata aor	Ayre		✓	
Nandus nandus	Veda		✓	
Glossogobius Giuris	Bele	✓		
Channa marulius	Gojar			✓
Pangasius pangasius	Pangas	✓		
Polynemus paradiseus	Taposi	✓		
Clarius batrachus	Magur		✓	
Raiamas bola	Bhol		✓	

b) Fishing Gears

Different fishing gear use by fisherman in different time and purpose. In this polder area, fishermen use some fishing net in which some are useful and some are harmful for fish.

Table 4: Fishing gears with their types

Fishing Gear	Non-Harmful	Harmful
Ilish jal/Shutar jal/Current Jal		✓
Pomar jal	✓	
Fasha jal	✓	
Behundi jal		✓
Ber jal	✓	
Moiya Jal	✓	
Chak jal		✓
Sip barshi	✓	
Chabi jal	✓	
Lamba jal	✓	
Dheson jal	✓	
Jhaki Jal	✓	

c) Aquaculture Status

(i) Culture System

Table 5: Culture system of this polder

System	%
Extensive	95
Semi Intensive	5
Intensive	0

(ii) Culturable Species

Table 6: Species cultured by fish farmers

Scientific Name	Local Name
Ctenopharyngodon idella	Grass Carp
Labeo rohita	Rui
Catla catla	Catla
Anabas testiduneus	Koi
Cirrhinus cirrhosus	Mrigal
Cyprinus carpio	Carpio
Macrobrachium rosenbergii	Golda
Hypophthalmichthys molitrix	Silver Carp
Pangasianodon hypophthalmus	Pangus
Oreochromis niloticus	Tilapia
Puntius gonionotus	Thai Punti

(ii) Feed

Table 7: Uses of Feed

Categories	% of use
No feed use	80
Supplementary feed (rice bran, mustard oil cake)	15
Commercial feed	5

(iv) Use of lime and fertilizer

Table 8: Use of lime and fertilizer

Status	Percentage (%)
Regular use	10
Irregular use	30
No lime use	60

(v) Stocking density

Table 9: Status of Stocking density

Status	%
Use optimum stocking density	0
Over stocking density	100

c) Fishermen Profiles

In all six polders, there approximately 15,072 fishermen engaged with fishing. Around 85% fishermen are regular. Some of the fishermen culture some common species such as rui, catla, tilapia, Thaipungus, golda fry etc. Maximum people do not use toxicants only potash for water clearance, some fertilizer like urea, TSP, and cowdung are use particularly. Using lime is common but not with desirable limit. Partially or no feed supply by the farmer. From the study we collected some fishermen personal information in the polder area. From each polder area, 40 fishermen data were collected.

Details results of catch assessment survey are given in Annexure 2.

2.1.4 Outcome:

The main outcomes of catch assessment survey are given below-

- Can know about the socio-economic condition of the polder areas.
- Can know about the biodiversity of the polder areas.
- Can know about the gears which are harmful for fisheries sector.
- Known about the positive as well as negative results of building polders.
- Known about the educational status of the fishermen.
- Came to know about the reason for decreasing fish in polder areas.
- Known about the environmental changes related to people work.

2.1.5 Specific causes of fish biodiversity declining

Fish Biodiversity loss is a major threat in the polder area and abundance of indigenous fish species are decreasing each year in different water bodies of polders. The specific causes of fish biodiversity declining in the polder area are given bellow:

1. Over fishing and indiscriminate fishing in the river and canals of the polders area are the major causes of biodiversity declining.

2. Catching of fish fry, juvenile and brood fishes by using illegal fishing gears in the polder area.
3. Katha fishing (use of trees, bamboo for fish aggregation) is common in the cannels of polders which need to be stopped.
4. Fishing by dewatering due to low water depth in winter. To save natural brood fish for next year fishing by dewatering should be stopped.
5. Poison fishing-some people illegally use poison at small canals to catch fish. As results all fishes including eggs, fish fry and juvenile are destroyed. Poison fishing must be stop to save fish biodiversity.

The above recommendations have been circulated & disseminated though the arranged program of CEIP-1 such as results demonstration, training program & awareness campaigning's.

2.1.6 Conclusions

From the above circumstances it is clear that the fish biodiversity is declining day by day due to various ways including the degradation or alteration of habitat which are used as frequently for feeding, breading, spawning and nursing ground. Besides coastal cyclones, siltation, over catching, indiscriminately uses of fisheries resources can be causes of fish biodiversity reduction. Besides establishment of permanent and temporary fish sanctuaries in the cannel of polders and proper management of these sanctuaries need to be ensured. Stocking of quality fry of indigenous may be an option for increasing abundance and diversity of fishes. Effort should be made to educate the local people and create awareness among them about the importance and the need for conservation and management of this valuable wetland.

From this survey we can get idea about the coastal fishermen profile such as their educational qualification, family size, fishing experiences etc. From this survey we can also know about the migration route of fish in different polders and biodiversity of fish and other aquatic animals. We can also be known about the past and present biodiversity of fish and other aquatic animal in different polders. In this survey people can know about the endanger dish and they can take necessary steps to protect them from extinct. From the economical point of view this survey has great importance and hope it will bring many solutions of many problems in near future.

2.2 Activity name: Net Pen Culture

2.2.1 Aim:

Given that cage culture of fish has a high productivity compared to traditional fish farming, the principal aim of cage culture in polder areas is to make fishing industry more profitable in these areas and contribute more effectively to the national economy. However, aim of cage culture of fish in polder areas can be pointed out as follow -

1. To increase the production of commercially important fish species.
2. To ensure non-seasonal supply of fish species those have high demand in market.
3. To ensure the proper utilization of vast water bodies in this region without intervening the other uses of those water bodies.
4. To create an alternative livelihood for the people of this coastal area.
5. To establish an effective fish culture system that is more adaptive to the negative consequences of climate change.
6. To make fish culture more productive and economically viable in this region.
7. To maximize fish production and reduce the negative impacts of fish culture on surrounding environment.

2.2.2 Methodology:

Location of the cage

Table10: Cage location of different polders

Sl. No.	Polder Number	Name of the Lake	Number of switch gate	Location
01	39/2C	Nadmula Khal	DS-12	Bhandaria
02	40/2	Charduani Bazar Khal	DS-4	Patharghata
03	41/1	Amajhuri Khal	DS-1	Barguna
04	43/2C	Golkhali Beribadh Khal	DS-3	Galachipa
05	47/2	Dalbugonj High School Khal	DS-3	Kalapara
06	48	Barohar Khali	DS-3/3	Kuakata

Preparation and setup of net pen:

a. **Netting Material and Mesh:** The netting materials are purchased locally. Rolled nets are purchased from the factory. They cut and sew to the particular shape and size of hapa/cages. As stocking size of fingerlings is 15-20 grams, the mesh size has to be around 2 cm. A finer meshed net (locally called Rachel net) of 0.5 meter height is attached to the upper inner side of cages to protect the floating feed pellets escaping out. A larger meshed (5 cm) net is used to cover the cages on top to protect from birds e.g. pelicans, eagles and others.

b. **Floating the Frames and Setting the Nets:** The cage frames are attached one another in a series supported to float by 2-3 exhausted 200L barrels in each gap. The whole structure is then hardened by binding with bamboos around the structure. The setting of frames and barrels was done on the land first and then pushed over the khalwater, placed in a suitable place and then tied with anchors in all sides. Then the cage-nets was attached with floating frame suspending down with the help of half-bricks tied at each corner. After setting the cages, they was left exhausted for about 15 days so that the inner parts of the nets lose their roughness so that fishes would not be wounded.

c. **Stocking Size and Stocking Density:** Large size fingerlings e.g. 5-8 g was stocked in the cage. Stocking density was500 fish per cage. Increasing the density beyond this wasincreases the mortality.

d. **Feeding Rate, Frequency:** Floating feed was used in cage. Feeding was done twice daily to satiation level spreading over the water surface in each cage. During feeding the cages are not disturbed by any other activities. A number of companies are supplying floating feeds; the quality of them is more or less similar. Good feeding management in cages ensures the FCR remain less than 1.75, whereas, inexperienced new farmers use more feeds unnecessarily.

PSTU, Patuakhali

PSTU, Patuakhali

Polder 39/2C

Polder 40/2

Polder 41/1

Polder 43/2

Polder 47/2

Polder 48

Figure 4. Preparation and Setting of Net Pen in different Polders

Stocking of Fish fry in Net Pen: Stocking density of tilapia fish was 500/cage and pangas 300/cage.

Polder 39/2C

Polder 40/2

Polder 41/1

Polder 43/2C

Polder 47/2

Polder 48

Figure 5. Net Pen culture at different Polders

Management of Net Pen:

Figure 6. Monitoring of fish growth and health

Study of water quality parameters:

Water quality parameters of the lake were recorded in every fifteen days interval throughout the culture period. Physico-chemical parameters, such as water temperature (°C), dissolved oxygen (mg/l), pH, ammonia (mg/l), nitrite (mg/l) and alkalinity (mg/l) hardness(mg/l), salinity (ppt) were measured on the spot.

a) Temperature (^{o}C)

Water temperature was measured by using portable thermometer. Thermometer was hold in pond and shaken gently to get the readings and calibrated up to mark.

b) pH

pH was measured by using pH meter. Meter was hold in experimental khal of different side near to the cage to get the reading and calibrated up to the mark.

c) Dissolved oxygen (mg/L)

Firstly, rinsed the glass bottle 3 times with water sample and fill to overflow. Inserted stopper and ensure that a small part of the sample spills over. Removed the stopper and added 5 drops each of Manganous sulphate solution and Alkali-Azide reagent. Added some more sample to fill the bottle completely. Carefully stoppered the bottle again ensured that a part of the sample spilled over. This was done to make sure that no air bubbles had been trapped inside, which would be corrupted the reading. Inverted several times the bottle. The sample was become orange-yellow and a flocculent precipitate was formed that means oxygen was present. Let the sample was stand and the flocculent precipitate was started to settle. After approximately 2 minutes, when the upper half of the bottle became limpid, added 10 drops of

sulphuric acid solution. Again, stoppered the bottle and inverted it until all particulate material was dissolved. The sample was ready for measurement when it was yellow and completely limpid. Removed the cap from the plastic vessel. Rinsed the plastic vessel with the solution in the bottle, filled to the 5 ml mark and replaced the cap. Then added 1 drop of starch indicator through the cap port and mixed by carefully swirling the vessel in tight circles. The solution was turned a violet to blue color. Pushed and twisted pipet tip onto tapered end of syringe ensuring an air tight-fit. Took the titration syringe and pushed the plunger completely into the syringe. Inserted tip into HI 3810-0 titrant solution and pulled the plunger out until the lower edge of the plunger seal was on the 0 ml mark of the syringe. Placed the syringe tip into the cap port of the plastic vessel and slowly added the titration solution dropwise, swirling to mix after each drop. Continue adding titration solution until the solution in the plastic vessel changes from blue to colorless. Read off the milliliters of titration solution from the syringe scale and multiply by 10 to obtain mg/l (ppm) oxygen. If results are lower than 5 mg/l, the precision of the test can be improved as follows. Add an amount of unused sample in the glass bottle to the 10 ml mark of the plastic vessel. Proceed with the test as described before and multiply the values on the syringe scale by 5 to obtain mg/l oxygen in the sample.

e) Ammonia (mg/L)

Ammonia was tested using HANNA instruments and reagents provided in kits (HI 3825 Ammonia Test Kits) as per instruction manual.

First 10 ml sample was taken in plastic beaker. Then 5 drops of Ammonia Reagent1 were taken and mixed carefully. 8 drops of Nessler Reagents were taken and mixed carefully. The solution was taken into the color comparator cube and after 5 minutes color formed. The color was matched with scale of comparator.

f) Nitrite (mg/L)

Nitrite was tested using HANNA instruments and reagents provided in kits (HI 3873 Nitrite Test Kits) as per instruction manual.

10 ml sample was taken in glass cuvette. 1 packet of HI 3873-0 Nitrite Reagent was taken, shaken gently for 15 seconds and waited 6 minutes to develop color. 5 ml of colored sample was taken in color comparator and taken the readings matches with scales that were given.Finally multiplied the readings with the factor 3.28.

g) Alkalinity (mg/L)

Alkalinity was tested using HANNA instruments and reagents provided in kits (HI 3811 Alkalinity Test Kits) as per instruction manual.

5 ml sample was taken in plastic vessel, 1 drop of Bromophenol blue indicator was mixed, formed blue appearance and next step was taken. Titrate the solution with low conc. HI solution given in kits with the help of the titration syringe. Titration continued until the solution turned yellow. Read off the value and multiplied by 300 to obtain mg/l (ppm) $CaCO_3$.

h) Salinity (PPT)

A refractometer is considered by many to be a more accurate way to measure salinity. It's easy to use a refractometer. Firstly, opened the prism cover. Placed a few drops of water on the prism. Closed the cover. Then looked through the eyepiece. Adjusted focus. As we look through the eyepiece, we will see the scale for salinity and specific gravity with a distinct shift in color between the upper and lower section of the scale. That lateral line of color separation is the salinity level in specific gravity and PPT measurements.

i) Hardness (mg/L)

Hardness was tested using HANNA instruments and reagents provided in kits (HI 3812 Hardness Test Kits) as per instruction manual.

5 ml sample was taken in plastic vessel, 5 drops of hardness buffer was mixed, then add 1 drop calmagnetic indicator, it turns into red violet. Titrate the solution with low conc. HI solution given in kits with the help of the titration syringe. Titration continued until the solution turned blue. Read off the value and multiplied by 300 to obtain mg/l (ppm) $CaCO_3$.

Polder 39/2C

Polder 40/2

Polder 41/1

Polder 43/2C

Polder 47/2

Polder 48

Figure 7. Measurement of water quality parameter in different polders

Estimation of growth performance:

The total length (cm) and weight (g) of individual fish was recorded separately during the stocking period and final harvesting period due to estimation of the growth performance. The growth rates of pabda was calculated by the following formula.

a. Weight gain = Mean final body weight - Mean initial body weight

b. Specific growth rate (SGR)

$$\text{Log}_e W_2 - \text{Log}_e W_1$$

$$\text{SGR (\% per day)} = \frac{}{T_2 - T_1} \times 100$$

Where

W_1= Initial body weight (g) at time T_1 (day)

W_2= Final body weight (g) at time T_2 (day)

c. Food conversion ratio (FCR)

Food conversion ratio is the amount of dry feed per unit of live weight gain. FCR was calculated by using the following formula

$$\text{FCR} = \frac{\text{Amount of feed (g)}}{\text{Live weight gain (g)}}$$

d. Survivability

The survival rate should be calculated by the following formula:

$$\text{Survival rate (\%)} = \frac{\text{No. of hatchlings survived}}{\text{Total no. of eggs}} \times 100$$

2.2.3 Results

a) Water Quality Parameter Data

Table11: Water quality parameters of Nadmula Khal (DS 12), polder no. 39/2C during the Net Pen Culture.

Date	Parameter							
	pH	Temperature (°C)	Ammonia (mg/L)	Nitrite (mg/L)	DO (mg/L)	Alkalinity (mg/L)	Salinity (PPT)	Hardness (mg/L)
27.08.22	7.2	30.9	0.3	0	5.5	105	0	180
11.09.22	7.7	30.2	0.3	0	6.3	110	0	180
25.09.22	7.8	29.5	0.2	0	6.7	113	0	185
11.10.22	7.9	28.3	0.2	0.1	6.1	115	0	188
25.10.22	8.1	27.5	0.1	0.1	5.9	120	0	190
10.11.22	8.2	26.1	0.1	0.1	6.0	130	0	195

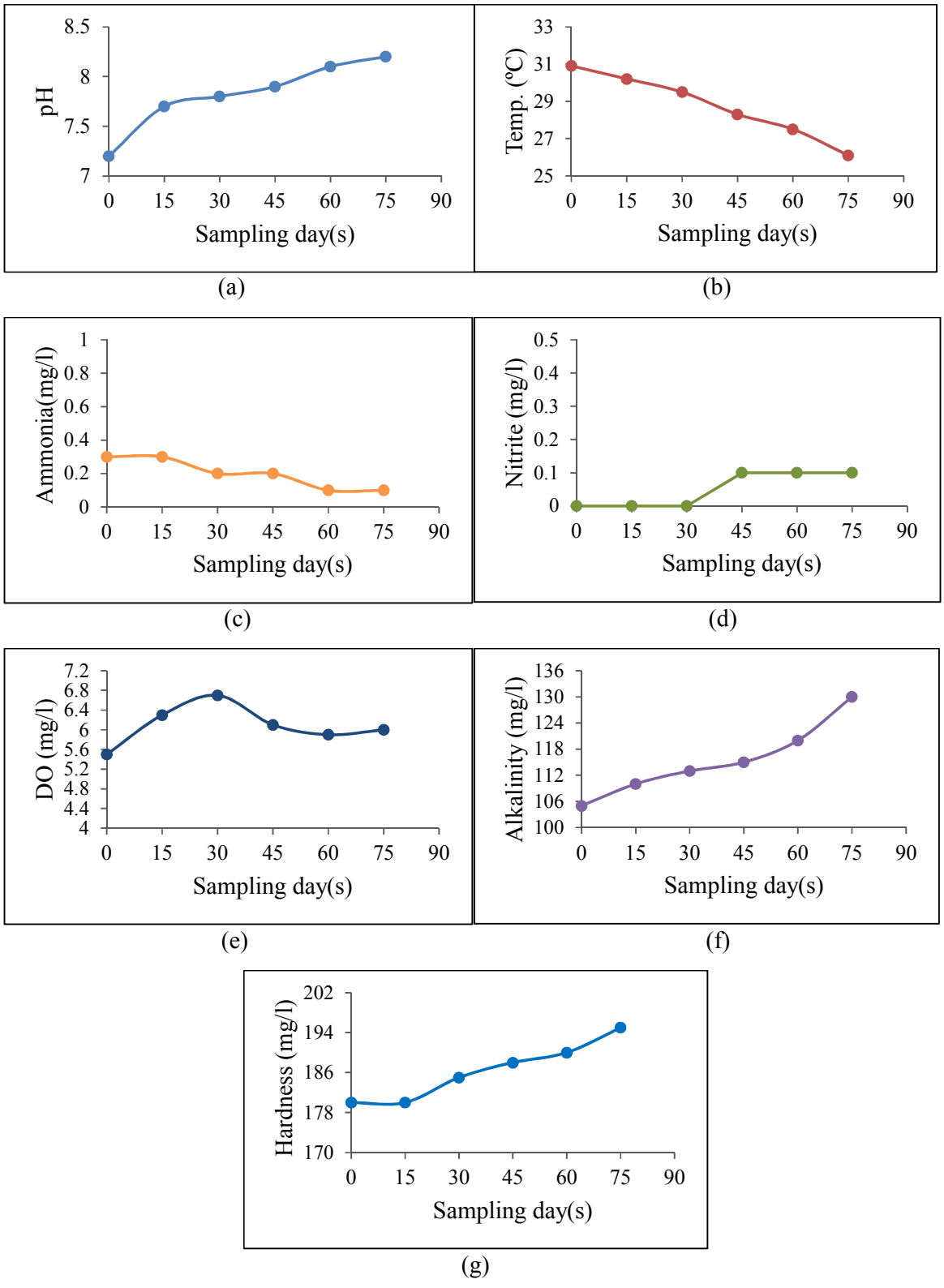
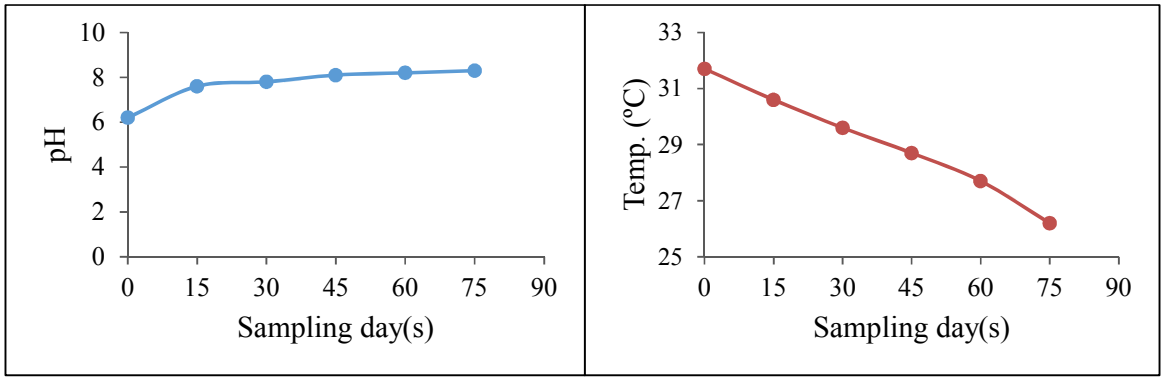


Figure 8. Water quality parameters of 39/2C during the study period: (a) pH, (b) Temperature, (c) ammonia, ((d) Nitrite, (e) DO, (f) Alkalinity (g) Hardness.

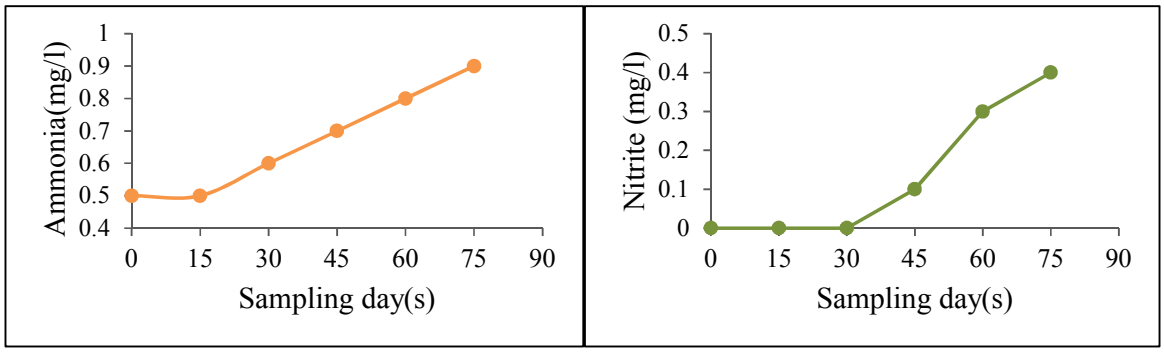
Water quality parameters of experimental khal in 39/2C during the study period recorded that pH ranged from 7.2 to 8.2, temperature 26.1-30.9 °C, ammonia 0.1-0.3 mg/L, nitrite 0-0.1 mg/L, DO 5.5-6.7 mg/L, alkalinity 105- 130 mg/L, salinity 0 ppt and hardness 180-195 mg/L.

Table 12: Water quality parameters of Charduani Bazar Khal (DS-4), polder no. 40/2 during the Net Pen Culture.

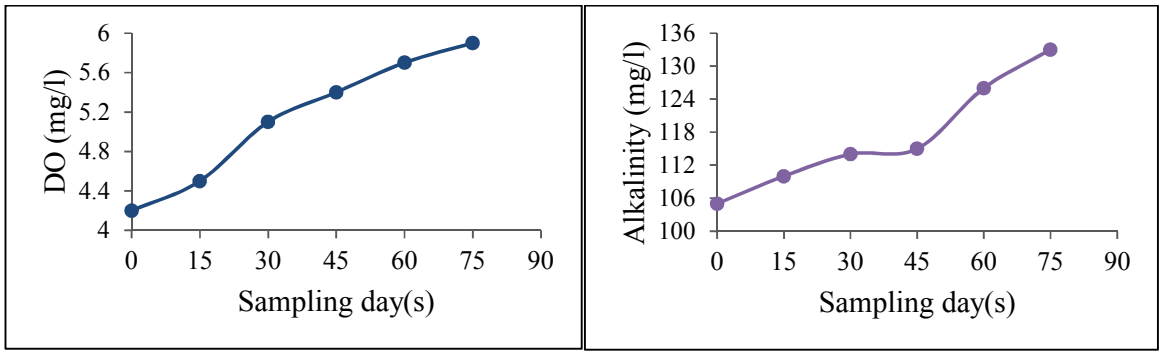
Date	Parameter							
	pH	Temperature (°C)	Ammonia (mg/L)	Nitrite (mg/L)	DO (mg/L)	Alkalinity (mg/L)	Salinity (PPT)	Hardness (mg/L)
28.08.22	6.2	31.7	0.5	0	4.2	105	0	120
12.09.22	7.6	30.6	0.5	0	4.5	110	0	122
26.09.22	7.8	29.6	0.6	0	5.1	114	0	130
12.10.22	8.1	28.7	0.7	0.1	5.4	115	0	136
26.10.22	8.2	27.7	0.8	0.3	5.7	126	0	142
11.11.22	8.3	26.2	0.9	0.4	5.9	133	0	148



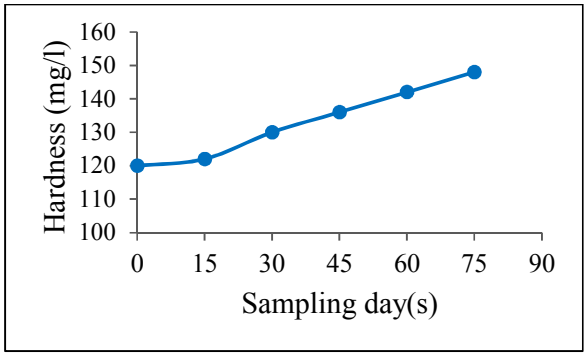
(a) (b)



(c) (d)



(e) (f)



(g)

Figure 9. Water quality parameters of 40/2 during the study period: (a) pH, (b) Temperature, (c) ammonia, ((d) Nitrite, (e) DO, (f) Alkalinity (g) Hardness

Table 13: Water quality parameters of Amajhuri Khal (DS-1), polder no. 41/1 during the Net Pen Culture

Date	Parameter							
	pH	Temperature (°C)	Ammonia (mg/L)	Nitrite (mg/L)	DO (mg/L)	Alkalinity (mg/L)	Salinity (PPT)	Hardness (mg/L)
28.08.22	7.4	30.7	0.4	0	5.4	112	0	181
12.09.22	7.6	30.1	0.4	0	5.5	118	0	186
26.09.22	7.7	29.3	0.5	0.2	5.9	123	0	189
12.10.22	7.8	28.7	0.6	0.3	6.1	125	0	195
26.10.22	8.2	27.5	0.7	0.4	6.2	136	0	198
11.11.22	8.4	26.2	0.8	0.5	6.3	141	0	202

Water quality parameters of experimental khal in 40/2 during the study period recorded that pH ranged from 6.2 to 8.2, temperature 26.2-31.7 °C, ammonia 0.5-0.9 mg/L, nitrite 0-0.4 mg/L, DO 4.2-5.9 mg/L, alkalinity 105- 133 mg/L, salinity 0 ppt and hardness 120-148 mg/L.

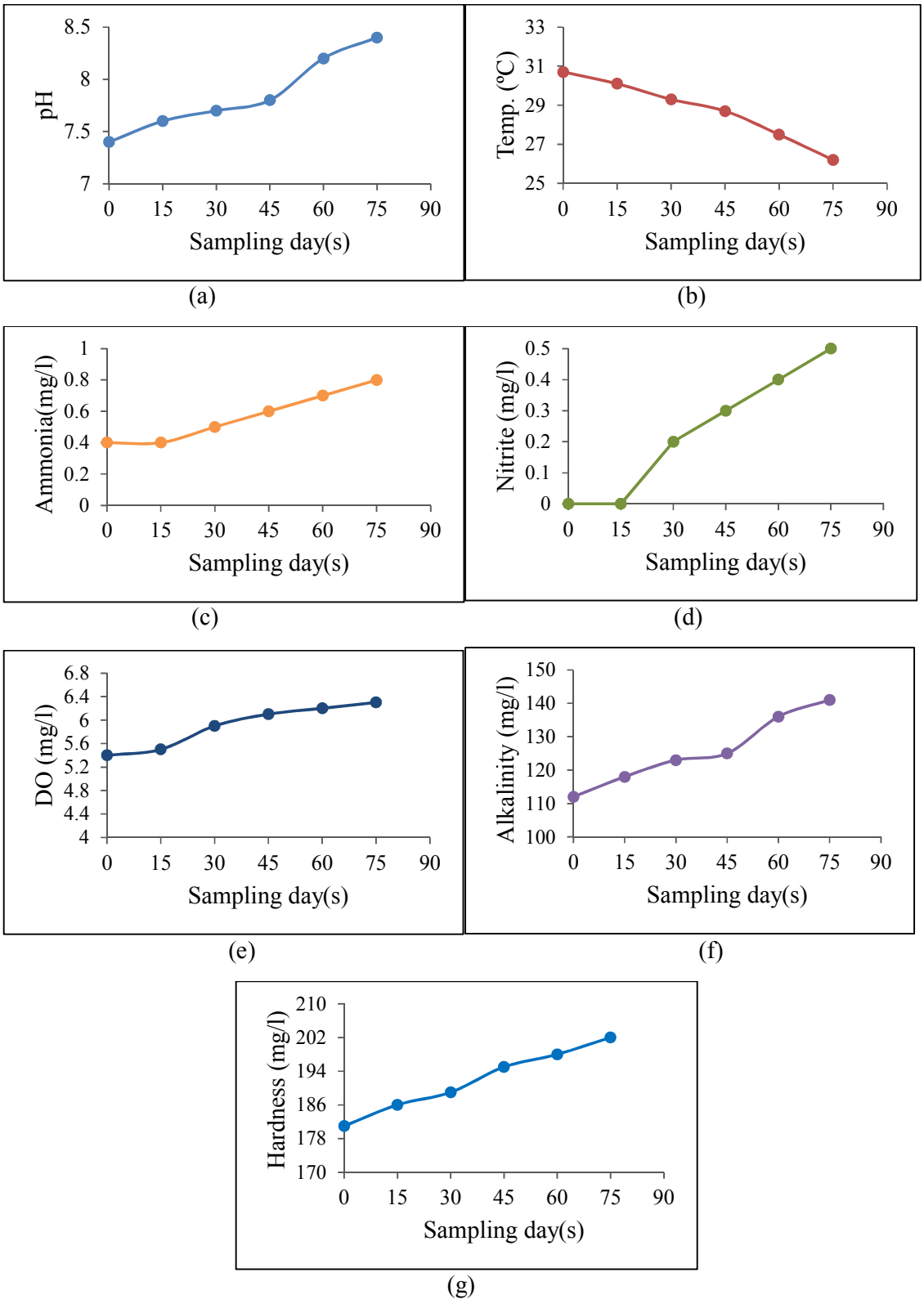
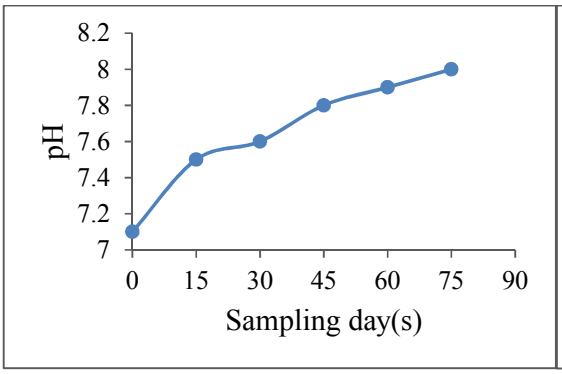


Figure 10. Water quality parameters of 41/1 during the study period: (a) pH, (b) Temperature, (c) ammonia, ((d) Nitrite, (e) DO, (f) Alkalinity (g) Hardness

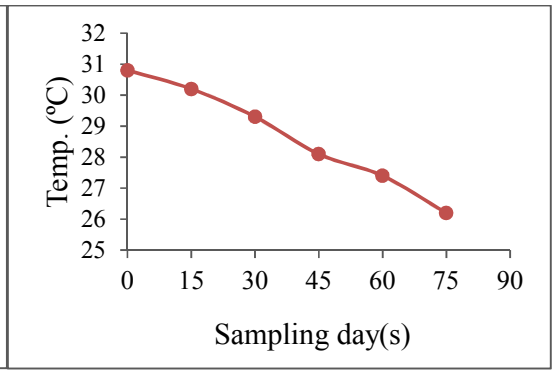
Water quality parameters of experimental khal in 41/1 during the study period recorded that pH ranged from 7.4 to 8.4, temperature 26.2-30.7 °C, ammonia 0.4-0.8 mg/L, nitrite 0-0.5 mg/L, DO 5.4-6.3 mg/L, alkalinity 112- 141 mg/L, salinity 0 ppt and hardness 181-202 mg/L.

Table 14: Water quality parameters of Golkhali Beribadh Khal (DS-3), polder no. 43/2C

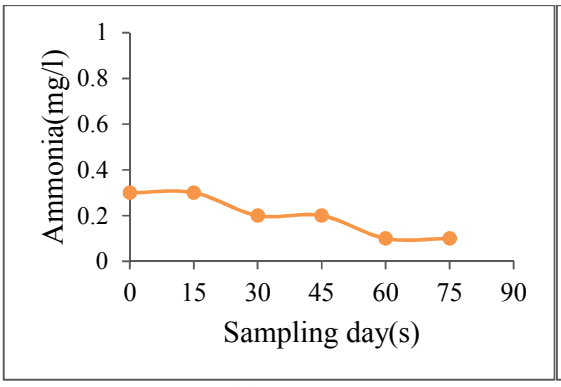
Date	Parameter							
	pH	Temperature (°C)	Ammonia (mg/L)	Nitrite (mg/L)	DO (mg/L)	Alkalinity (mg/L)	Salinity (PPT)	Hardness (mg/L)
26.08.22	7.1	30.8	0.3	0	5.5	105	0	180
10.09.22	7.5	30.2	0.3	0	6.3	110	0	180
24.09.22	7.6	29.3	0.2	0	6.7	113	0	185
10.10.22	7.8	28.1	0.2	0.1	6.1	115	0	188
24.10.22	7.9	27.4	0.1	0.1	5.9	120	0	190
09.11.22	8.0	26.2	0.1	0.1	6.0	130	0	195



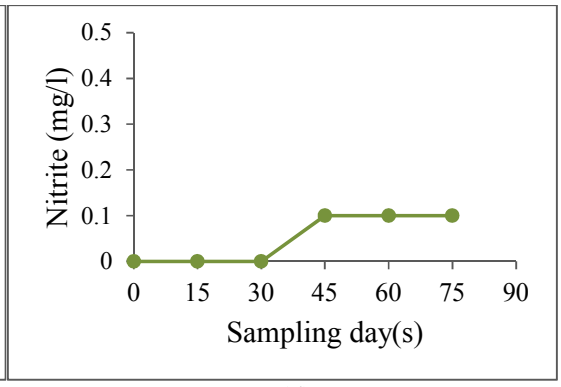
(a)



(b)



(c)



(d)

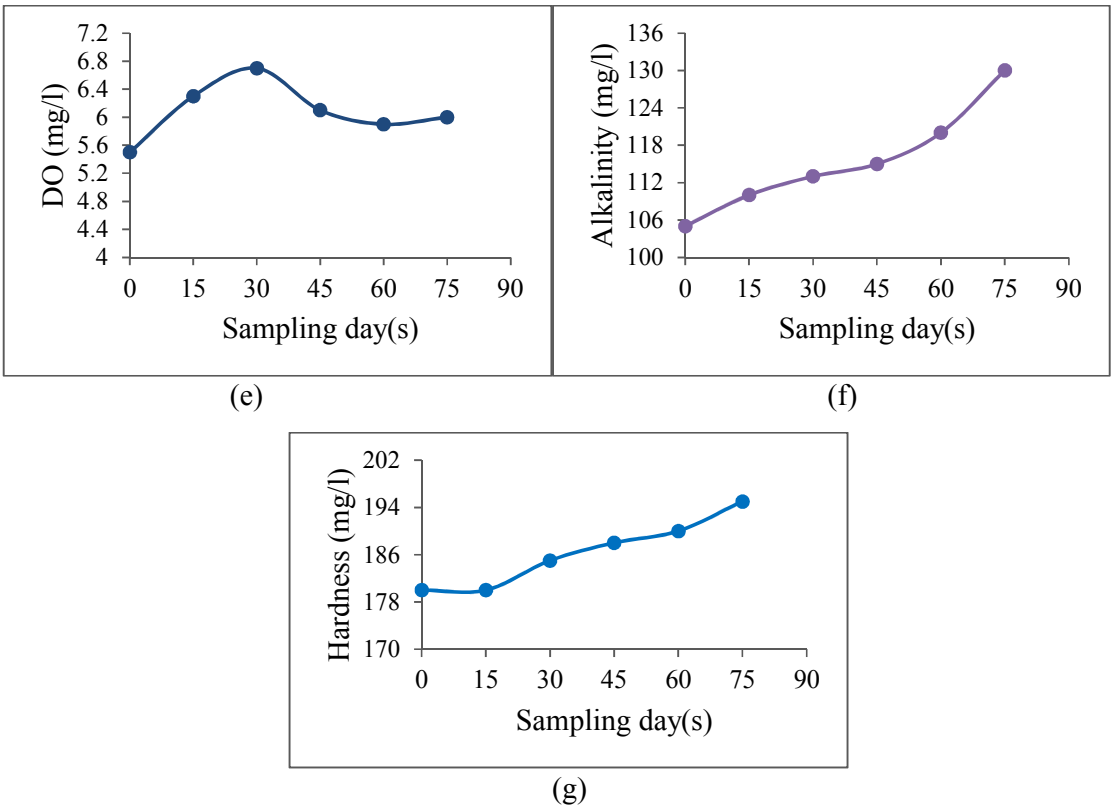


Figure 11. Water quality parameters of 43/2C during the study period: (a) pH, (b) Temperature, (c) ammonia, ((d) Nitrite, (e) DO, (f) Alkalinity (g) Hardness

Water quality parameters of experimental khal in 43/2C during the study period recorded that pH ranged from 7.1 to 8.0, temperature 26.2-30.8 °C, ammonia 0.1-0.3 mg/L, nitrite 0-0.1 mg/L, DO 5.5-6.7 mg/L, alkalinity 105- 130 mg/L, salinity 0 ppt and hardness 180-195 mg/L.

Table 15: Water quality parameters of Dalbugonj High School Khal (DS-3), polder no. 47/2 during the Net Pen Culture

Date	Parameter							
	pH	Temperature (°C)	Ammonia (mg/L)	Nitrite (mg/L)	DO (mg/L)	Alkalinity (mg/L)	Salinity (PPT)	Hardness (mg/L)
29.08.22	7.6	31.1	0.1	0	4.7	140	0	164
13.09.22	7.7	30.3	0.1	0	4.9	142	0	169
27.09.22	7.9	29.4	0.2	0	5.3	147	0	173
13.10.22	8.3	28.3	0.2	0.1	5.4	153	0	176
22.10.22	8.4	27.6	0.3	0.2	5.8	158	1	178
12.11.22	8.6	26.7	0.4	0.2	6.1	165	2	181

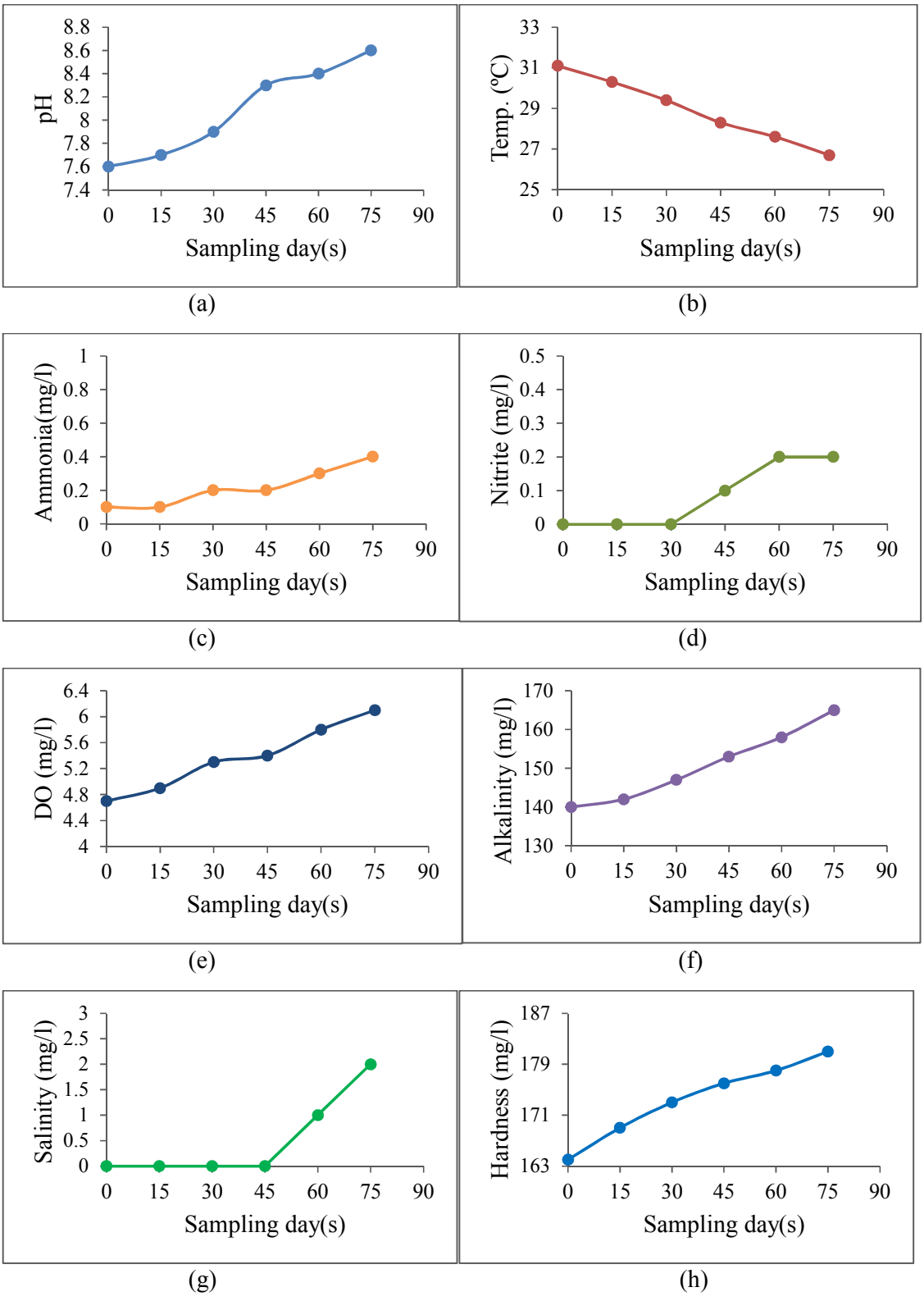
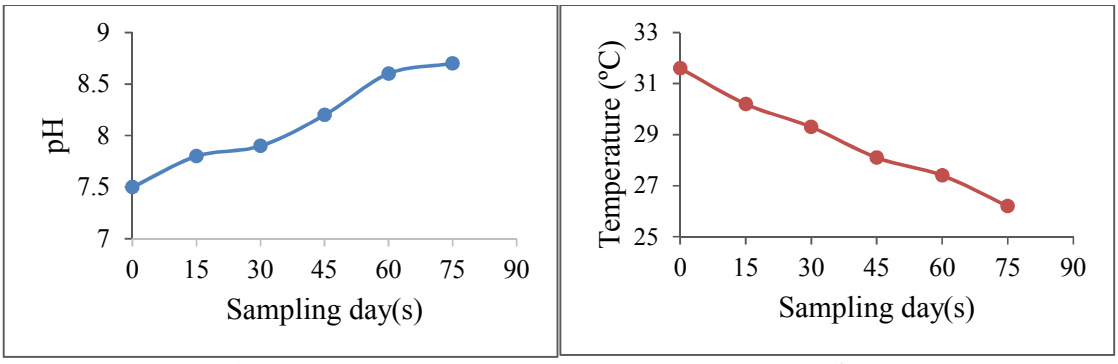


Figure 12. Water quality parameters of 47/2 during the study period: (a) pH, (b) Temperature, (c) ammonia, ((d) Nitrite, (e) DO, (f) Alkalinity (g) Hardness, (h) Salinity

Water quality parameters of experimental khal in 47/2 during the study period recorded that pH ranged from 7.6 to 8.6, temperature 26.7-31.1 °C, ammonia 0.1-0.4 mg/L, nitrite 0-0.2 mg/L, DO 4.7-6.1 mg/L, alkalinity 140- 165 mg/L, salinity 0-2 ppt and hardness 164-181 mg/L.

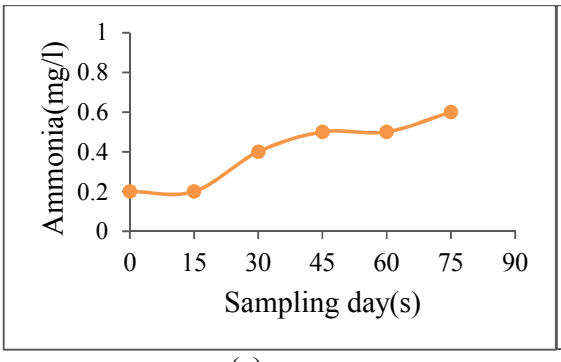
Table 16: Water quality parameters of Barohar Khal (DS-3/3), polder no. 48 during the Net Pen Culture.

Date	Parameter							
	pH	Temperature (°C)	Ammonia (mg/L)	Nitrite (mg/L)	DO (mg/L)	Alkalinity (mg/L)	Salinity (PPT)	Hardness (mg/L)
29.08.22	7.5	31.6	0.2	0	4.3	140	0	154
13.09.22	7.8	30.2	0.2	0	4.5	142	0	160
27.09.22	7.9	29.3	0.4	0.1	4.7	147	0	164
13.10.22	8.2	28.1	0.5	0.2	5.1	155	1	171
22.10.22	8.6	27.4	0.5	0.3	5.2	165	2	173
12.11.22	8.7	26.2	0.6	0.4	5.4	172	3	176



(a)

(b)



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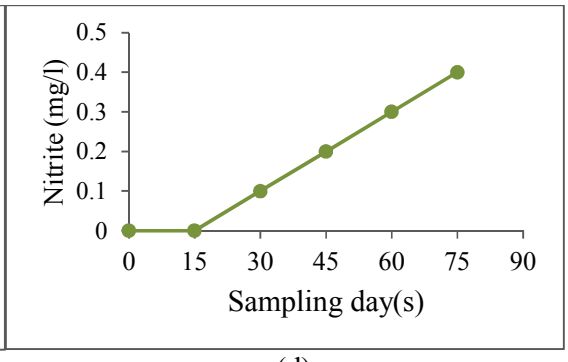

(d)

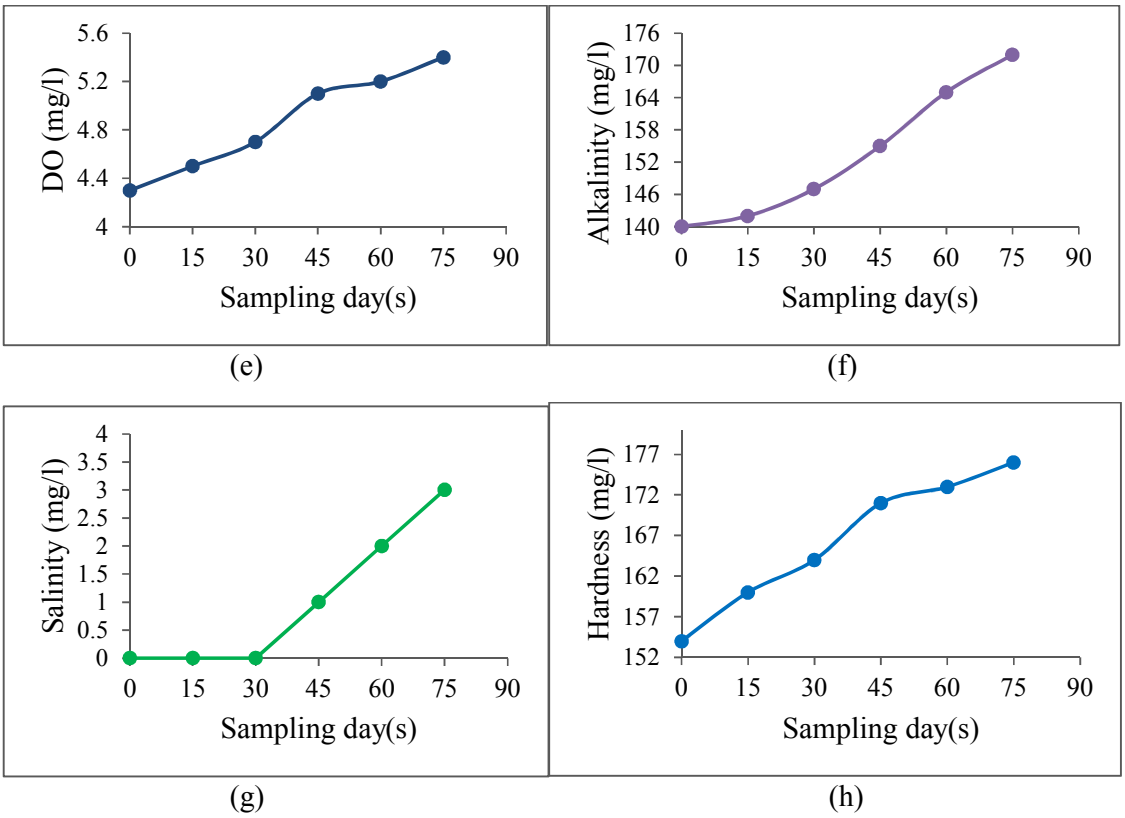

Figure 13. Water quality parameters of 48 during the study period: (a) pH, (b) Temperature, (c) ammonia, ((d) Nitrite, (e) DO, (f) Alkalinity (g) Hardness, (h) Salinity

Water quality parameters of experimental khal in 48 during the study period recorded that pH ranged from 7.5 to 8.7, temperature 26.2-31.6 °C, ammonia 0.2-0.6 mg/L, nitrite 0-0.4 mg/L, DO 4.3-5.4 mg/L, alkalinity 140- 172 mg/L, salinity 0-3 ppt and hardness 154-176 mg/L.

b) Growth parameter data

i. Tilapia:

Table 17: Comparison of yields parameters of Tilapia among different Polders

Yield parameters	39/2C	40/2	41/1	43/2C	47/2
Mean initial weight (g)	15	15	15	15	15
Initial length (cm)	9.5	9.5	9.5	9.5	9.5
Mean final weight (g)	220	180	190	200	190
Final length (cm)	22	19	20	21	20
Mean weight gain (g)	205	165	175	185	175
Specific Growth Rate (SGR)	2.98	2.76	2.82	2.87	2.82
Survival Rate (%)	93	94	92	95	94
Food Conversion Ratio (FCR)	1.86	1.88	1.90	1.85	1.85

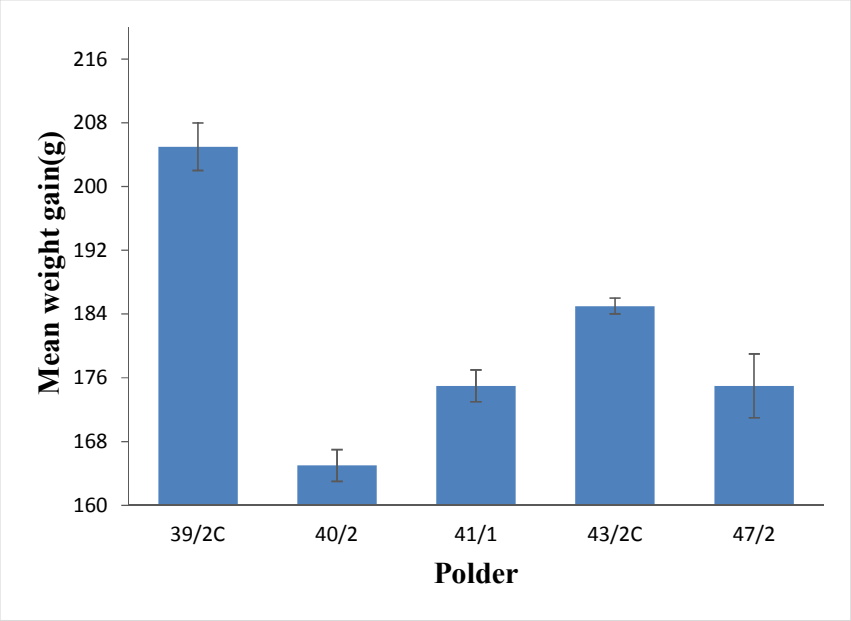

Figure 14. Mean weight gain variation of tilapia in different polders

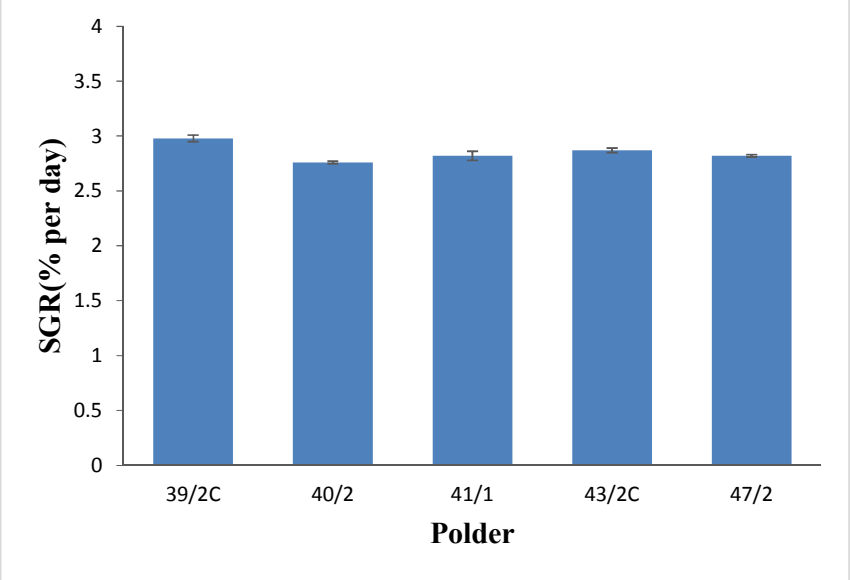

Figure 15. Specific growth rates (SGR) variation of tilapia in different polders

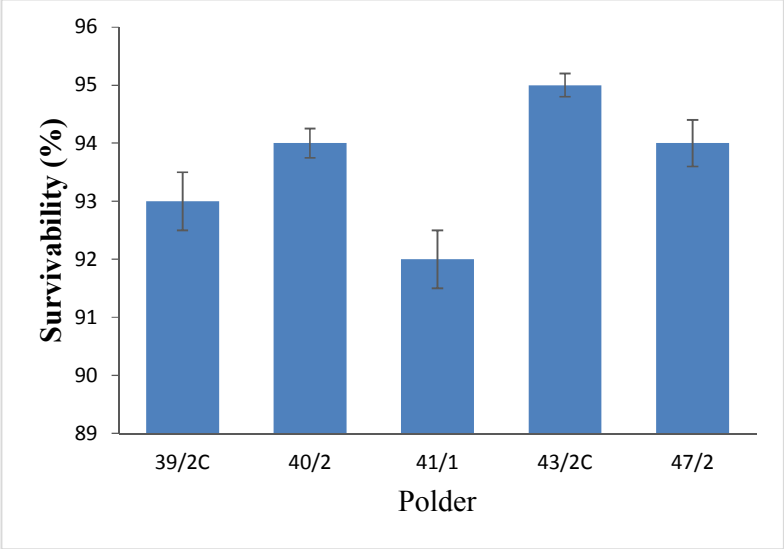

Figure 16. Survivability (%) variation of tilapia in different polders

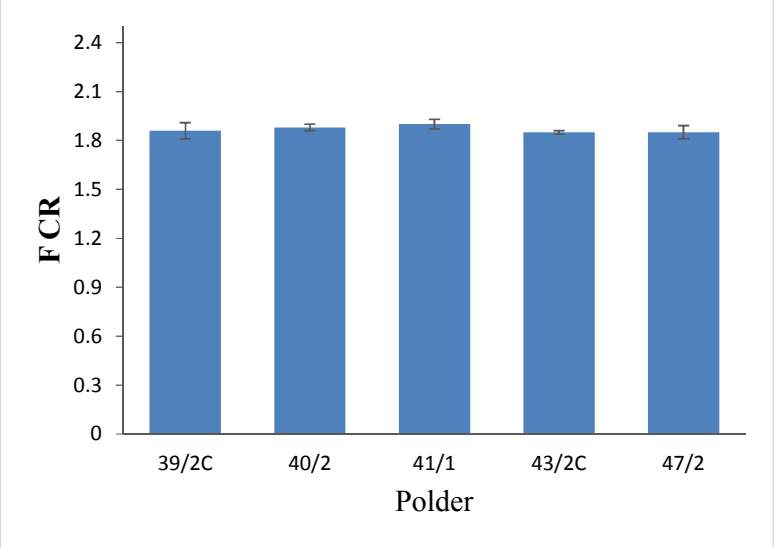

Figure 18. Food conversion ratio (FCR) variation of tilapia in different polders

The mean weight gain obtained in polder39/2C, 40/2, 41/1, 43/2C and 47/2 was 205g, 165g, 175g, 185g and 175g respectively. The specific growth rate (SGR) obtained in polder 39/2C, 40/2, 41/1, 43/2C and 47/2 was 2.98% day^{-1}, 2.76% day^{-1}, 2.82 % day^{-1}, 2.87 % $day^{-1}$and 2.82 % day^{-1}respectively. The calculated survival rate of tilapia was 93%, 94%, 92%, 95% and 95% inpolder39/2C, 40/2, 41/1, 43/2C and 47/2respectively. The average food conversion ratios (FCR) was 1.86, 1.88, 1.90, 1.85 and 1.85 for polder 39/2C, 40/2, 41/1, 43/2C and 47/2 respectively.

ii. Pangas:

Table 18: Comparison of yields parameters of pangas among different Polders

Yield parameters	**43/2C**	**48**
Mean initial weight (g)	71	55
Initial length (cm)	18	17
Mean final weight (g)	650	520
Final length (cm)	42	35
Mean weight gain (g)	650	520
Specific Growth Rate (SGR)	2.46	2.49
Survival Rate (%)	98	97
Food Conversion Ratio (FCR)	1.75	1.76

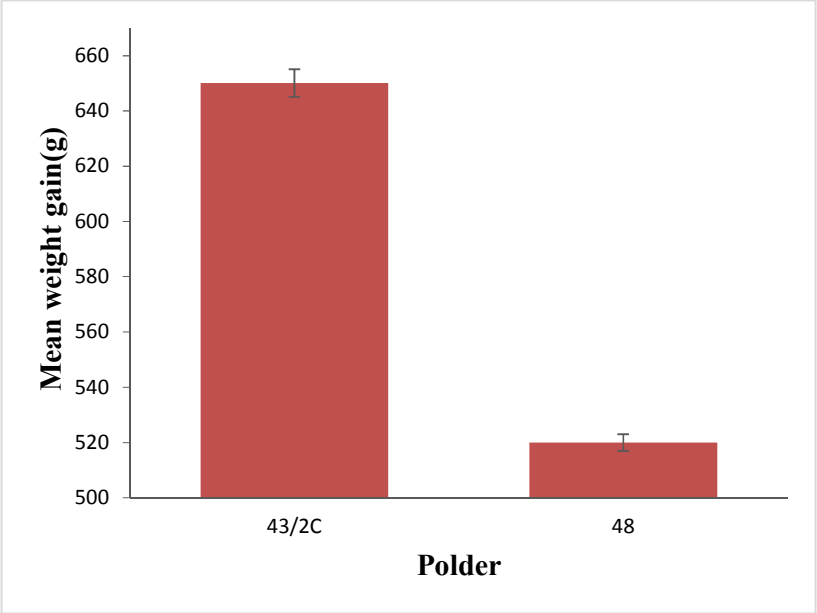

Figure 19. Mean weight gain variation of pangas in different polders

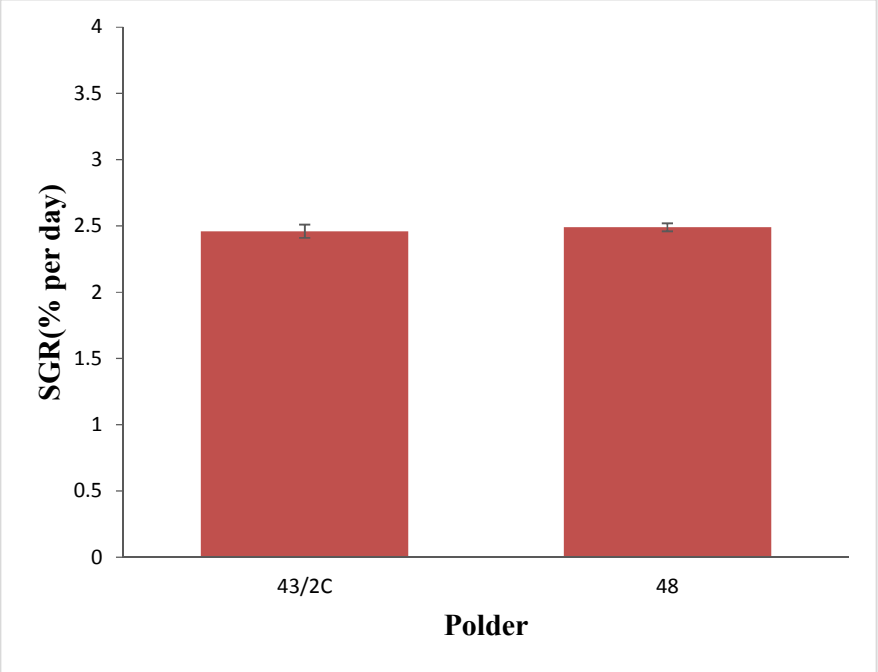

Figure 20. Specific growth rates (SGR) variation of pangas in different polders

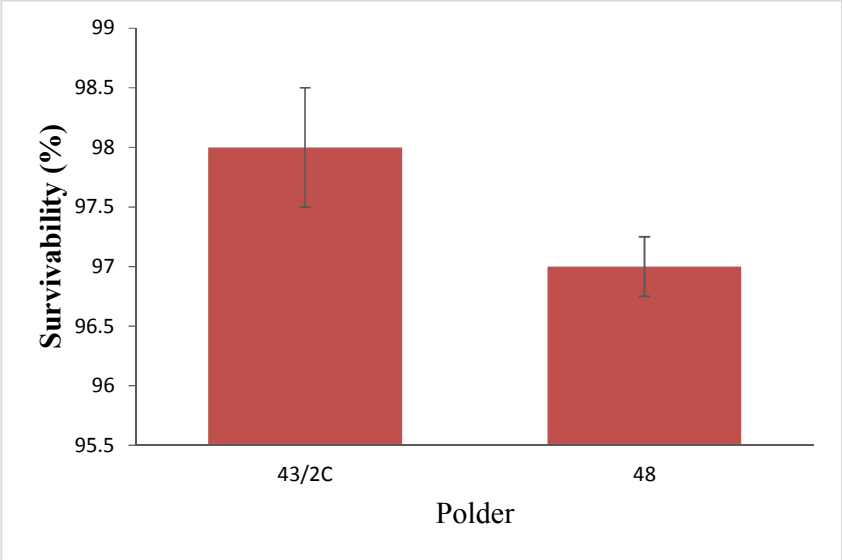

Figure 21. Survivability (%) variation of pangas in different polders

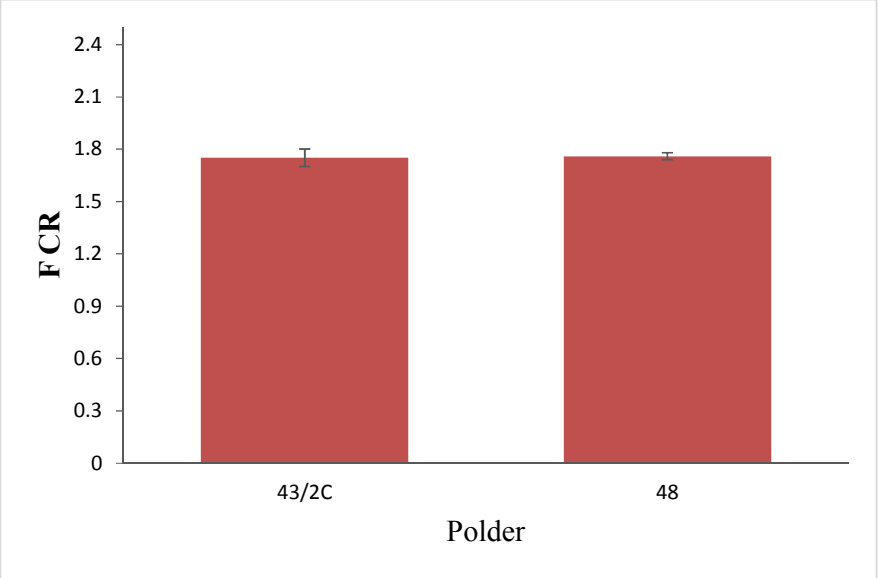

Figure 22. Food conversion ratio (FCR) variation of pangas in different polders

The mean weight gain obtained in polder43/2C and 48 was 650g and 520g respectively. The specific growth rate (SGR) obtained in polder 43/2C and 48 was 2.46% $day^{-1}$and 2.49% day^{-1}respectively. The calculated survival rate of tilapia was 98% and 97% inpolder 43/2C and 48 respectively. The average food conversion ratios (FCR) was1.85 and 1.85 for polder 43/2C and 48 respectively.

2.2.4 Results Demonstration:

Excellent fish production in the net pen was done in different polders. Color and growth of fish were impressive. WMA members and farmers were present during results demonstration. After the observation of net pen culture, they became motivated to do net pen culture.

Polder 39/2C

Polder 40/2

Polder 41/1

Polder 43/2C

Polder 47/2

Polder 48

Figure 23. Results demonstration of Net Pen culture

Schedule of Results demonstration

Date	Polder No.	Category of Participant
1.10.2022	39/2C	WMA and WMG members, Fish farmers & Fisherman
03.10.2022	40/2	WMA and WMG members, Fish farmers & Fisherman
04.10.2022	48	WMA and WMG members, Fish farmers & Fisherman
6.10.2022	41/1	WMA and WMG members, Fish farmers & Fisherman
07.10.2022	47/2	WMA and WMG members, Fish farmers & Fisherman
21.10.2022	43/2C	WMA and WMG members, Fish farmers & Fisherman

2.2.5 Outcome:

- ✓ The first and foremost outcome of cage culture of fish in polder areas was increased fish production. Thus cage culture of fish was found more profitable and economically viable for people in these areas. Moreover, cage culture of fish in polder areas was found to be effective in creating positive attitude among fishermen towards fish culture as it was convenient in terms of management of the culture unit.
- ✓ Most of the people in the polder areas are mainly fishermen who catch fish in Bay of Bengal and at a certain time of the year there are several ban periods on fishing in Bay of Bengal and its adjacent rivers. Cage culture of fish found to be an effective livelihood alternative for those fishermen during ban period.
- ✓ Cage structure is made up of large plastic barrels so that the cage can float in water. This also allows the cage to move with water and to be removed from one place to another in emergencies.
- ✓ Cage culture of fish also found to be effective in reducing social conflict over the use of existing water bodies in this area. Installation of cage required small fraction of area in pond and canal and didn't intervene the other uses of the water body.

2.2.6 Conclusion

Polder areas are blessed with vast water bodies and people in this area are also found to be ardent towards fish culture out of traditional system. National fish production can be increased by using this potentiality of this area. Large scale commercial fish culture in cage system can be the trump card for alleviating poverty and uplifting the social status of people in this area. Government should focus in this promising sector which will in turn help to obtain the goals of vision 2041.

2.3 Activity Name: Sanctuary Establishment

Due to natural and man-made causes, aquatic bio-diversity especially species diversity of fish and other aquatic organism in open water have been declining sharply. It is very essential to undertake necessary attempts on conserving and enhancing aquatic biodiversity. Hence establishment of sanctuary has become obligatory to protect and conserve fish species from extinction and increase fish diversity in the country.

2.3.1 Aim:

Fish sanctuary is defined as an area of public lands and water that is permanently set aside by the Government to have no human interferences round the year. Establishment of a fish sanctuary is an effective way to save the existing fish diversity in a water body and in some cases restoration of habitat. Many government and non-government organizations have taken initiatives to establish fish sanctuary in Beels and rivers of Bangladesh to improve stock structure of fish species. It was previously proved to be an effective management tools to ensure sustainability of natural water body. Thus, as a consequence of decreasing fisheries resources of the polder area, implementation and evaluation of fish sanctuaries become an urgent need. The abundance and distribution of fishes from different khals are decreasing day by day due to the environmental degradation and anthropogenic activities such as overfishing, indiscriminate use of chemicals, destruction of natural feeding and breeding ground of fishes etc. To save the fisheries species of polders from further losses, different conservation approaches are highly required as it helps in improving fish production as well as maintaining diversity.

2.3.2 Methodology:

a. **Location of the fish sanctuary:** Fish sanctuary was constructed in different perennial khals of polders such as Sonakhali khal, ChotoLobongula khal, Carkgasia khal. Total six sanctuaries were constructed under the program of CEIP-1/W-02.

Table 19: Location of the sanctuaries in different polders

Sl. No.	Polder Number	Name of the Lake	Number of switch gate	Location
01	39/2C	Nadmula Khal	DS-12	Bhandaria
02	40/2	Charduani Bazar Khal	DS-4	Patharghata
03	41/1	Amajhuri Khal	DS-1	Barguna
04	43/2C	Golkhali Beribadh Khal	DS-3	Galachipa
05	47/2	Dalbugonj High School Khal	DS-3	Kalapara
06	48	Barohar Khali	DS-3/3	Kuakata

b. **Collection of sanctuary materials:** For the establishment of fish sanctuary, a brush shelter was prepared in the selected khal by using two types of materials; materials for shed and materials for shelter of fishes. Floating aquatic weeds such as water hyacinth (*Eichhorniacrassipes*) was used for shed of fishes. Branches and roots of different trees like hijal (*Barringtoniaacuitangula*), black-berry (*Syzygiumcumini*), and jarul (*Lagerstroemia speciosa*) was used for the shelter of fishes. To build sanctuary 100 bamboos were brought from the local market for the sanctuary. Besides 50 branches of trees and 10 tree roots was brought from the nearby villages.

c. **Sanctuary preparation** During construction, about 30 bamboo poles (approximately 9.14-13.72 meter in length) was placed surrounding the selected area where every bamboo poleholds down about 1.0 meter in the bottom soil to keep it strong and vertical position. About 50 long bamboos with branches was tied with bamboo poles by using Galvanized Iron wire (GI) /nylon rope to encircle and fix aquatic weeds, branches and roots of different trees. Inside the fish sanctuary, 50 branches and 10 roots of trees was tied by GI wire with the different bamboo poles. Thus, the bamboo poles, branches and roots of trees was created a nice habitat and shelter for fishes and other aquatic organisms. Red flags and sign board was used for the demarcation of the sanctuary area.

d. **Stocking of fish:** 50% of total harvested fish from Net Pen culture will be stocked in the sanctuary.

2.3.3 Results:

Six sanctuaries were established at different khal of six polders. It was observed that the following natural fish were accumulated in the sanctuary for shelter.

Polder 39/2C

Polder 40/2

Polder 41/1

Polder 43/2C

Polder 47/2

Polder 48

Figure24. Fish sanctuary in different polders

2.3.4 Outcome:

Fish sanctuary is a risk-free shelter of fishes. Fish sanctuary is a demarcated protected area, where targeted fish will not be disturbed or captured. Due to sanctuary establishment at 6 different polders the following outcomes were found:

- ✓ Fish biodiversity has protected in the particular canal due to construction fish sanctuary.
- ✓ It helps protect breeding and nursery ground and helps produce brood fish and other fish and enhance fish diversity.
- ✓ Increase fish production in the polder areas
- ✓ Increase ecological balance and also increase economic condition of the fishermen
- ✓ Increasing the abundance of threatened fish species
- ✓ Protect many other aquatic fauna and flora etc.

2.3.5 Establish more fish sanctuaries and management:

For the conservation of biodiversity and to increase the fish production in the cannels and river of polders area, it is inevitable to establish more fish sanctuary in suitable places of different canals through the direct participation of on WMG and WMA community. After establish fish sanctuary at some suitable canals of different polders, fishes can congregate in the sanctuaries for shelter, lead peaceful life without any disturbance and can move independently towards the feeding and breeding grounds.

Management: Community based management approach should be used to manage the fish sanctuary. A management committee has formed mainly consisting of surrounding community people with an emphasis on WMG and WMA members for the management and protection of the each fish sanctuary. The committee should be formed including women, fishers, and local leaders. A group leader should be selected among WMG and WMA members according to the opinions of all members. All the committee members should follow the instructions for better management of the sanctuary. A year-round ban on fish catch has to impose in and around 500 m of the sanctuary. To prevent fish poaching, two people were periodically selected as night guards among the committee members. All the members of the committee should be very conscious about protecting the sanctuary and they are actively involved in the repair of the sanctuary, reintroduction of species.

2.3.6 Conclusions:

The present study was carried out to obtain the knowledge of fish sanctuary establishment, harvesting system of fish and its impact on biodiversity in the coastal region of Bangladesh. Sanctuary installation to harvest fish from the rivers is a common phenomenon in this region by the middle to upper class people who have land opportunity is a trend here. From the present study, it was observed that sanctuaries have positive impacts to grow natural food, provide space for feeding, breeding and protection and make a congenial environment to regenerate and increase aquatic biodiversity in the coastal region. We suggest to establish more sanctuaries and to apply proper management system in the open water bodies which conserve the fisheries resources and facilitate to sustain the indigenous, threatened as well as other aquatic organisms in the coastal region of Bangladesh.

2.4 Activity Name: Awareness Building

2.4.1 Aim:

- ✓ Making people aware about aquatic biodiversity conservation
- ✓ Increase production of all kind of fish
- ✓ Enhance and preserving aquatic biodiversity
- ✓ Fulfill the demand of fish seed
- ✓ Increasing the abundance of threatened fish species
- ✓ Protect many other aquatic fauna and flora etc.

2.4.2 Methodology:

Awareness building activities is an important tool for better management of sanctuary, protection of biodiversity and net pen culture. Meeting and farmers field day was organized by Chongqing International Construction Coporation(CICO**)** and the consultant team with fisher's community and local people about management of sanctuary, net pen culture and its benefits. Various type of awareness building activities was discussed in the training and meeting, such as overfishing, harmful effect of poison fishing, katha fishing, fishing by dewatering, catching of fry from wild habitat, water pollution, etc. Importance of sanctuary with buffer zone and contribution of sanctuary for increasing aquatic biodiversity and fish production was also discussed.Awareness building was done using the following way:

a) Motivational speech, b) Rally, c) Human chain

2.4.3 Results:

Polder 39/2C

Polder 40/2

Polder 41/1

Polder 43/2C

Polder 47/2

Polder 48

Figure 25. Awareness building programme in different polders

2.4.4 Outcome:

Awareness is the state of being conscious of something. Public awareness is a way to bring a certain issue to the attention of a group of people. It is a great way to highlight the need to save aquatic biodiversity and the aquatic environment of the polder area. After implementation of awareness building program, the following outcome were found:

- People became aware regarding aquatic biodiversity.
- People of the polders area were commuted to save aquatic biodiversity.
- They never catch brood fish and fish fry during breeding season.

- People agreed to stop poison fishing in the canal of the polder area. Now they know about the harmful effects of poison fishing on the aquatic resource of Bangladesh.
- Fishermen agreed to stop the use of harmful fishing gear such as current jal, china net, set bag net etc to increase natural fish production in the polder area.

2.3.5 Recommendation: We were able to involve alimited number of people compare with total population of polders in the awareness building program. As huge number of people lives in each polder area, more motivation program should arrange to save aquatic biodiversity, stop poison fish, stop use of restricted fishing gear and increase natural fish production.

2.4.6 Conclusion

Public awareness is demand of the time to teach polder community that only healthy functional aquatic ecosystems can provide all the benefits of improved water quality, fish production and biodiversity richness. As huge amount of people lives in each polder area, more motivation program should arrange to save aquatic biodiversity and increase natural fish production. Immediate action in the form of strategic plans, economic incentives, public awareness and stakeholder involvement should be taken for the management and restoration of water resources and aquatic ecosystems. The management of fisheries resources and aquatic ecosystems needs sustainable implementation of proper fisheries management technique. With the increase in population and human activities there will be more utilization of water resources and their biodiversity. Hence, more awareness building program need for restoration of aquatic habitat and conservation of biodiversity of this modern time to maintain the quality of life.

2.5 Activity Name: Training

Training is teaching, or developing in oneself or others, any skills and knowledge or fitness that relate to specific useful competencies. Training has specific goals of improving one's capability, capacity, productivity and performance.

2.5.1 Aim:

The specific objectives of the present acuities are:

- ✓ To know the importance of scientific fish culture.
- ✓ To understand the pond nursery management.
- ✓ To disseminate the knowledge of fish and prawn disease management.
- ✓ To know the Rice cum Golda culture.
- ✓ To disseminate the knowledge of Net pen culture among polder community.

2.5.2 Methodology:

a) 1st TrainingProgram on "Improved fish culture practices and rice cum golda farming"in at a glance.

Date of Training	Polder No.	Place	Number of Participant	Category of Participant
17.04.2022	39/2C	Nadmula School, Bhandaria	25	WMA members, switch gate committee members, Fish farmers & Fisherman
23.04.2022	40/2	Charduani School, Patharghata	22	WMA members, switch gate committee members, Fish farmers & Fisherman
27.04.2022	48	Latachapli Union Parishad, Alipur	25	WMA members, switch gate committee members, Fish farmers & Fisherman
5.05.2022	41/1	Maysa Gov. School, Barguna	22	WMA members, switch gate committee members, Fish farmers & Fisherman
15.05.2022	47/2	Dalbugonj Union Parishad, Kalapara	25	WMA members, switch gate committee members, Fish farmers & Fisherman
21.05.2022	43/2C	Galachipa High School	25	WMA members, switch gate committee members, Fish farmers & Fisherman
Total Farmers Trained up			144	

b) Schedule of 1st Training Program on "Improved fish culture practices and rice cum golda farming".

Time	Subjects	Trainers
09:30-10:00	Registration	Research Associate
10:00-11:00	Importance of scientific fish culture and pond nursery management	Prof. Dr. Md. Lokman Ali
11:00-12:00	Fish farming methods through advanced technology	Prof. Dr. Md. Lokman Ali
12:00-1:00	Conservation of fish biodiversity and establishment of fish sanctuaries	Prof. Dr. Md. Lokman Ali
1:00-1:30	Prayer break	-
1:30-2.30	Rice cum Golda culture	Prof. Dr. Md. Lokman Ali
2:30-3.30	Fish and prawn disease management	Prof. Dr. Md. Lokman Ali

c) Materials provided:

The following materials were provided to the all trainees by consultant team during the training program:

1. Trainee Remuneration- Each trainee was provided 500.00 Taka for remuneration.
2. File
3. Note Book
4. Pen
5. Lecture notes

d) Selected Pictures of 1st training program on "Improved fish culture practices and rice cum Prawn (Golda) farming".

Polder 39/2C

Polder 40/2

Polder 41/1

Polder 43/2C

Polder 47/2

Polder 48

Figure 26. Training program on "Improved fish culture practices and rice cum golda farming in different polders

e) 2nd TrainingProgramon "Net pen culture" in at a glance.

Date of Training	Polder No.	Place	Number of Participant	Category of Participant
1.10.2022	39/2C	Nadmula School, Bhandaria	25	WMA members, switch gate committee members, Fish farmers & Fisherman
02.10.2022	40/2	Charduani School, Patharghata	25	WMA members, switch gate committee members, Fish farmers & Fisherman
04.10.2022	48	Latachapli Union Parishad, Alipur	23	WMA members, switch gate committee members, Fish farmers & Fisherman
6.10.2022	41/1	Maysa Gov. School, Barguna	21	WMA members, switch gate committee members, Fish farmers & Fisherman
05.10.2022	47/2	Dalbugonj Union Parishad, Kalapara	25	WMA members, switch gate committee members, Fish farmers & Fisherman
09.10.2022	43/2C	Horidevpur High School, Galachipa	27	WMA members, switch gate committee members, Fish farmers & Fisherman
Total Farmers Trained up			146	

f)Schedule of 2nd Training Program on "net pen culture"

Time	Subjects	Trainers
09:30-10:00	Registration	Research Associate
10:00-11:00	Importance of scientific Net pen culture in polder area	Prof. Dr. Md. Lokman Ali
11:00-12:00	Preparation of Net pen	Prof. Dr. Md. Lokman Ali
12:00-1:00	Site selection and fish species selection criteria for net pen culture	Prof. Dr. Md. Lokman Ali
1:00-1:30	Prayer break	-
1:30-2.30	Feeds and feeding	Prof. Dr. Md. Lokman Ali
2:30-3.30	Cage management technique	Prof. Dr. Md. Lokman Ali

g) Materials provided:

The following materials were provided to the all trainees by consultant team during the training program:

1. Trainee Remuneration- Each trainee was provided 500.00 Taka for remuneration.
2. File
3. Note Book
4. Pen
5. Lecture notes
6. Snacks

h) Selected Pictures of 2nd training program on "net pen culture":

Polder 39/2C

Polder 40/2

Polder 41/1

Polder 43/2C

Polder 47/2

Polder 48

Figure 27. Training program on net pen culture in different polders

2.5.3 Results:

Total 150 farmers of six polders were trained on**"** Improved fish culture practices and rice cum golda farming" and "net pen culture" for two days. They are now able to

2.5.4 Outcomes: Outcome of 12 training program at 6 different polders is given bellow:

- People were known about scientific fish culture technique.
- Fish farmers now know that fish culture is a profitable business if they use proper technology.
- They were informed regarding culturable fish species, source of good quality fry and their their stocking density.
- After training farmers are able to prepare the pond scientifically to produce plankton, benthos and others natural foods.
- Fish farmers were known about the fish disease and their treatments.
- People are able to produce fish using net pen culture.
- People can produce rice and fish in their rice field after gathered knowledge regarding rice cum fish culture.

2.5.5 Recommendation: Under this activity we only trained up about 150 people of 6 polders. As huge number of people live in each polder, more training program should be arranged on scientific fish culture including carp fish culture, semi-intensive culture of Pangas, Tilapia, Koi, Shing, Magor, Pabda, Gulsha, Prawn and rice cum fish culture.

2.5.6 Conclusions:

It has been found that average 95% fisherman has no any idea about scientific fish culture. They don't maintain proper stocking density and never use artificial diet, proper fertilizer and lime. Only 5% fisherman fisher man use lime, fertilizer and supplementary feeds. As a result of these trainings, farmers are able to increase their yields, build their skills in pond management, earn more income through aquaculture and improve the polder economy. In general, there was a strong sense of appreciation articulated by the participants about being invited for the training. Participants were very engaged and enthusiastic about what they learn about best aquaculture practices, they highlighted that agriculture is their lifeline in food security and livelihood, they urged that future training be done often and should include more practical classes. Participants responded very positively throughout the training, and expressed a strong desire to enhance their skills in best aquaculture practices.

SECTION 3: NOURISHMENT PLAN

3.1. Net Pen culture

3.1.1 Management of Net Pen Culture:

Cage Dimension and Orientation

Cage dimensions were basically used the same as in Thailand (6 m X 3 m). Cage frames are made up of 2.54 cm diameter GI pipe. Cage height is maintained 2 m maximum as the Dakatia River is not so deep. The cage frames are arranged in series keeping 45 cm gap between two to accommodate exhausted barrels. The frames are set by connecting rods with clamps in each head. As the river water has multiple use covering inter district river-path navigation, cages should arranged in a single row and in some places in double rows either one side or both the sides of the river leaving enough space in the middle of the river for navigation.

Netting Material and Mesh

A group of laborers should be trained to make the cages for farmers. The netting materials have to purchase locally. Rolled nets have to purchase from the factory. They should cut and sew to the particular shape and size of hapa/cages. As stocking size of fingerlings is 15-20 grams, the mesh size has to be around 2 cm. A finer meshed net (locally called Rachel net) of 0.5 meter height should be attached to the upper inner side of cages to protect the floating feed pellets escaping out. A larger meshed (5 cm) net should use to cover the cages on top to protect from birds e.g. pelicans, eagles and others.

Floating the Frames and Setting the Nets

The cage frames are attached one another in a series supported to float by 2-3 exhausted 200L barrels in each gap. As the river water gets saline (influenced by ebb-tide) the steel sheets of barrel last only two years. So, farmers are using the plastic barrels nowadays. The whole structure then have to hardened by binding with bamboos around the structure. The setting of frames and barrels are done on the land first and then pushed over the river water, placed in a suitable place and then tied with anchors in all sides. Then the cage-nets should be attached with floating frame suspending down with the help of half-bricks tied at each corner. After setting the cages, they are left exhausted for about 15 days so that the inner parts of the nets lose their roughness so that fishes would not be wounded.

Stocking Size and Stocking Density

larger fingerlings should stock e.g. 20 g although there is higher mortality compared to smaller ones during transportation from hatcheries/nursery ponds. Stock of 1,000-1,100 mono-sex tilapia fingerlings per cage of 27m^3 (6m X 3m X 1.5m) i.e. 37-40 per m^3 is applied. Increasing the density beyond this increases the mortality.

Feeding Rate, Frequency and FCR

Floating feed was first introduced by RUPSHEE fish feed in Bangladesh only in 2006. Before 2006 feeding in cages was difficult job as it was not clear how the sinking feeds were used by the fish. Production of floating feeds assisted farmers a lot as farmers can observe and control feeding. Feeding have to done twice daily to satiation level spreading over the water surface in each cage. During feeding the cages should not disturbed by any other activities. A number of companies are supplying floating feeds; the quality of them is more or less similar. Good feeding management in cages ensures the FCR remain less than 1.75, whereas, inexperienced new farmers use more feeds unnecessarily.

Sorting and Grading

Depending on the feed quality, variation in fish size becomes obvious. Fishes shouldgraded and kept in different cages. Better the quality of feed and shorter will be the seed sorting interval. Normally, sorting is done once a month that means during the culture cycle of 6-7 months it requires 5-6 sortings. Fish are sold when they get larger than 400 gm. If smaller fish are kept further to grow. Sorting is done from late morning to noon.

Marketing Pattern

Unlike pond cultured fish, marketing of caged fish is very easy. Retailers come to the cage sites at a pre-set time, and collect on desired amount of fishes. The cage operators usually sort out the marketable sized fishes a day before selling date. Feeding should stopped 6 hours before harvest. Usually fish sellers collect two times from the cages, in the morning and in the afternoon and sell them in different markets even in neighboring village markets. In addition, some sellers collect live caged-fishes early in the morning and ferry them to the urban housing areas to sell live fishes.

Growth is rapid in the warm climate of Bangladesh and the fish attain marketable size within 3-9 months, providing farmers with a rapid return on their investment and labour. Fingerling production culture cycle is between 1 and 2 months. Cage nursery producers can sell

fingerlings to the pond farmers and ox-bow lake operators. Fish for food culture cycle is between 4 and 6 months. Fish food producers consume the cage fish as well as selling them in the market.

Profitability depends on many factors including the type of water body and culture, cage construction materials, the choice of fish species, fingerling size and price, stocking density, feed price, availability of protein rich feed, culture duration, cage management, harvesting and marketing. Another concern relates to economies of scale. Almost all enterprises are subject to economies of scale, and cage culture is no exception. The labour of looking after one small cage is far greater per kilogram of product than that for looking after a large one. The cost of the cage per kilogram of production will also be higher for a small cage versus a large cage. However, co-operative use of labour can be used to realise economies of scale in relation to labour, and this is already done in many villages. The third concern, related to the second, is comparative advantage. A significant proportion of the fish is intended to be sold for cash rather than consumed by the farmer and his family. In the medium term, an important question is whether small-scale producers in villages are well placed to compete – either with larger commercial producers, or producers from elsewhere. If they are not, and if competition increases, then prices - and returns - will steadily decline. In practice there is strong local demand for fish throughout the country, and small-scale producers are well placed to serve widely-dispersed rural markets. Secondly, the use of surplus off-season and/or family labour is itself a comparative advantage. Thirdly, in those systems which use local food resources, such as natural foods and kitchen wastes, feed costs are relatively low compared with those for commercial producers. Small-scale fish producers should therefore be able to survive competition in much the same way as village-scale poultry producers have survived, and even to some extent benefit from the increasing number of intensive poultry operations.

3.2. Fish Sanctuary

Bangladesh is blessed with the world's richest and most diverse inland aquatic ecosystem having a wide variety of living aquatic resources such as ponds, canals, ox-bow lakes, haors, baors, river, floodplain, beel etc. But over the years, due to natural and man-made causes, aquatic bio-diversity especially species diversity of fish and other aquatic organism in open water have been declining sharply. It is very essential to undertake necessary attempts on conserving and enhancing aquatic biodiversity. Hence establishment of sanctuary has become obligatory to protect and conserve fish species from extinction and increase fish diversity in the country. So, the importance of fish sanctuary is infinite.

The general importance of fish sanctuary is outlined below –

- Increase fish production
- Protect the fish from genetic pollution
- Provide breeding and feeding ground
- Enhanced and a preserving aquatic biodiversity
- It helps protect breeding and nursery ground and helps produce brood fish and other fish and enhance fish diversity
- Restoration as well as conservation of habitat may be possible by establishing aquatic sanctuary
- Increasing the abundance of threatened fish species
- Full fill the demand of fish seed
- Improved the livelihood conditions
- Protect many other aquatic fauna and flora etc.

a) Establishment and Management of Fish sanctuary

Fish sanctuary is a risk-free shelter of fishes. Size/Area of fish sanctuary is positively related with the size of target fish sp. So, we should have established fish sanctuary in the river for river fishes and in the Beel for Beel fishes. Place size of fish sanctuary should be selected by considering opinion of local fishermen and their livelihood. Fish sanctuary is established in such a place where fishing can be prohibited or restricted seasonally or round the year.

In the management system of sanctuary, site selection is very important. Following factors are considered for site selection-

- It should be the deepest part of the river or beel
- Relatively low water current is found in that place
- The place should have less probability of siltation
- The transportation route of river should not be hampered
- The place should be safe from human interference.

Generally, 8-10% areas in dry season of a water body can be selected for fish sanctuary. But positive results are also achieved in flood plain or beel areas even establishing sanctuary in ditches (400-500 square mile area). After selecting a site for sanctuary sufficient bamboo and tree branches are provided in to selected area. The protect area where there is chance of siltation concert tetrapod may be used instead of tree branches. Selected area should be marked with distinguishable symbols (eg. red flag, tree, bazaar etc.) As a result, it will raise an opportunity to increase fish diversity in concerned water body. In last sixties and later eighties decade several sanctuaries have been established though DoF. But due to lack of proper management, these sanctuaries were closed with the end of the projects. The main causes of closing of the project were no active participation of the local fishermen. In 1997 again fish sanctuaries have been established in beel Ashura under CBF-1 project of DoF. Later fish sanctuary has been established in different water bodies of the country under 4th fisheries project, CBF-2 and MACH project. Till 2005-2006, 377 sanctuaries have been established throughout the country involving fishermen community.

In the last few years, many fish sanctuaries have been established with different shape and size using different Katha materials there has been no set rule as to the size and design of the sanctuaries. The performance of different Katha materials and their relative size are not known. It has been found that many very small size sanctuaries have been established which are not sufficient in protecting fish on the other hand, management and maintaining of very big sanctuaries is difficult in terms of financial involvement and acceptance by local community.

There are many techniques are used to protect and maintain sanctuaries so that expected benefit can be obtained. Protection needs to be ensured so that fish and other biota taking shelter are not poached or harvested by anybody. The protective measures start along with the planning process. Some of the measures found useful are discussed below-

b) Work through or with WMAs:

This is very important. So far it is found that without a committed and organized local community it may be impossible to establish and maintain a sanctuary. So before establishing a sanctuary it is to be ensured that there is a WMA who are committed to protect the sanctuary.

c) Awareness among wider community:

Through different media awareness must be created among the wider community so that the sanctuaries are protected. Proper publicity is important. Sanctuary is to be part of a larger management plan for sustainable use of the resource / fishery that has been made by the community and is widely accepted.

d) Identification, demarcation and declaration:

Location of the sanctuary selected along with the WMA and local people with also expert advice. Formal declaration of sanctuary by relevant authority / organization managing water body, with proper demarcation with bamboo, red flags, signboard, demarcation pillars etc. should be done so that people can easily understand that this is a protected area and should not enter.

e) Katha and other sanctuaries:

Bamboo, tree branches and other structure in the sanctuary will give further protection for fish from poaching or any other disturbances. Katha can be given covering the whole sanctuary area or in small clusters within the area. Water hyacinth or other aquatic vegetation cal also be used to create a suitable refuge for fish. Algae grow on the tree branches or on bamboos, and that is an extra attraction for fish to congregate. A part of the bamboos and tree branches should be firmly shoved into bottom mud so they are not easily moved. But note that brushpiles in rivers may increase siltation of the deeper pools that are being protected.

f) Fish Protection Device:

In few places a series of bamboo cage like structures are being used to protect fish from poaching as well as to protect small fish from predation by bigger fish. In some places RCC tetra-pods and pipes are used for an extra and long-term protection.

g) Guarding:

Finding a shelter, protection and some food, fish congregate in a sanctuary especially in dry season. This is a place of attraction for poachers. Within a small area fish become more vulnerable to poaching. Considering this situation, besides many other protective measures guarding for few months (4/5 months during dry season) should be considered.

h) Sampling:

To observe the impact of the fish sanctuary, survey on different factors mainly on change in fish diversity and production, size classes and cohorts of each species and socio-economic status of fishermen can be done.

By maintaining this technique,a well-developed fish sanctuary can be made for conserving the valuable diversity of fishes and others fisheries organism.

3.3 Fish disease management

Fungal infections are among the most common diseases seen in tropical fish. Because fungal spores are found in all fish tanks, they can quickly colonize and create problems in stressed, injured, or diseased fish. Poor water quality can also lead to an increase in fungal infections in an otherwise healthy fish population. Most aquarium owners easily identify external fungal infections. Most fungal infections have a characteristic white fluffy appearance and are commonly known as 'cotton wool disease.' As the fungal infections worsen, they may take on a gray or even red appearance.

Fortunately, most fungal infections only attack the external tissues of fish and eggs. Most infections are usually associated with a preexisting infection or injury and this is why a two-part treatment is often necessary to completely cure these infected fish. There are a few fungal infections that will infect the internal organs of fish and they will be touched on a little later.

i) Disease name: EUS (Epizootic Ulcerative Syndrome)

Epizootic: Greek "epi" means upon and"zoon" means animal. Any disease of animals that attacks many animals in the same area is called epizootic. Or, Disease outbreak among animals other than human in a localized area is called epizootic.

Ulcerative: When the lesion affects internal site after invading the epithelial tissue then we call it ulcer. As all ulcers are lesions but all lesions are not ulcers.

Syndrome: Greek syndrome concerent-

- ✓ A set of symptoms which occur together
- ✓ The sum of signs of any morbit state
- ✓ A symptom complexes

Causative agent: *Aphanomyces invadans*

History of EUS: EUS is first occurred in Japan in 1972 as mycotic granulomatosis. Then occurred EUS in Papua New Guinea 1974 and in most South-east and South -Asian countries like Indonesia 1980, Malaysia 1979-83; Thailand 1981-85; Myanmer 1984-85; Srilanka 1987; Bangladesh 1988; India 1988 and Pakistan 1996. It was introduced in Bangladesh from Myanmer in 1988. EUS occurs during the beginning of winter when rainfall is minimum and

temperature is low (15-25^{0}c). Recently EUS occurs in koi and shing fishes in Mymenshing in 2006.

Susceptible fishes: Over 100 freshwater fishes and few brakish water fishes-snakeheads, perches, eels, gobies, barbs, Chinese carps and catfishes; very recently in shing fish.

Epizootiology:

- ✓ Usually occur at low temperature during the starting of winter, at low oxygen content in relatively shallow water.
- ✓ Transmitted via water supplies and diseased fish.
- ✓ The free-swimming zoospore is responsible for outbreak and their rapid spread.
- ✓ Over 50% of the population will show clinical signs within 7-14 days if infected water is supplied.

Clinical signs and pathology:

- ✓ Affected fish show necrotic dermal ulcers characterized histologically by the presence of distinctive mycotic granulomas in underlying tissues.
- ✓ Large red or gray shallow ulcers generally on lateral body surface, often with a brown and white rim.
- ✓ Myocytolysis associated with invasive non-septic fungal hyphae.
- ✓ After musculature the fungus may penetrate liver and kidney.
- ✓ Red sopts, lesions with white cottony appearane, stop feeding, lethergy-stay at bottom or near pond dikes.
- ✓ Fungal/mycotic granuloma, necrosis, pyknosis, vacuolation.
- ✓ *Ahanomyces* appeared as and entered inside, become severe, appear as dense granuloma like structure in skin and muscle, liver, kidney etc. with massive narcotizing, pyknotic, hemorrhagic and inflammed characters

Diagnosis: Clinical, histopathological, squash preparation and culture method.

ii)Disease name: Saprolegniasis(water moulds, skin fungus, cotton wood disease, secondary skin diseases)

Causative agent:*Saprolegnia parasitica*

Epizootiology:

- ✓ Environmental stress including poor water quality, handling, overcrowding and water temperature are responsible for the disease.
- ✓ Disease occurs in all seasons of the year.
- ✓ Freshwater fishes and their eggs are more susceptible.
- ✓ Salmons are susceptible during their freshwater stage.
- ✓ Disease may also occur in brackish water upto a salinity of 28ppt.

Clinical signs and pathology:

- ✓ A whitish cotton-wool like tuft at infection site mainly on integument gill and eggs which may spread over the entire body surface.
- ✓ Brushing against solid objects is a typical clinical sign
- ✓ A chronic and superficial infection occurs but become quicker due to bacterial involvement.
- ✓ Gill injuries are breatening hampering respiration
- ✓ Also, can penetrate the deeper tissue producing mycosis
- ✓ Eggs mortality can increase rapidly
- ✓ Loss of integrity of the integument
- ✓ Edema and degenerative changes in muscle mass
- ✓ Severe lesion shows deeper myofibrilarllar and fungal cellular necrosis
- ✓ Spongiosis and intracellular edema and slouhing of the epidermisallowing hyphae to penetrate the membrane.

Susceptible species:

- ✓ All freshwater fishes and their eggs
- ✓ Common infection of egg incubation.
- ✓ Dead fish and egg are as a growth medium for the fungi.
- ✓ Both wild and farmed fishes – carps, perches, salmons, trouts, tilapia.
- ✓ EUS with saprolegnia and Acromonas *hydrophila* with *Argulus*.

Diagnosis:

- ✓ Wet mount preparation and culture method.
- ✓ Identification upto species is difficult; requires reproductive organs.
- ✓ Oogonia and antheridia are produced under special cultural conditions.

iii) Disease name: Branchiomycosis (gill rot)

Causative agent :*Branchiomyces demigrans, B. sanguinis, B. spp*

Epizootiology:

- ✓ Most devasting epizootics among fish populations occur in slightly acidic pH low dissolved oxygen reduced water flow
- ✓ High levels of nutrients in the water phytoplankton blooms high stocking dencity and water temperature above 20° C favour Branchiomysis outbreaks
- ✓ Branchiomycosis is mainly a summer and usually occurs when water temperature rises above 20° C.
- ✓ Also occurs in early spring (April and May) when the water temperature is 14-16° C.
- ✓ Fish with chronic branchiomycosis act as carriers of the disease
- ✓ Sports are transmitted from to gill tissue.

Susceptible species:

- ❖ The heaviest loses occur among one and two-year-old common carp
- ❖ All freshwater species
- ❖ European catfish
- ❖ European carp
- ❖ Tench
- ❖ Trout (rainbow trout mainly)
- ❖ Whitefish
- ❖ Three-spine stickleback
- ❖ Catfish
- ❖ Japanese eels
- ❖ Indian carps
- ❖ Guppies

Clinical signs and pathology:

- ✓ Fish loss their appetite and shoaling near the inlet
- ✓ Seriously diseased fish raise their snouts and they die from asphyxiation when the water quality is poor
- ✓ Gill appear dark red sometimes pale white or brown
- ✓ Mucus secretion is severe in gill filaments
- ✓ Damaged gill tissue with fungal hyphae and spores

- ✓ Clear spotty hemorrhage, marked congestion spots and faded spots due to anemia are seen
- ✓ Blood circulation stagnates or completely spots causing haemorrhage and necrosis and collapse the gill tissue since the hyphae develop and grow in the blood vessels of the gills
- ✓ The gill lamellae become deformed or thicken due to growth of fungal hyphae and fusion also occurs in various places.

Diagnosis

- ➢ Squash preparation, Culture method

iv) Disease name: Ichthyophoniasis

Causative agent:*Ichthyophonus hoferi*

Epizootilogy:

- ✓ Disease affects a wide variety of freshwater and marine fishes (herring 20%) are particularly affected in winter and spring
- ✓ The infection develops in the intestinal tracts after the parasitic is ingested with food
- ✓ Clinical signs appear 24 days after feeding infected material
- ✓ The dissemination of disease occurs mostly through feeding oninfected fish and possibly through feeding on infected copepods

Susceptible species:

- ➢ Various types of tropical fish
- ➢ Mainly herring (20%) among marine fish
- ➢ Trouts
- ➢ Mackerel
- ➢ Salmon (mainly *salmon gairdnerii*)

Clinical signs and pathology:

- ✓ Numerous small, spherical, polynucleated white nodules (cysts) appear in the internal organs especially in the liver, kidney, heart and spleen of affected fish.
- ✓ Encystment of the fungus is followed by inflammation and proliferation of the affected tissue producing granulomatous inflammation with a fibrous capsule around the parasite.
- ✓ Fibrosis occurs as the disease progresses.
- ✓ Infected organs feel rough due to sand paper effect.

- ✓ The roughness of the scales is particularly striking when skin is affected.
- ✓ Necrotic lesions and hyperpigmentation also appear on the skin especially in herring.
- ✓ Curvature of the vertebral column may risedue to muscle spasms.
- ✓ Abdominal swelling can arise from hepatomegaly and ascites formation.
- ✓ Incoordination (staggering sickness) of trout and herring is well known.

v) Disease name: Dermocystidium disease (also known as skindermacystidium disease in Cyprinus carpio.

Causative agent: *Dermocystidium koi*

Epizootiology:

- ✓ Outbreak of disease adult Chinook salmon caused 25% mortality and in emerging fry and also referred to the disease in Coho and Sockeye salmon.
- ✓ Outbreaks appeared to be more severe at temperature below 15 $^{\circ}$ C.

Susceptible species:

- ➢ Common carp
- ➢ Trout
- ➢ Salmon (Chinook, coho and sockeye salmon)

Clinical signs and pathology:

- ✓ The affected areasuch as reticular fibrous connective tissue capillaries etc.become a round protuberance
- ✓ The affected areas collapse and the spores are dispersed and recovers shortly
- ✓ The mascular tissue collapses and forms granulomas asprotruding reddening clumps externally
- ✓ The affected area ruptures and spores are emitted after maturation of parasites
- ✓ Lesions also occurs in the spleen with congestion and fibrosis around parasite colonies
- ✓ Death usually resulted from anoxia
- ✓ In adult fish many small cysts occur in the gills resembling epitheliocystis lesions and contained a large number of unicellular organisms

3.4 Scientific Fish culture

3.4.1 Selection of Sites for Aquaculture

There are many other factors to be considered in selecting a suitable site for sustainable aquaculture farm.

a) **Quality of soil of the site or site characteristics.** Soil containing nutrients of all kinds and high-water holding capacity are suitable for aquaculture. Therefore, fine textured soils (**clay, silty clay, clay loam, silty clay loam, and sandy clay**) are more suitable for aquaculture.

b) **Availability of suitable water** for aquaculture. Good quality (having desired range of water temperature, pH, salinity, turbidity etc.) and sufficient quantity of water and case of filling and draining should be confirmed in selecting a site.

c) **Climate conditions** of the area should be suitable for aquaculture production. Temperature, rainfall, evaporation, sunshine, flood, water table, speed and direction of wind should be considered thoroughly during selecting site for aquafarm. Pond dike should higher than the highest flood level of last ten years. Area having a slope (**not more than2%**) which is suitable for fillings and draining by the gravity is good for site selection.

d) For selecting a site, the **species and culture technology** is very important. Species having high growth rate, market demand and the ability to take artificial feed in one hand and on the other hand well known culture technology of the species are important for viable aquaculture.

e) **Access to market.** The aquaculture product should have market demand and the farmer should have easy access to the market. Demand for the aquaculture product should not fluctuate too much for sustainable aquaculture.

f) **Suitable communication.** Well communication infrastructure should provide for quick and smooth reach of the aquacultural product to the market. Aquaculture site should be well communicated with the communication network of the country to reach product to the sales centers and/or export center quickly.

g) **Protection from natural disasters** (like flood). Pond dike should be higher than the highest food level of the last ten years to protect fish from being escape during flooding.

h) Availability of skilled and unskilled **personnel** within the aquaculture area. For effective aquaculture operation skilled and unskilled labour supply should be confirmed.

i) **Public utilities.** Public should be aware of the activities to be performed there in the farm. Farm activities should not create any public nuisance or in other word public should accept the activities.

j) **Security.** Law and order situation of the area should be such that people involved in aquaculture activities can move freely, fishes and other aquaculture **amenities** should not be stolen or damaged by any means. For family pond, it is better to select the site near the residence so that it can be easily look after.

k) **Information on development plans** for the neighborhood areas is necessary, so that aquaculturist might be aware of the possible sources of pollution and also the nature of pollutants to be taken care of.

In conclusion it can be said that although all the factors stated above should be addressed in selecting a site; site characteristics, species and appropriate technology are the most important. When these three factors favour the site, it may be possible to find out solutions of other factors that are unfavorable with an additional investment.

There are some major texture classes:

Sand	Silt	Clay	Loam
Loamy sand	Sandy loam	Sandy clay loam	Sandy clay
Silt loam	Clay loam	Silty clay loam	Silty clay

3.4.2 Species selection for Aquaculture

It would probably be possible to culture almost all aquatic organisms, but the main consideration is whether it is worth the effort and how far they can contribute the main objectives (increase protein supply, export earning, creation of job opportunity etc) of aquaculture. Long traditional experience and scientific research, so far, have actually succeeded in domestication only a small number of species are still being investigated. Therefore, until now aquaculture is suitable for only a restricted number of species.

A species is considered suitable for cultivation when-

- ✓ It can withstand the climate of the region in which it will be raised.
- ✓ Its rate of growth is sufficiently high. It is the most important characteristics that determine the suitability of a species for aquaculture, as higher the growth rate more the production is.
- ✓ It grows marketable size before first maturity. So that most of the food and energy are used for somatic growth.
- ✓ It successfully reproduces under conditions of rearing or can be easily artificially breed.
- ✓ It accepts artificial feed and converts that feed into flesh efficiently.
- ✓ It supports high population density in ponds.
- ✓ It is the member of the short food chain; normally herbivorous and omnivorous fishes are selected. Predatory fishes are often selected for aquaculture rendering high protein feed for their high market price.
- ✓ It is resistant to diseases, handling stress and environmental stress.
- ✓ It should be satisfactory to the consumers are ready to pay high price for it. High market price can make a slow growing species as a vital candidate for aquaculture.

It is almost impossible to find a species, which match all the criteria, stated above. The species on which through biological information are known, culture technology is known and matches up as many as criteria stated above should be selected for aquaculture.

3.4.3 Criteria of a nursery pond:

The following factor should be considered during selection of a nursery pond.

- ✓ Pond size should be 10-30 decimal.
- ✓ Less amount of mud should be required in pond bottom.
- ✓ Pond embankment should be free from shady plant.
- ✓ Sandy loom soil is good for nursery.
- ✓ Pond embankment should be free from any type of linkage
- ✓ There should be good rood communications for transport of fingerling in case commercial nursery.

3.4.4 Management of nursery pond:

Ready to release the fish seed of the pond is called nursery management. Management of nursery pond can be done properly under two headings:

a) Pre-stocking management
b) Post stocking management

a)Pre-stocking management: There are some points including-

i. Control of aquatic vegetation
ii. Control of undesirable species
iii. Pond drying
iv. Liming
v. Water supply
vi. Fertilization
vii. Selection of species
viii. Control of aquatic insect

i. Control of aquatic vegetation: All type of aquatic vegetation will be removed from nursery pond because the aquatic vegetation creates some problems.

- ✓ Prevent light penetration.
- ✓ Decrease oxygen concentration.
- ✓ Harmful predator or animal may be hiding in the dense aquatic vegetation.
- ✓ Nutrient /productivity of the pond will be reduced.

It may be controlled by the following methods:

a) Mechanical or manual method
b) Biological method
c) Chemical method

ii) Control of undesirable species: It may be controlled by some poisons, such as, Rotenone. Undesirable species can be controlled by the following two ways:

- By poisons
- By repeated netting

By poisons

Doses of Rotenone: 5% of Rotenone in derris rot powder.

- ✓ Normally used: 0.5 ppm
- ✓ For small fishes: 3-4 ppm
- ✓ Predatory fishes: 6-12 ppm
- ✓ Killing all undesirable species in the nursery pond: 5-6 ppm

iii) Pond drying: For control of undesirable species pond drying is better than poisoning because:

- ✓ To kill the insect and parasites.
- ✓ To increase the fertility of soil.
- ✓ To complete control undesirable species.
- ✓ To stimulate the growth of algae.
- ✓ To repair the dyke.
- ✓ For maintenance routine work.

Harmful effect of pond drying:

- ✓ Loss of nutrients.
- ✓ Loss of organisms directly or indirectly used to the fish.
- ✓ Loss of environmental relation between plants and animals.
- ✓ Loss of aquatic life in the pond.

iv) Liming: Liming should be done for the following purposes-

- ✓ It acts as anti-disease, anti-parasites, anti-fungus.
- ✓ It acts as buffer in the water.
- ✓ It supplies calcium in the pond.
- ✓ It balances the pH of the pond water at desirable level (7.0 to 8.0)

Lime should apply in the bottom of the dry pond or in water. If poisonous chemical is applied, it should apply after 3 days.

Doses: It depends on the pH of the soil.

Table 26. Requirement of lime for different types of pond soil

Soil pH	Soil type	Requirement of lime(kg/ha)
4.0 – 4.9	Highly acidic	2 000
5.0 – 6.4	Moderately acidic	1 000
6.5 – 7.4	Near neutral	500
7.5 – 8.4	Mildly alkaline	200
8.5 – 9.5	Highly alkaline	Nil

v) Water supply:

For the successful development nursery pond should be located where permanent supply of suitable water is available. We can supply water in pond with various sources, such as,

- ✓ Parennial streams and rivers
- ✓ Springs
- ✓ Rainfall

But the precaution is the end of the pipe fine meshed screen to prevent not to allow the fish or the debris. Mesh should be made by wire or fine meshed screen.

vi) Fertilization:

- ✓ Cow dung: 3 kg/decimal
- ✓ Urea:150- 200g/decimal
- ✓ TSP: 75-100/ decimal

vii) Selection of species:

It fully depends on our purpose we can select monoculture, polyculture and composite culture.

- ✓ The species should be adapted on our environment.
- ✓ Disease resistance of species.
- ✓ Fast growing of the species.
- ✓ It should have market demand.
- ✓ The species should have herbivorous or omnivorous.

Control of aquatic insect: Sumithion/Melathion: 10ml/decimal.

b) Post stocking management:

i) Density of stocking: It depends on the

- The size of the pond
- Size of the fry
- Not to overcrowded any way, otherwise it will create food competition, thus growth will be stunted.
  - ✓ For 1 step nursery: 100-150g fry/decimal
  - ✓ For 2 step nursery: 200-300g fry/decimal

ii) Fertilization: Repetition of fertilization should be done if necessary, by the same method above. We can usually use after 15 days based on the availability of natural food in water. In this case the dose of the fertilizer will be half of the initial dose.

iii) Use of supplementary food:

1st week: 4 egg/decimal/ day for two days. Then 100g wheat flower for two days and 150g fermented mustard oil cake for 3 days. Then rice bran, wheat bran, oil cake, fish meal, finely powder form twice in the days one in morning next in the evening.

iv) Sheltering: Sheltering with aquatic vegetation and bamboo poles to protect the fish from natural hazards.

v) Periodic checking of the pond: Periodic checking is done for mainly observe physical condition of the pond.

vi) Management of water quality parameters: Water quality parameters such as Oxygen, pH, alkalinity, hardness, ammonia, nitrite etc.

3.5 Pond drying

3.5.1 Objectives of pond drying

- ✓ To kill the insects and parasites.
- ✓ For maintenance routine work of the pond.
- ✓ To increase the fertility of soil.
- ✓ To complete control undesirable species.

During winter the best time of pond drying. Very early in the history of pond culture, the value of pond drying must have been observed.

3.5.2 Advantages of pond drying

- ✓ To kill the harmful insects, fish parasites, disease bacteria and fungus.
- ✓ To restore the fertility of the pond.
- ✓ Pond drying can be used for routine maintenance works to the pond banks; drainage channels which are very difficult when the pond in under water.
- ✓ To repair the dyke of the pond.
- ✓ Sometimes, a pond accumulates organic matter, (specially plant and animal debris which may not completely decay because of lack of oxygen. So, anaerobic conditions may obtain in such pond bottoms and both soil and water may become acid. With lack of oxygen is harmful to the full development of the organisms, which are the chief food of the carp. When pond drying, there is free access of oxygen and then this organic matter is completely oxidized and the contained nutrients released.
- ✓ Pond drying is a well-approved measure to stimulate the growth of the algae on which the milkfish feed.

3.5.3 Disadvantage of food drying

- ✓ Loss of nutrients.
- ✓ Loss of organisms directly or indirectly useful to the fish.
- ✓ Loss of environmental relation between plants and animal.
- ✓ Loss of all aquatic life in the pond.

3.6 Pond Management

3.6.1 Pre-Stocking Management

A. Pond Renovation

Dyke repair

Height: 2-3 feet above the highest flood level.

Slope: inside 1: 2, outside 1:1.

- ✓ Fixing of screened inlet and outlet pipe in the dyke.
- ✓ Pruning of trees on the southern and eastern side.
- ✓ Removal of excess bottom mud, if necessary.
- ✓ Leveling of the bottom.
- ✓ Construction of pits and platforms on dykes for the cultivation of vegetables and horticultural crops.

B. Eradication of Undesirable Weeds and Predatory Animals

- ➢ Dewatering
- ➢ Sun drying of the bottom for 8 days
- ➢ Application of pesticides - if de-watering is not possible/feasible attempt should be made to eradicate them through repeated netting. If it is not at all possible to eradicate them by the above methods, they can be eradicated by the application of the following:
  - ✓ **Rotenone:** 3.5 ppm i.e. 20-36 g/dec foot of water or
  - ✓ **Mohua oil cake:** 200-500 ppm i.e. 2.5-3.0 kg/dec foot of water or
  - ✓ **Tea seed cake:** 75-100 ppm i.e. 0.9-1.2 kg/dec foot of water

After 1 day

C. Liming:

The amount of lime generally applied is 1-2 kg/dec. The required quantity of lime should be sprinkled evenly all over the dried bottom of the pond after grinding and should be evenly mixed with the bottom soil through plowing and, laddering. If de-watering is not possible, the required quantity of lime should be dissolved in water and then sprinkled evenly over the pond water when in becomes cool.

After 3 days

D. Organic Manure Application: kg/dec

Decomposed cow dung: 8 or Poultry litter: 4. If dried, the required quantity of manure should be sprinkled evenly all over the dried bottom of the pond and should evenly be mixed with the bottom soil through plowing and laddering. If not dried, the required quantity of manure should be sprinkled on the pond water and should be distributed evenly through horra dragging.

After 3 days

E. Water Supply: 50% (2.5-3.0 feet) if dried

The required level of the pond should be filled up with underground water. If water from other source(s) is irrigated, it must be free from undesirable aquatic plants and predatory animals.

After 1 day

F. Chemical Fertilizer Application after Horra Dragging

Urea: 250 g + TSP: 250 g

The required quantity of fertilizers should be dissolved together in sufficient quantity of water and sprinkled evenly all over the surface of pond water.

After 3 day

3.6.2 Stocking Management

- ✓ Fingerling transportation in well oxygenated water container preferably in oxygen filled polythene bag (closed system).
- ✓ Disinfection of fingerling before stocking.
- ✓ Acclimatization of fingerling with pond water environment.
- ✓ Proper stocking density and species composition of cultured species.

Fish fingerling (5-6 inch) stocking:

Table 27: No./dec. for the effective pond area

Name of fish	No. to be stocked/model		
	Model-1	**Model-2**	**Model-3**
Catla	6	3	8
Silver carp	8	12	4
Rohu	4	3	3
Grass carp	3	3	3
Rajputi	10	12	12
Mrigal	6	3	-
Kalibaush / ghannya	-	-	5
Carpio / mirror carp	3	4	5
Total	**40**	**40**	**40**

The larger the size of stocking organisms, the faster the rate of growth and higher production could be obtained quickly.

3.6.3 Post-stocking management

A) Water Supply: 100% of the pond depth (5-6 feet). The pond should be filled up to the desired level with under-ground water. If water from other source(s) is irrigated, it must be free from undesirable aquatic plants and predatory animals.

B) Fertilizer Application: g/dec/day

- ✓ Raw cow dung: 200 g + Urea: 5 g + TSP: 5 g

Or

- ✓ poultry litter: 100 g + Urea: 5 g + TSP: 5 g

The required quantity of fertilizers should be dissolved in sufficient quantity of water and after storing for 24 hours, the fertilizer emulsion should be sprinkled evenly over water of the pond every morning since sixteen day of stocking of seed.

C) Supplementary Feeding:

Supplementary feed should be supplied for proper growth of fish as stocking density is high in cultured ponds and natural food cannot meet up their food demand. Supplementary feed, consisting of the following ingredients should be delivered twice a day: in the morning and in the afternoon at a rate of 3-5% of body weight.

Table 28: Inclusion rate of feed ingredients for supplementary feed

Feed Ingredients	Amount of ingredients (%)
Fish meal	25.00
Mustard oil cake	15.00
Sesame meal	15.00
Rice bran	20.00
Wheat bran	19.00
Flour	5.00
Vitamin-mineral premix	1.00
Total	**100.00**

D) Inspection of Fish Health and Disease Prevention Measures

Growth and health condition of the stocked fishes should be monitored at least once a month through netting. Prevention is better than cure, so when the immune response of fish is reduced at the onset of the winter (beginning of November) application of lime at the rate of 1 kg/dec. in 3-4 equal installments considered to be effective to protect the fishes form disease infection. Pond should be monitored periodically for controlling dissolved oxygen deficiency, algal bloom and toxic gases accumulation. If there is any possibility of toxic gas accumulation horra can be draggedon the pond bottom. Disinfected nets, container and other equipment should be used and fish pathogen carrying birds, aquatic animals and insects should be controlled.

E) Partial Harvesting and Restocking

If it is possible to continue the cultural operation for a longer period, individuals attaining the marketable size should be harvested and replaced by bigger size fingerlings of the same species to get more production from the same plot.

Effective Pond Volume: Taking into account pond depth, sunshine & climate if the effective volume of your pond is 600 Liters, look for a filter that is rated for ponds up to 1,200 Liters.

3.7 Liming

3.7.1 Action of liming

Liming is part of the maintenance for ponds. It has a varied and favorable action on the health of fish on the one hand, and on the biological factors of production on the other.

- ✓ The use of quicklime or calcium cyanamide for liming the pond bottom has an anti-parasitic action.
- ✓ One of the consequences of the liming of acid water is an increase in the pH to more desirable levels, slightly alkaline (pH=7.0 to 8.0).
- ✓ The liming of the bottom produces quick and considerable improvement.
- ✓ Liming brings about the precipitation of excessive organic matter in suspension in the water.
- ✓ The nitrification of ammonium compounds into nitrites nitrates depends the presence of sufficient quantities of lime.

3.7.2 When should liming take place?

Liming is indispensable:

- When the pH of the water is too low;
- When the alkalinity is too low;
- When the bottom is too muddy or neglected (through ponds not being regularly dried out each winter)
- When the organic matter content is too high and there is a danger of lack of oxygen;
- When there is a threat of, or contagious diseases are noticed.

3.7.3 Types of lime

There are four types of lime-

i) Powdered limestone and marl

These substances contain calcium in the form of calcium carbonate ($CaCo_3$, agricultural lime), which is insoluble in water. The powdered limestone contains about 90 to 95% of $CaCo_3$, and the marl contains 80 to 90% $CaCo_3$. They are more effective when they are finely

ground. The grains should be less than 1mm in diameter. Calcium is used in the form of $CaCO_3$ when the pH of the water is too low or when the use of quicklime is a danger to the fish.

ii) Quicklime

The quicklime combines with carbon dioxide of the water or the air according to whether the water or the bottom is limed, and transforms rapidly into carbonate which deposits on the bottom of the pond. In 1 to 2 month it is transformed into bicarbonate. It is found in two forms, one is lumps and another is finely ground powder. Generally, lumps are particularly effective for disinfecting and killing parasites in small ponds. On the other hand, finely ground quicklime is used for the destruction of enemies of the fish or against diseases.

iii) Caustic lime (CaO)

This, also called slaked lime or powdered hydrated lime [Ca (OH) 2], is obtained by stirring water on quicklime or leaving it exposed to the air. It is used commercially. It contains at least 65 percent CaO. Sometime it is as quicklime, because it is relatively toxic for fish.

iv) Calcium cyanamide ($CaCN_2$)

It is comprising 60 % calcium cyanamide and 17% CaO. Its action is toxic not only because of the quicklime it contains but above all the cyanamide. The use of this product is advisable for the control of encysted and very resistant parasites.

3.7.4 Methods of liming

Liming can be carried out in three different ways:

A. Liming the bottom of a dried pond
B. Liming the pond water
C. Liming the water flowing into the pond

A) Liming the bottom of a dried pond

The quantities to use for liming the bottom of a pond are very variable and depend on the aim and the nature of the soil.

- If it is for the control of parasites, then 1,000 to 1,500 kg of CaO or calcium cyanamide are used per hectare. The product is spread over soil, which isstill damp.

- If it is to improve the soil before using the other fertilizers, the ratio is 200 to400kg of CaO per hectare provided the pond is not acid.
- If the aim is to increase the pH and alkalinity of an acid pond the quantities usedvary considerably according to the degree of acidity and the nature of the soil.

B) Liming the pond water

A boat is used. If the operation is with ground limestone no special precautions need be taken. If quicklime is used it can be distributed up to 200 kg per hectare per day even over several days. It is necessary to keep an eye on the pH variation, which might result, especially when the water is poor in calcium. The pH should not exceed 9.5.

C) Liming the water flowing into the pond

This avoids the necessity of spreading. A lime mill placed in the water channel. It comprises a funnel into which the limestone or the caustic lime is poured. The bottom of the funnel can be regulated. A water wheel turned by the current drives an endless chain connected with a hammer which strikes the outside of the funnel, causing a certain amount of lime to fall through the funnel at each blow.

3.8 Pond Fertilization

3.8.1 Pond fertilization

The fertilization of ponds and lakes for increased production of fish has its origin in antiquity. For centuries it has been a common practice in Europe and parts of Asia to fertilize carp ponds.

3.8.2 Objective of fertilization

- ✓ It keeps the hygienic of the pond.
- ✓ To increase the productivity of the pond.
- ✓ To increase the natural food of the pond.
- ✓ To avoid the dietary disease of fishes.

3.8.3 When the fertilization is more effective?

The following conditions must be met if the use of the fertilizer is to have a favorable effect.

- ✓ The water and the soil must have a neutral reaction or be slightly alkaline in nature.
- ✓ There should be no over hangs of aquatic vegetation.
- ✓ There should be no over submerged vegetation.
- ✓ The bottom must be covered with good quality mud rich in colloids, not too thick.
- ✓ Time, doses and frequency of fertilization should be maintained appropriate.

3.8.4 Time, doses & frequency of fertilization

i. Dry season is not suitable for fertilization, because in this season water retention capacity is reduce.
ii. Summer season is the best for fertilization.
iii. During winter should not fertilized, because, it's may be cause blooming.

- ➢ **Inorganic fertilizers**
  - ✓ Urea: 100-150 gm/ decimal
  - ✓ TSP: 50-75 gm/ decimal
  - ✓ M.P: 20-40 gm/ decimal

- **Organic fertilizers**
  - ✓ Cow / cattle dung: 7-10 kg/decimal
  - ✓ Poultry manure:3-5 kg/ decimal
  - ✓ Compost:10-12 kg/decimal
  - ✓ Green manure:450-650 kg/ acre

3.8.5Why the pond should be fertilized?

- ✓ The pond is to be fertilized to maximum yield of fish to increase the productivity of pond to enhance the natural production of natural food.
- ✓ A part from artificial feeding, fertilization provides the best means of increasing fish production in ponds.
- ✓ Fertilization assures a more hygienic intensification of production than artificial feeding.
- ✓ Fertilization increases the production without the risk of dietary diseases, on the contrary, it improves the hygienic condition of the pond.
- ✓ By fertilizing we can produce fishes cheaper rate than of artificial feeding.

So, fertilization is an important for fish cultivation as it is in exploitation of farmland.

3.8.6 Types of fertilizer

I. Inorganic fertilizer
II. Organic fertilizer

I. Inorganic fertilizer

a) Limestone: Limestone is a fertilizer to the extent that it supplies calcium, which is one of the essential plant nutrients. Lime is used mainly to correct acidity in the soil and water. Lime assists in the release of nutrients from the soil and promotes the bacterial breakdown of waste material including green manure added as organic fertilizers. Lime is toxic and also useless for pond production until it has had time to take up CO_2 from the air or soil and become first calcium carbonate and then calcium bicarbonate. For this reason, it is suggested that ponds should not be stocked with fish until at least a fortnight after treating the pond with quicklime. Because of useful effects of limestone, liming is considered as essential preliminary to successful pond fertilization.

b) **Phosphate fertilizer:** Phosphate is by far the most important fishpond fertilizer. It produced by far the greatest increase in fish crops in pond. So it is most widely recommended and employed. The results obtained under varied conditions suggest that phosphorous is the most important "minimum substance" controlling organic production in the natural waters. It may be added in various ways. The dose usually recommended is 25 to 30 kg P_2O_5 per hectare. This is equivalent to 150 to 200 kg per hectare of super phosphate. Phosphate fertilizers are said to stimulate the growth of plankton rather than that of higher vegetation. Super phosphate helps to stimulate the activity of nitrogen fixing bacteria and to increase the nitrifying activity of the soil.

c) **Potash manure:** Potash is frequently used as a manure on land crops, but in general it seems that a lack of potash is not a limiting factor on the production of fish in most ponds. Potash is one of the essential nutrients, but the bodies of fish contain very little. At the level of fish production usually in temperate climates, potash manure seems unnecessary. No harm would be done, however, by applying potash fertilizer from time to time. Where potash is given, it is usually mixed with the phosphate fertilizer, and a typical dose is about 25 to 30 g per hectare.

d) **Fertilizers containing nitrogen:** Nitrogenous fertilizers often have the stimulating effect on the growth of phytoplankton, which is one of the most vital raw materials for the production of fishponds.

Wunder (1949) believes that nitrogenous fertilizers do not play beneficial role in carp ponds and they have deleterious effects on the fish.

Commonly employed nitrogenous fertilizers are i) Chile saltpeter (sodium nitrate) dose 60kg/ hectare, ii) Ammonium sulphate, dose 50kg/hectareand iii) Calcium nitrate, dose100kg/hectare. Urea is also commercially available as a fertilizer. Dose 100 to 150 gm urea per decimal. Aqueous ammonia contains 20% nitrogen and is just as effective as a fertilizer as sulphate of ammonia.

II. **Organic fertilizer:** Organic fertilizers are by far the most commonly used in fishpond work. Organic manures such as dung is a by-product of other small-scale peasant industries such as, pig, poultry and duck raising.

a) **Green manure:** The advantages of green manuring in fish ponds considered to follow partly from direct organic manuring and poultry from the provision of a suitable substratum for a rich growth of attached algae, zooplankton, insect larvae

and other forms of fish food. During dry periods, crops grown on the pond bottom are ploughed into the mud, or left to rot after the pond is filled again. The green manure should not be broadcast over the pond bottom but stocked in heaps with a topping of mud to prevent heaps drifting away. The dose is 700 to 800 kg per hectare.

b) Liquid manure: The manure powerfully stimulates the growth of the plankton. It should be applied sparingly in frequent doses, if possible, added in the deeper parts of the pond. If liquid manure is given in too strong doses, there may be an unwanted outbreak of filamentous algae.

c) Sewage water: Heavy fish crops can be obtained by fertilization of ponds with sewage water at high tropical temperatures. In the ponds, the sewage water takes up oxygen and releases it nutrients. Sewage is admitted into the ponds at monthly interval in the proportion of 1:4 sewages to water, so slowly that it takes 4 to 5 days to admit the desired dose.

d) Animal manure: Animal manures like cowdung, housedung etc are by far the commonest manures used in fishpond work. Cowdung and pigdung are the most frequent, indeed the pigsties may be built over the ponds, so that the dung and urine drop directly into the water. organic manures are especially valuable in conditioning the soil of new ponds. Cowdung is considered to be the best fertilizer for fry ponds in India. The usual treatment appears to be at the rate of about 7-10 kg per decimal.

Poultry manures may be as good as inorganic fertilizers but can give rise to gill rot in fish (fungal disease in gills of fishes). The dose is 3-5 kg per decimal.

The pond is to be fertilized for

- ✓ To increase the natural productivity or natural food which in turn lead to increase the production of fishes.
- ✓ It gives the hygienic condition of the pond.
- ✓ It helps to reduce the dietary diseases of the fishes.

We used mixed fertilizer in the pond.

Dose: Inorganic fertilizer

- ✓ Urea: 100- 150 gm/decimal

- ✓ TSP: 50-75 gm/decimal
- ✓ Potash: 20-40 gm/decimal

Organic fertilizer

- ✓ Cowdung: 7-10 kg/decimal
- ✓ Poultry manure: 3-5 kg/decimal
- ✓ Compost: 10-12 kg /decimal
- ✓ Green manure: 450-650 kg/decimal
- ✓ We give fertilizer just after 10-15 days fry releasing.

Artificial feed and supplementary feed

For proper growth of fry artificial and supplementary feed are required. It helps in better fast growing. Artificial feed is the balance diet for fish and supplementary feed e.g., mustard cake, fishmeal and rice straw will also help. We will supply the food in the pond at the rate of 5% per body weight of fish twice a day. Generally, one is in the morning and other in the evening and try to give the food at a particular place and same times every day so that reduced the less possibility for destroyed the supplementary feed.

Periodic checking

Periodic checking is very essential for the following purpose:

- ✓ To know the general condition of the fish.
- ✓ To know the growth rate of fish.
- ✓ To observe the physical soundness of fish.
- ✓ Netting over the pond for better aeration as well as for better exercise of the fish.

Harvesting and marketing

We must harvest the fishes at marketable size. When the fishes will attain 700-1000 GM, we may harvest them and marketing as early as possible in a live condition with the help of drum.

3.9 Carp culture

Carp culture mainly indicates the culture of Indian major carps and Chinese carps for commercial purpose. We should not include the minor carps respectively. Among this carps we can practice polyculture or monoculture.

The following steps should be considered for carp culture with commercially importance:

- Selection of species for monoculture or polyculture
- Stocking ratio and density
- Fertilization
- Artificial feed or supplementary feed
- Periodic checking
- Exploitation

Selection of species

The following factors should be considered for selection of species:

- ✓ Having rapid growth
- ✓ Be hardy and disease resistance
- ✓ Fry or seed is available in the local hatchery
- ✓ Have high market demand
- ✓ Highly tolerance to the adverse aquatic condition
- ✓ Adaptation to the environment
- ✓ Mostly feed on plankton and natural food

Monoculture: The species, which feed on in different layer of food, can be selected for monoculture purpose.

Polyculture: Different size of groups of fishes to be used for polyculture or composite culture which feed on different region of the pond with different feeding habit.

Stocking ratio and density

Stocking density depends on the size of the pond and the size of the fry or fingerlings. The stocking density should be optimum level, otherwise the species will be suffering from overcrowding, food consumption, space distribution and ultimately the growth rate of the fishes will be reduced. So, the stocking density plays a very important role for the aquaculture purpose.

The farmers can be selected the stocking rate depending on the species market value.

The combination in polyculture practice:

Catla: Rui: Mrigal: Kalibaus = 3:3:2:2 or 4:3:2:1

Silver carp: Bighead carp: Grass carp = 2:2:1

3.10 Catfish culture

Catfishes belonging to Ictaluridae, Claridae, Pangasidae and Siluridae are widely distributed in different parts of the world. Their hardy nature and ability to remain alive out of water for long periods have been of special value in tropical countries. Among them Pangas, Magur, Boar, Airh, Pabda included. In Bangladesh, Pangasiushypophthalamus (thai pangas) culture is practiced all over the country for the farmer acceptability and for its market demand.

The following steps should be considered for catfish culture with commercially importance:

- ✓ Selection of species
- ✓ Preparation of the pond
- ✓ Stocking ratio and density
- ✓ To give artifial food and supplementary feed
- ✓ Periodic checking
- ✓ Prevention of diseases
- ✓ Harvesting and marketing

Selection of species

Following factor should be considered for selection of species:

- ✓ Availability of seed or fry for the culture medium and transportation is easy.
- ✓ Easy to rear in a high density.
- ✓ Very hardy and disease resistance.
- ✓ Omnivorous and showing no competition with others.
- ✓ Showing high growth rate and friendly behavior with other.
- ✓ Depends on artificial food and can feed any kinds of food.

Also, it feeds in different layers of food which is very much profitable for the fish farmer.

Preparation of the pond: Pond preparation is an important factor for fish culture especially fish growth. For catfish culture, at first we will dry the pond to control the unwanted species, insects and parasites and construction the dyke and embankment of the pond if necessary. After 2-3 days we will apply lime for better growth of zooplankton and increase the productivity of the pond. After 2-3 days we refilling the pond and after 4-7 days we can release fry or fingerlings.

Stocking ratio and density: Stocking density depends on the size of the pond and also size of the fry or fingerlings. The stocking density should be optimum level otherwise fishes

suffer from over crowing, food competition and space distribution. The optimum rate of releasing fry is 8000 /ha. for catfish, 20,000-25,000 fry /ha can be released but the longevity will be loss. We must release the over wintering fry, which is 4-5-inch-long normally and 2-3-inch-long in a high density. The farmer can also select the stocking density depending on the market value.

To give artificial and supplementary feed

We will give artificial food at the rate of 13-14% per body weight for the 4-5-inch-long fry, two to three times even 4 times in a day. For 500 gm weighted fish 5% per body weight feed and 1000gm weighted fish 3-4% per body weight feed should be supplied respectively for proper growth of catfish. But we should must have considered our economic condition that the production will be profitable.

Moina which is a zooplankton cultured in Thailand used is the best food for hatchling. The ratio 1 kg hatchling and 2 kg Moina release in the nursery pond. Supplementary feed is given in the morning and in the afternoon period of the day and stopped for one day per week. As a result, the fishes will eat unused and halfused food as well as clean the environment and our cost will be reduced. Below 15^0C fisheswill stop feeding.

Periodic checking

Periodic checking is done for observe the growth rate, general condition, better aeration and prevent disease.

Prevention of disease

The disease is attack mainly in winter season. The fungus diseases, which attack pectoral and dorsal, fin spines and deposit. The bacterial diseases which attack mouth and caudal region and becomes red. IN that both can, we can apply ‘Renamycin’ the drug of ‘Tetramycin’ group. We can mix 4 Renamycin tablets of 500 mg per 100kg feed. This treatment can give a good result.

Harvesting and marketing

We must harvest the fishes at marketable size. When the fishes will attain 500-600 gm, we may harvest them and marketing as early as possiblein alive condition with the help of drum. For catfishes’ partial harvest cannot be done. Total catch is done with the help of thick twine net for a short time harvest.

SECTION 4: POST ACTIVITY DIRECTION

Community based management approach was taken to manage the fish sanctuary and net pen culture. Respective WMA operated and managed the fish sanctuary and net pen. WMA engaged women, fishers, boatmen, and local leaders from the WMO members. A group leader was selected among committee members according to opinions of the all members. All the committee members agreed to follow the instructions for better management of the sanctuary and net pen. The WMO (WMA/WMG) took the responsibilities of protecting the fish sanctuary having motivational training from the consultant team. The year round ban on fish catch was imposed in and around 500 meter of the sanctuary. To protect fish poaching management committee selected two people periodically as night guard among the committee members. Artificial feed was delivered in the cages two times per day by particular community members. Besides all the members of the committee was very conscious about protection of the sanctuary and they were actively involved in the repairing of the sanctuary, reintroduction of species, management of the net pen, etc.

SECTION 5: OVERALL CONCLUSION AND RECOMMENDATIONS

5.1 Overall conclusion

From the above circumstances it is clear that the fish biodiversity is declining day by day due to various ways including the degradation or alteration of habitat which are used as frequently for feeding, breading, spawning and nursing ground. Besides coastal cyclones, siltation, over catching, indiscriminately uses of fisheries resources can be causes of fish biodiversity reduction.

From the results of net pen culture, it has been revealed that, as every polder has huge number of unutilized canals, net pen culture can play a vital role to increase the fish production and livelihood status of polder community. Physico-chemical parameter of canals water of all polders is suitable for net pen culture.

Fish sanctuary is a demarcated protected area, where targeted fish will not be disturbed or captured. The abundance and distribution of fishes from different khals of polder area are decreasing day by day due to the environmental degradation and anthropogenic activities such as overfishing, indiscriminate use of chemicals, destruction of natural feeding and breeding ground of fishes etc. It was observed that sanctuaries have positive impacts to grow natural food, provide space for feeding, breeding and protection and make a congenial environment to regenerate and increase aquatic biodiversity in the coastal region.

Awareness building activities is an important tool for better management of sanctuary, protection of biodiversity and net pen culture. More awareness building program should be organized in six different polders to aware people about aquatic biodiversity conservation, enhance and preserving aquatic biodiversity, increasing the abundance of threatened fish species, protect many other aquatic fauna and flora and increase production of all kind of fish in the polder area.

Training has specific goals of improving one's capability, capacity, productivity and performance. Smallholder farmers produce far below their potential yields, often due to poor farming practices and poor access to extension services. Training in good aquaculture practices help farmers learn how to capably manage the health of their pond, effectively cultivate their crops, and increase their harvests. As a result of trainings, farmers are able to increase their yields, build their skills in pond management, earn more income through aquaculture and improve the polder economy.

5.2 Recommendations

To increase fish production and conserve aquatic biodiversity in the polders area the following recommendation should be address:

1. Net pen fish culture system should be practiced at probable canal of all polders to increase livelihood status of polder community. Large scale commercial fish culture in cage system can be the trump card for alleviating poverty and uplifting the social status of polders people.

2. For the conservation of biodiversity and to increase the fish production in the canals and river of polders area, it is inevitable to establish more fish sanctuary in suitable places of different canals through the direct participation of WMG and WMA community. Community based management approach should be used to manage the fish sanctuary **following the guidelines stated in section 3.2**.

3. As huge number of people lives in each polder area, more motivation program should arrange to save aquatic biodiversity, stop poison fish, stop use of restricted fishing gear and increase natural fish production.

4. Every polder area has huge number of ponds presently practicing extensive fish culture and some are unutilized. All pond should be taken under semi intensive fish culture system to increase the fish production.

5. More training program should be arranged on scientific fish culture including carp fish culture, semi-intensive culture of Pangas, Tilapia, Koi, Shing, Magor, Pabda, Gulsha, Prawn and rice cum fish culture. The respective Upazila fisheries officers are the prime part in this regard. WMA can also invite fish Expert for conducting annual training making liaison with BWDB.

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Annexure 1

Details of participants of aquaculture training program

Table 1: List of participants of aquaculture training program at Polder 39/2C (Bhandaria)

SL No.	Name of the Participant	Address	Mobile Number
01	A B Siddik Ahmed	Boroshoula, Mathbaria	01713955782
02	Ahmed Nurullah	Darul-huda, Mathbaria	01712129957
03	Md. Chan Mia	Nodmula, Vandaria	01778337715
04	Md. Monir	Nodmula, Vandaria	01729873867
05	Md. Fazlool Haque Sipahi	Nodmula, Vandaria	01734438439
06	Abdur Jabbar	Dhaowa, Vandaria	01756883334
07	Md. Yousuf	Golbunia, Vandaria	01728195061
08	Jahangir Talukdar	Vaylabunia, kathalia	01728920070
09	Sujit Chandra Mistri	Shingkhali, Vandaria	01752813644
10	Md. Masum Mia	Shingkhali, Vandaria	01724265260
11	Md. Shah Alom Howlader	Telikhali, Mathbaria	01726723833
12	Abdul Mannan	Boroshoula, Mathbaria	01723443064
13	Md. Torikul Islam	Hetalia, Vandaria	01716828891
14	Md. Imran Hossain	Darul-huda, Mathbaria	01728995733
15	Md. Shahadat	Darul-huda, Mathbaria	01640138152
16	Md. Forkan Howladar	Darul-huda, Mathbaria	01731194041
17	Md. Shaylu Shikdar	Charkhali, Vandaria	01717809763
18	Afjal hossain	Boroshoula, Mathbaria	01734581359
19	Md. Ramjan	Nodmula, Vandaria	01719274786
20	Abul Kashem	Nodmula, Vandaria	01610798261
21	M. A. Kaium Zaman	Rahupasha, Vandaria	01781838281
22	Rafikul Islam	Ikri, Vandaria	01789343560
23	Md. Nurul Islam	Ikri, Vandaria	01724915180
24	Md. Barkatullah	Golkhali, Vandaria	01724214816
25	Md. Hasan	Kalirchar, Vandaria	01714208420

Table 2: List of participants of Aquaculture training program at Polder 40/2 (Patharghata)

SL No.	Name of the Participant	Address	Mobile Number
01	Md. Zakir Hossain	Chaherabad, Charduani	01713954072
02	Rezaul Islam	Dokkhin Charduani,	01725760040
03	Shahjahan Jomaddar	Nij Lathimara, Patharghata	01747707926
04	Mahbubur Rahman	Takhalbaria, Patharghata	01725360633
05	Md. Jahangir Munshi	Chaherabad, Charduani	01719016557
06	Md. Rafikul Islam	Gabbaria, Patharghata	01713956028
07	Md. Mishad	Chaherabad, Charduani	01610027975
08	Md. Mona	Chaherabad, Charduani	01646577611
09	Md. Alamgir	Chaherabad, Charduani	01736391284
10	Shiuli Begum	Chaherabad, Charduani	-
11	Md. Forkan	Chaherabad, Charduani	01745554349
12	Md. Faruk mia	Chaherabad, Charduani	01940604022
13	Md. Manju	Chaherabad, Charduani	01712795000
14	Aoual Hossain	Chaherabad, Charduani	01319809936
15	Raja Mia	Chaherabad, Charduani	01791963275
16	Surma Aktar	Dokkhin Charduani,	01777955879
17	Moyna	Chaherabad, Charduani	01723899500
18	Unnoti Rani	Chaherabad, Charduani	01746341491
19	Runu Begum	Chaherabad, Charduani	01757227542
20	Poli Begum	Chaherabad, Charduani	01313130211
21	Jhumur Bepari	Hoglapasha, Patharghata	01757842075
22	Aroti Rani	Dokkhin Charduani,	01678431612
23	Jahir Rayhan	Chaherabad, Charduani	01713954631
24	Md. Golam Kibria	Chaherabad, Charduani	01730826098
25	Md. Rakib	Chaherabad, Charduani	01755930843

Table 3:List of participants of Aquaculture training program at Polder 41/1 (Barguna)

SL No.	Name of the Participant	Address	Mobile Number
01	Deloara	Lobongola, Barguna	01700969726
02	Rani Begum	Burirchar, Barguna	01891812024
03	Mst. Nilufa	Charokgachia, Barguna	01305300302
04	MD. Matiur Rahman	Maitha, Barguna	01925263949
05	Boni Amin	Chonbunia, Barguna	01753640699
06	Md. Rafikul Islam	Lobongola, Barguna	01744941463
07	Md. Abdus salam Gazi	Burirchar, Barguna	01780545941
08	Md. Humayon Kabir	Maitha, Barguna	01724479766
09	Montu Chowdhury	Lobongola, Barguna	01917802914
10	Md. Rafik	Shonakhali, Barguna	01681581965
11	Md. Nijam	Manikkhali, Barguna	01745372877
12	Shahed Ali Khan	Hajarbigha, Barguna	01727802594
13	Md. Najmul Hasan Sagir	Lobongola, Barguna	01721690912
14	Md. Riyajul Islam	Charokgachia, Barguna	01710606755
15	Md. Selim Reza	Burirchar, Barguna	01740583373
16	Md. Nazrul Islam	Charokgachia, Barguna	01732453922
17	Md. Alamgir Hossain	Charokgachia, Barguna	01910449792
18	Mitanur Rahman	Maitha, Barguna	01717867228
19	Mst. Haowa Begum	Keorabunia, Barguna	01780795443
20	Md. Kamal Hossain	Keorabunia, Barguna	01731016163
21	Md. Kabir Gazi	Keorabunia, Barguna	01781917325
22	Sabita Rani	Burirchar, Barguna	01726736584
23	Abdus Salam Howladar	Burirchar, Barguna	
24	Md. Ismail Hossain	Maitha, Barguna	01727316711
25	Salma Begum	Maitha, Barguna	01722528025

Table 4:List of participants of Aquaculture training program at at Polder 43/2C (Galachipa)

SL No.	Name of the Participant	Address	Mobile Number
01	Md. Faruk Hossain	Golkhali, Galachipa	01744551593
02	Shahabuddin Shihab	Golkhali, Galachipa	01706460705
03	Md. Shahidul Khan	P Golkhali, Galachipa	01731408405
04	Md. Amirul Islam	P Golkhali, Galachipa	01735502070
05	Abdul Jalil	Purbo Golkhali, Galachipa	01921192566
06	Md. Badsha Haowladar	Golkhali, Galachipa	01751235788
07	Md. Shahidul Sardar	Golkhali, Galachipa	01736763210
08	Jhorna Begum	Purbo Golkhali, Galachipa	01748680618
09	Shajeda Begum	Purbo Golkhali, Galachipa	01792053708
10	Shathi Begum	Purbo Golkhali, Galachipa	013116451103
11	Md. Shaheb Ali	Purbo Golkhali, Galachipa	01938544956
12	Md. Rayhan	Purbo Golkhali, Galachipa	01757221048
13	Md. Miraj	Purbo Golkhali, Galachipa	01300973859
14	Md. Ensan Khan	Golkhali, Galachipa	01958544956
15	Md. Ismail Gorami	Golkhali, Galachipa	01771930830
16	Md. Imran Haowladar	Badarpur, Galachipa	01772299892
17	Salim Malkar	Boro Gabua, Galachipa	01775398993
18	Jahid Al Imran Masud	Purbo Golkhali, Galachipa	01735521717
19	Md. Shafikul Islam	Purbo Golkhali, Galachipa	01754261900
20	Md. Mannan Molla	Char Azizia, Galachipa	01741182183
21	Rafik	Suhori, Galachipa	01707295327
22	Shah-Alom Mridha	Golkhali, Galachipa	01772060730
23	Belal Khan	Purbo Golkhali, Galachipa	01902149560
24	Md. Nur Hossain Pyada	Golkhali, Galachipa	01710850918
25	Hemayat Uddin	Golkhali, Galachipa	01719459671

Table 5: **List of participants of Aquaculture training program at Polder 47/2 (Dalbugonj)**

SL No.	Name of the Participant	Address	Mobile Number
01	Md. Najmul	Dalbugonj	01734803818
02	Md. Jashim uddin	Shirpur, Dalbugonj	01741583946
03	Md. Bashir Uddin	Rasulpur, Dalbugonj	01726453146
04	Md. Liton	Rasulpur, Dalbugonj	01765788983
05	Shahjahan	Rasulpur, Dalbugonj	01719933754
06	Md. Montu Haoladar	Fulbunia, Dalbugonj	01650178644
07	Md. Faruk Haowladar	Jamalpur, Dalbugonj	01789842239
08	Abu Jafar	Peyarpur, Dalbugonj	01754277570
09	Md. Abul Hossain	Peyarpur, Dalbugonj	01716710266
10	Md. Rasel	Nurpur, Dalbugonj	01732582783
11	Abdul Mannan	Mirpur, Dalbugonj	01714043852
12	Md. Mijanur Rahman Bacchu	Mirpur, Dalbugonj	01717118514
13	Md. Omor Faruk	Nurpur, Dalbugonj	01710773040
14	Md. Zakir Morol	Fulbunia, Dalbugonj	01727429832
15	Md. Oyares mia	Fulbunia, Dalbugonj	01752904673
16	Md. Monirul Islam Pannu	Nurpur, Dalbugonj	01718482831
17	Md. Harun	Meherpur, Dalbugonj	01733394012
18	Md. Rubel	Jamalpur, Dalbugonj	01780892314
19	Md. Nasiruddin Molla	Rasulpur, Dalbugonj	01721810058
20	Md. Rabiul	Rasulpur, Dalbugonj	01782633713
21	Md. Ruhul Amin	Peyarpur, Dalbugonj	01733172235
22	Md. Najrul Islam	Meherpur, Dalbugonj	01766272563
23	Md. Naser	Mirpur, Dalbugonj	01622111730
24	Nurjahan	Fulbunia, Dalbugonj	01716699630
25	Md. Liton Gazi	Meherpur, Dalbugonj	01782973351

Table 6. List of participants of Aquaculture training program at Polder 48 (Alipur)

SL No.	Name of the Participant	Address	Mobile Number
01	Md. Sagir Ahmed	Tulatuli, Alipur	01719436631
02	Md. Goni Haowladar	Maitvanga, Alipur	01736862931
03	Md. Golam Faruk Tuku	Tulatuli, Alipur	01735018632
04	Md. Zakir Hossain	Tulatuli, Alipur	01713951979
05	Md. Khalil Akon	Tulatuli, Alipur	01718118143
06	Shomir Chandra Shil	Tulatuli, Alipur	01782815024
07	Mst. Razia Begum	Poschim Chabli,Alipur	01796444840
08	Rahima	Tulatuli, Alipur	01789842851
09	Mst. Shahanaj Begum	Kashipara, Alipur	01710408090
10	Asma Begum	Lakshmipara, Alipur	01715683071
11	Mst. Rebeka	Khajura, Alipur	01650080382
12	Md. Idris	Tulatuli, Alipur	01712366937
13	Md. Sahed Matubbar	Maitvanga, Alipur	01744491277
14	Md. Naim	Tulatuli, Alipur	01610400570
15	Md. Mostafa Mridha	Lakshmipara, Alipur	01752606274
16	Md. Mujammel	Tulatuli, Alipur	-
17	Md. Kalam	Azimpur, Alipur	01783420882
18	Md. Jabbar	Misripara, Alipur	01751609754
19	Md. Rasheduzzaman	Tulatuli, Alipur	01716858658
20	Md. Ansar molla	Tulatuli, Alipur	01718815601
21	Md. Yousuf Ali	Amkhola, Alipur	01735952757
22	Md. Ismail	Maitvanga, Alipur	01718248697
23	Pabitro Chandra	Tulatuli, Alipur	01718335751
24	Mst. Minara Begum	Latachapli, Alipur	01733263756
25	Md. Abdul Malek	Latachapli, Alipur	01769167663