

FINAL REPORT

Hilsa fisheries improvement in river Ganga



National Mission for Clean Ganga (NMCG)

Ministry of Jal Shakti

Government of India



ICAR-CENTRAL INLAND FISHERIES RESEARCH INSTITUTE

(Indian Council of Agricultural Research)

An ISO 9001 : 2015 Organisation

Barrackpore, Kolkata-700120, West Bengal



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Foreword

The National Mission for Clean Ganga (NMCG), Ministry of JalShakti with vide letter no. CIFRI/PS/NMCG-II/2018/2277, dated 18/09/2018 awarded a short term project on “*Hilsa fisheries improvement in river Ganga*” to ICAR-CIFRI, Barrackpore for a period of one year during 2018 to 2019. The major objective of the project was to increase the natural stock of hilsa in river Ganga (upstream of farakka barrage) and to study the upstream migration of hilsa in the main river Ganga through suitable methodology. To execute the project objectives, intensive surveys were carried out to select the sampling sites those are suitable for adult hilsa collection, transportation and ranching. Based on these criteria, hilsa ranching station was established in the right bank of river Ganga near to Farakka barrage (upstream). Both adult and juvenile live hilsa were collected with different nets and recorded that lift net is most suitable for keeping the hilsa live without much physiological stress. During the project period of one year, a total number of 3274 live hilsa were ranched at the upstream of Farakka barrage. These ranched live hilsa were representative of adult of varied gonadal maturity stages. A total of 403 hilsa were tagged with T-bar anchor Floy tag to study the upstream migration. The recovery report of these tagged hilsa was interesting, though it was 3.8%. Tagged hilsa showed a migration rate of 49 km/day. These results were received from the ground by the fishermen during the awareness programme carried out from Farakka to Prayagraj. Our awareness programmes helped us to understand the economy of the hilsa fish that contributes towards the daily livelihood of the fishermen. The results recorded here were interesting and provided clues for successful re-establishment of lost hilsa fishery in the middle stretched of the river Ganga from Prayagraj to Farakka, if holistic approach is being adopted.

Barrackpore

18-07- 2022

(B. K. Das)
DIRECTOR

EXECUTIVE SUMMARY

Over the past four decades after the commissioning of Farakka barrage (1975), hilsa *Tenualosa ilisha*, a commercial and nutritional important fish of river Ganga has stopped migrating from downstream to upstream of the barrage resulting in drastic declined in hilsa landing at Allahabad, Buxar, Patna, Bhagalpur and at Rajmahal, representing the middle stretch of river Ganga. While at the downstream of Farakka barrage, the hilsa catch has increased. Though barrage is the major factor, other factors including river siltation, pollution, reduction of river flows and overfishing have been identified as the potential threats for the species. Therefore, a holistic approach was developed under the National Mission for Clean Ganga (NMCG) to re-establish the lost hilsa population in the upstream of the Farakka barrage particularly from Prayagraj to Farakka with a project title on “Hilsa fisheries improvement in river Ganga at Farakka” The project activities were carried out with the following objectives 1) to increase the natural stock of hilsa in river Ganga (upstream of Farakka barrage) through ranching of wild collected hilsa seed / juveniles and 2) To study and monitor hilsa migration across the Farakka barrage in main river Ganga through suitable method with a project period during 2018 to 2019.

After a detailed investigation, considering the suitability of live hilsa collection, transportation and ranching, a ranching station was established at the upstream of Farakka barrage i.e right bank of river Gang towards hilsa fisheries improvement in river Ganga. The main objective of ranching station establishment was to carry the live hilsa for a longer period, and acclimatization of the species. Furthermore, artificial breeding could be achieved with the present facilities at the station. In addition, three potential sites were identified for the live hilsa collection i.e Beniagram, (2 km downstream of barrage), Dhulian (12 km below the barrage), and feeder canal. Intensive experimental fishing showed that sites at Beniagram and below Farakka barrage, were most suitable for live hilsa collection and transportation. Furthermore, the hand net was recorded as the best for the live hilsa collection as this gives minimal physiological stress to the animal. To increase the natural stock of hilsa in the middle stretch of the river Ganga, a total of 3274 nos. of adult hilsa fishes with a weight and total length ranges between 150 to 350 gm and 20 to 24.5 cm respectively, were ranched at the ranching sites, which is located 5 to 10 km upstream of the Farakka barrage.

In order to understand the migratory path of hilsa, a total of 403 individual hilsa with an average length of 22.88 cm and weight of 152.88 g were tagged with floy T bar anchor Tags of standard size with customized (ICAR-CIFRI) serial number and ranched. Detailed physiology and stress parameters of tagged hilsa were studied after the tagging. The result indicated that the elevated stress factors comes to the near normal level after 45 to 60 min of tagging and showed 100% survival. Our recovery of tagged hilsa report, which is based on the ground level data, collected from the fishermen, showed that adult hilsa could migrate 49 km per day. Our study indicated that hilsa was recovered from Sahebganj (84 km) and Kahalgaon (120 km) within 15 days of ranching. Though the recovery percentage of tagged fish was 3.8%, this showed the hilsa could re-establish in the middle stretches of the river

Ganga. Furthermore, this study provided clues that river protective sites for hilsa and other fish species could be identified and established in the river Ganga in future.

Public awareness particularly for fishermen on hilsa fisheries and conservation of juveniles and brooders was found to be the key success towards hilsa fisheries improvement in the river Ganga. Sensitization on hilsa conservation was done in the upstream region from farakka to prayagraj, a stretch of about 770 km. A total number of 1200 fishermen belonging to 25 villages under 4 states covering U.P, Bihar, Jharkhand and West Bengal were sensitized. They were advised with proper guidelines by the ICAR-CIFRI research team to increase hilsa population in their native place. They were also asked to report ICAR-CIFRI if they get any tagged hilsa during their fishing operation. During the awareness programme, fishermen were more enthusiastic on the activities taken up by the NMCG towards hilsa fisheries improvement. A comparative analysis on income of fishermen from Hilsa catch (lower stretch of the barrage) and without Hilsa (upper stretch of barrage) showed us interesting results. The study showed fishermen could earn Rs. 25000 to Rs. 30000/month during peak season from hilsa catch only in the lower stretch of barrage. Therefore, highlights hilsa availability in the upper stretch of barrage could definitely improve the economy and livelihood of the fishermen.

The results obtained from the one year study was very interesting and provided clues towards possibilities of hilsa improvement in the middle stretches of the river Ganga, which was a lost species in last four decades. As the study period was very short to understand the impact of the ranching of hilsa in the river Ganga, it is proposed to have the continued activities for another three years with a target of 30000 adult hilsa. This could help us to understand the impact of our project towards hilsa fisheries improvement. Furthermore, the project felt that artificial breeding and extensive field based mass awareness programme among the fishermen could help us to achieve the mission towards reestablishing hilsa in river Ganga.

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1. Introduction

The Hilsa, *Tenualosa ilisha* is one of the most important fish species in India and designated as the state fish of West Bengal and the national fish of Bangladesh and forming a major source of employment for millions of fishermen in Ganga Brahmaputra and Meghna (GBM) basin. Hilsa fishery in India prevails mostly in the rivers of the east coast of the Bay of Bengal (Bhagirathi-Hooghly, Godavari, Mahanadi and Chilika) and in the rivers of West Coast of Arabian sea (Narmada and Tapti). As such country's 90 per cent hilsa production comes from the Hooghly-Bhagirathi river system. Hilsa has a great market demand with global average annual catch about 0.72 million tons representing 50 to 60% of total catch from Bangladesh, 20 to 25% from Myanmar, 15 to 20% from India. Among all the Indian states, West Bengal consumes most of the hilsa that are caught in India and imported from Bangladesh. As a result of high price and low availability the volume of consumption has reduced drastically. A survey was carried out through questionnaires on hilsa catch and wholesale price at different landing in Digha and Diamond harbour, Odisha, Gujrat and Mumbai. According to a local market survey in West Bengal (Kolkata), hilsa price was at Rs.1400.00 to Rs.3500.00 per kg, while in Odisha (Chilka) the price was Rs.900.00 to Rs.1800.00 for a size range of 400 to 800 g. The wholesale delivery price for hilsa (500 to 1000 g size) in Karnataka (Bangalore) was Rs.700.00 to Rs. 1200.00 per kg (source: Spar Supermarket, Bangalore). The survey results observed a disappointing market for hilsa in India because of limited supply of local hilsa from the wild (Sahoo *et al.*, 2018). Majorly, due to over exploitation, and blocked migration, the hilsa production in all the Indian river systems has gone down significantly.

During 1822, first record of hilsa was found in river Ganga near Kanpur and Agra. While during 1877 the species was recorded at Delhi from the lower stretch of river Ganga. During mid 1960s, Hilsa was also constituted a lucrative catch in river Ganga. During 1955-72, the average catch of Hilsa at Allahabad was 48.42 t, while at Buxar was 140t. However, at present, the catch in those stations in river Ganga have become almost nil and majorly catch concentrated to the below Farakka (Padma river in Bangladesh) stretch. There are number of factors attributed to the decline of catch including (i) construction of barrages across the rivers that has obstructed the migration to reach its natural breeding ground (ii) high rate of fishing pressure at different life stages in all the habitats i.e. estuary, and river stretches (iii) alteration in physico-chemical parameters of the river and estuarine ecosystem because of addition of industrial pollution and domestic effluent, and (iv) increase in water abstraction and climate change resulting in reduction in water flows, and (v) higher rate of sedimentation in rivers. All

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these factors have contributed to the habitat loss resulting in decline of hilsa catch. The loss of habitat is directly related to the recruitment potential of hilsa fishery.

The hilsa is an anadromous species, whose natural habitat is the lower region of the estuaries and the foreshore areas, that migrates to the rivers during the breeding season and return to the sea after spawning. Upstream movement of hilsa is a seasonal or periodic. The peak upstream migration of the fish in most of the rivers of the country coincides with the advent of monsoon viz July and August and continues upto October and November. The lower stretch of river Ganga is known as Bhagirathi-Hooghly stretch. In this stretch, Hilsa is the major component of fishery accounting for about 15-20% of the total fish landings. The annual fish catch of hilsa from the Bhagirathi-Hooghly river system is highly fluctuating over the years. During pre-Farakka period (1957-74), the annual landings of this species varied between 114 and 6573 t with an average of 1,427.6 t. But, increased level of yield was observed during post-barrage period. The average annual harvest of hilsa was recorded as 2,471 t and 6,370 t during 1975-76 to 1990-91 and 1991-92 to 1998-99 respectively (Annual reports, CIFRI). Hilsa landings in the Bhagirathi-Hooghly river system during 2000-01 to 2010-11 varied between 12,733 and 77,912 t. The observations on production trends over five decades indicate that every ten years there is a spurt in the hilsa production, which is also evident from the hydrological changes with higher freshwater discharge caused by water diversion at Farakka barrage through the Bhagirathi-Hooghly river system, that may be attributed to for the increase. Tremendous increase in effort from nineties with further mechanization to exploit the hilsa catch in the estuary mouth also contributed to this many-fold increase of hilsa landing. In general, about 80-90 % of the hilsa is captured during monsoon months (July to October). Based on the investigation conducted by the Institute due Impact of Farakka barrage on hilsa fisheries was very much vivid in upstream of the barrage where in all the landing centres, contribution of hilsa is almost negligible in total catch.

An exploratory survey on hilsa, *Tenulosa ilisha* catch and life stages availability in the vicinity of up and down streams of the Farakka barrage and feeder canal was carried out by ICAR-CIFRI, Barrackpore under National Mission for Clean Ganga (NMCG) project during March to June 2017. The significant results showed that the total catch of hilsa from the down-stream of Farakka and feeder canal was recorded to be 1,315 kg and 736 kg respectively, and the total being 2,078 kg during March to June 2017 in both the sites. While, hilsa catch in the upper stretches and navigational channel is majorly represented by juveniles, which was negligible in quantity of 3.5 kg. The reduced catch of hilsa in both down-stream and feeder

canal was recorded during the period as compared to earlier years, could be attributed to the stray migratory run of the species. It was evident from our previous study that, due to lack of connectivity, the hilsa population from Bhagirathi could not migrate to the main channel of river Ganga. While, due to non-functional of fish lock gates at 25 and 25A, the hilsa population from Padma river could not migrate upstream resulting in the complete decline in hilsa catch touching to zero. Therefore, it was conceptualized to revive the hilsa population in the middle stretch of the river Ganga not only to improve the hilsa population but also to improve the livelihood of poor fishermen. With this background ICAR-CIFRI is awarded with a project entitled “Hilsa Fisheries Improvement in River Ganga” under National Mission for Clean Ganga with a major objective of ranching, tagging of hilsa fish at the upper stretch of barrage and awareness among the fisherman throughout the stretch from Prayagraj to Farakka during 2018-19 with the following objectives.

2. Objectives of the Study

- To increase the natural stock of hilsa in river Ganga (upstream of Farakka barrage) through ranching of wild collected hilsa seed / juveniles
- To study and monitor hilsa migration across the Farakka barrage in main river Ganga through suitable method

3. Work plan

Objective -I

1. Creation of hilsa ranching station through intensive survey.
2. Live hilsa collection from the downstream of Farakka and transportation.
3. Ranching of wild stock hilsa.
4. Hilsa acclimatization through raceways /tanks
5. Ranching of wild stock hilsa in the upstream of Farakka Barrage

Objective -II

1. Experimentation on fish migration with different suitable methodologies.
2. Awareness on Hilsa fishery and conservation among the fishermen in the river stretch from Prayagraj to Farakka.

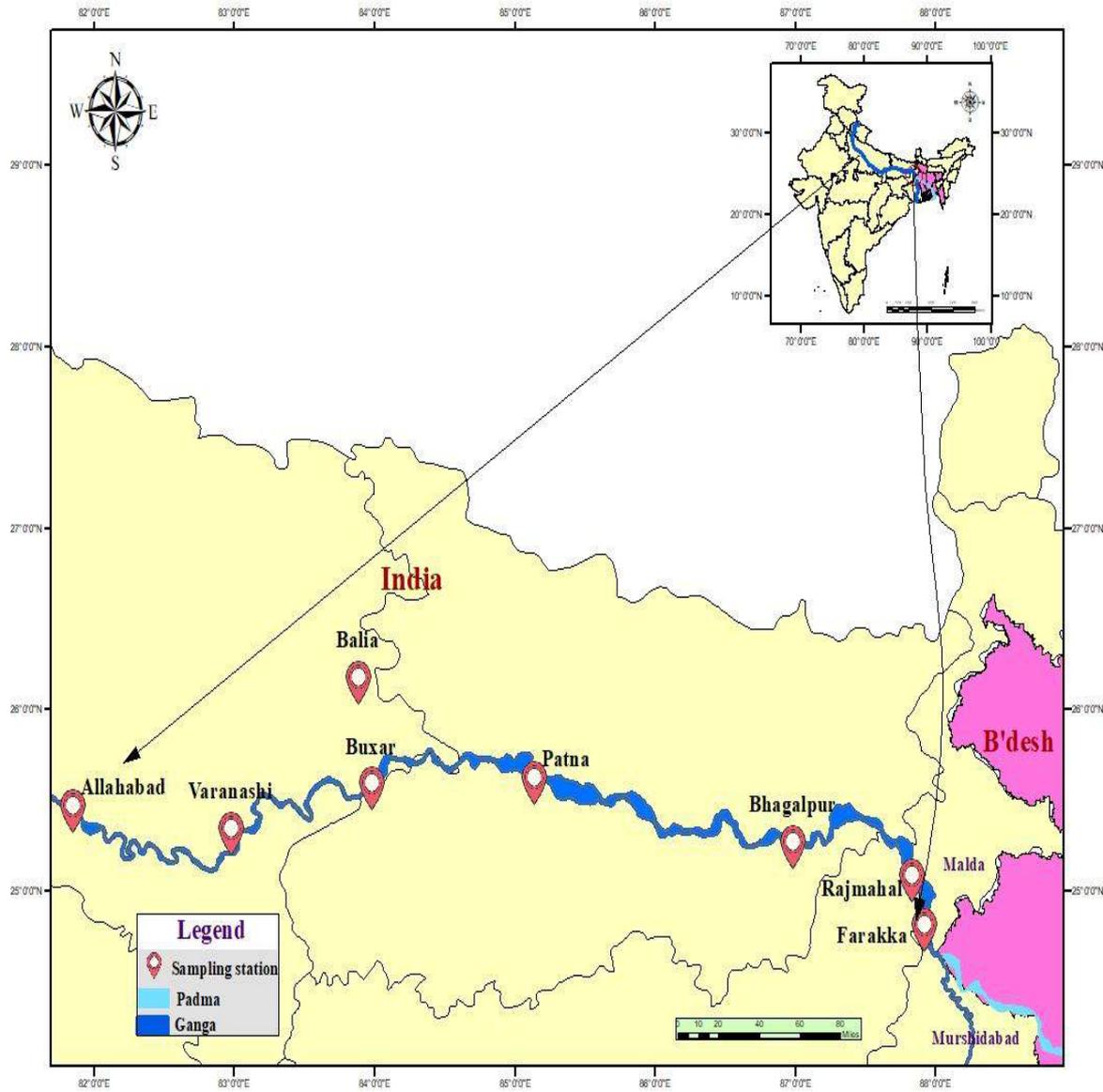


Fig. 1 Stretch from Allahabad (Prayagraj) to Farakka in river Ganga for Hilsa study

4. Objective based achievements

4.1 *To increase the natural stock of hilsa in river Ganga (upstream of Farakka barrage) through ranching of wild collected hilsa seed / juveniles*

River ranching of fish species is one of the managerial techniques to conserve the native germplasm in the open waters. Among several managerial methods to conserve and enhance the native fish or germplasm in the river, *ex situ* conservation is one of most effective. As per Convention on Biological Diversity (CBD) Article 2, *Ex-situ* conservation is defined as “means the conservation of components of biological diversity outside their natural habitats” (Jena and Gopalakrishnana, 2011). Realizing the importance of the declining hilsa species in the river Ganga, two methods have been adopted i) collection of wild adult hilsa from river Ganga and ranching them in the upstream of Farakka barrage (5 km to 8 km upstream of the barrage) ii) collection of adult hilsa from the nature and rear them under the captive condition in the hatchery/ranching station and further releasing the young ones in the upstream of barrage, so that natural recruitment of the lost hilsa would be enhanced. Based on these principles the following accomplishments were made.

4.1.1 Establishment of hilsa ranching Station

The site selection for the Hilsa ranching station was made through intensive survey carried out at both downstream and upstream of the Farakka barrage. During the survey, different criteria were taken into considerations including i) distance from station to the ranching site ii) river water accessibility iii) electrification facility iv) less human intervention v) flood protected area vi) site suitability for the hatchery/rearing units. Based on these criteria, the ranching station was established on the right bank of river Ganga just 200 m above the Farakka barrage. The Hilsa ranching station was inaugurated by Shri Babul Supriyo, Union Minister of State (Ministry of Heavy Industry & Public Enterprises), and emphasised to replicate the ranching facilities in large scale to make it more impactful and visible in national level. It is also advised for installing floating cages at suitable locations to rear the hilsa juveniles prior to ranching in the river Ganga. The ranching station is equipped with i) 5000 l circular water carrying tanks (3 no.) ii) 1000 l water carrying tank (6 nos.) iii) All tanks with aeration facility with air blower iv) Water pump for withdrawing Ganga river water for rearing unit v) FRP boat with hilsa transportation facility vi) Temporary room for the analysis of water quality and fish samples. The photographs of the ranching stations and facilities are depicted in Fig. 2, 3 and 4.



Fig. 2 Hilsa Ranching station at the upstream of Farakka Barrage



Fig. 3 Inaugural of ranching station by honorable minister Shri Babul Supriyo



Fig. 4 Meeting on Hilsa project activities with honorable minister Shri Babul Supriyo

4.1.2. Collection and transportation of live hilsa

The anadromous migration of hilsa towards rivers, is mainly for the purpose to fulfill their breeding attributes. The upstream migration of hilsa in most of the major rivers of the country starts from July and continues up to November and downstream migration takes place during January-March. Over the last four decades, the available hilsa in the upstream of Farakka barrage is nil due to the blocked migratory path of hilsa across the barrage. This has resulted in sharp decline in hilsa landing in the middle stretch of river Ganga (Farakka barrage to Prayagraj), while at the downstream of barrage, adult and juveniles hilsa are available particularly peak during September to December. Realizing that barrage is the major issues towards migration to the upstream of the barrage, as per the objectives, both adult and juvenile hilsa were collected and transported from downstream to upstream of the Farakka barrage.

4.1.2.1 Collection of live hilsa

Prior to collection of live adult hilsa, site suitability studies were carried out for hilsa availability preferably in the downstream of the barrage. Different locations including Beniagram, (2 km downstream of barrage), Dhulian (12 km below the barrage), Feeder canals and in the navigational canal were selected. During the survey, the study observed that just below the barrage the live hilsa are available in large catch varying between 3 to 10 ton, during the monsoon period (August to November), while during off-monsoon the availability is less varied between 1 to 2 ton. It has been observed that the discharge of water from the barrage plays a critical role in the live hilsa availability. As hilsa is very sensitive to oxygen and other stress, different gears were experimented during the collection. Majorly hand lift net and gill nets were used to capture the live hilsa. The major objective of this gear is to keep the live hilsa under less stress condition so that survival during the transportation would be better.

Live hilsa adult of average size 225 g. were collected through gill net and hand lift net (Fig. 5). The study observed that hand lift net is most suitable for catching live hilsa fish, as there is no injury during the net operation. It is also observed that the survivability rate of captured hilsa was high by using hand lift net than the gill net. The length and weight of individual hilsa fish was taken for record before the transportation (Fig. 6). Just after collection, live hilsa were shifted to 30-40 l plastic tub with sufficient dissolve oxygen supply in order to reduce the acute stress and better survivability.



Fig. 5 Hand lift net used for live hilsa collection below the barrage



Fig. 6 Length/Weight measurement of live hilsa before transportation

4.1.2.2 Transportation of live hilsa

Fishes of various life stages are generally transported live for several purposes *viz.*, re-stocking in ponds, wetlands, rivers, live marketing, and/or delivered to processing plants. A number of internal as well as external factors are considered critical for improving the survival of fish during their transportation. Stress is one of the greatest concerns affecting the health status as well as its survival during live transportation. Stress in fishes during transportation showed symptoms like sluggish movement, speedy respiration, and other behavioural changes. In addition, both biochemical and histological showed increased blood cells and goblet cells in the gill tissues. Therefore, careful handling practices coupled with thorough knowledge on the tolerance limit of critical water quality parameters like dissolve oxygen are mandatory for effectual transportation and storage protocol. Commonly two types of transportation methods have been used i) open type ii) closed type. In open type, it has been recorded that the rate of survival is better than closed type.

In the present study open type transportation was followed. Prior to the transportation, the river water was kept filled in the plastic tub with continuous aeration. Live hilsa after being caught through the nets were released into the open tub of 30-40 l water capacity. Per tub of 30-40 l water capacity, 3-4 live hilsa with average weight of 150 g hilsa were transported through the vehicle to the ranching station for further acclimatization. It has been showed that 10 l per fish of 150 g with continuous aeration showed minimal stress for a transportation of 30 min. During the transportation period of 30 min, mortality shows 8-10%, while transportation period for more than 1 hr showed 50% mortality. However, in some studies, anesthesia has been used to slow down the physiological processes during the transportation. In our present study, though no anesthesia was used at the beginning, later stages we have used Tanavarhi (a product of ICAR-CIFRI). This showed very good results for the adult hilsa of above 100 g shows 100% survivility within 30 min of transportation. While, the product showed little response toward juvenile hilsa transportation. Hilsa fish moves fast opposite to the current it indicates a good health, if the fish moves with the current the condition shows weak health. Immediately after reaching ICAR-CIFRI hilsa ranching station length and weight of live hilsa were measured and acclimatized them in 1000 l tanks for 1-2 hours to reduce their stress condition due to transportation. After that live hilsa were transported by using speed boat with special design for ranching. The same has been depicted in Fig. 7, Fig. 8 and Fig. 9.



Fig. 7 Open type transportation of live hilsa with proper aeration facility



Fig. 8 Transportation of live hilsa to the ranching station for acclimatization



Fig. 9 Special design FRP boat with hilsa carrying plastic tub for transportation to a distance of 5-10 km

4.1.3 Ranching of live hilsa adult/juvenile in the upstream of Farakka barrage

Ranching is one of the very important aspects to improve the hilsa population at the upstream of farakka barrage. Ranching activities have been classified into two groups i) ranching of adult hilsa (>150 g) ii) ranching of hilsa juveniles (50 g to 100 g). The major objective of the ranching of adult is to identify the migration route of the adult for the breeding/spawning i.e current migratory location from the Farakka barrage. It is believed that the fecundity of 1 kg hilsa is around 10 to 15 lk. Assuming the survival of hatchlings at 20%, and considering natural mortality, fishing and predation, 2 lk seeds would be naturally recruited in the river. After acclimatization of the adult hilsa, length and weight of the individual fish was taken and were released at the upstream of Farakka barrage. Captured hilsa were ranched around 5-10 km away from the Farakka barrage using ICAR-CIFRI speed boat. During the project period of one year, a total number of 3274 hilsa adult fish was ranched in the upstream of the barrage. The detailed month-wise adult hilsa ranched in the upstream of the Farakka barrage has been depicted in Fig. 9. This indicated, adults are majorly available during October to November months, while the adults availability is less during February and March months. The juveniles availability restricted to December and January months only. The ranching activities are depicted in Fig. 11 and Fig. 12.

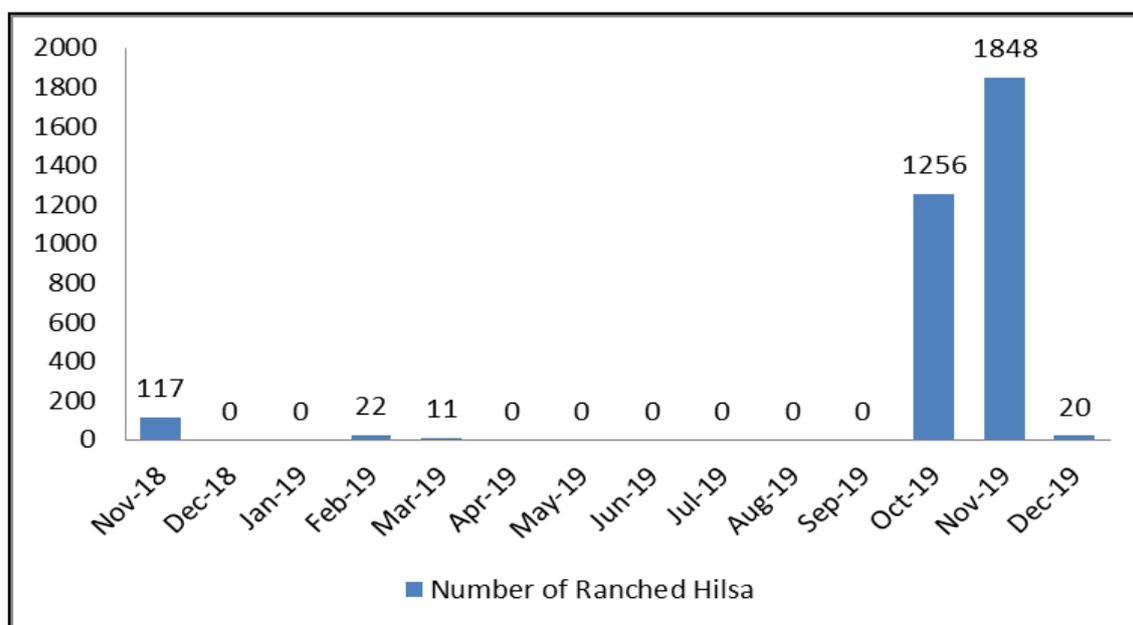


Fig. 10 Number of ranched hilsa in different month of study period (2018-19)



Fig. 11 A) and B) Live hilsa ranching at the up-stream of Farakka Barrage at river Ganga



Fig.12 Transportation and Ranching of adult hilsa at 12 km upstream of the Farakka barrage

4.2 *Objective 2: To study and monitor hilsa migration across the Farakka barrage in main river Ganga through suitable method*

4.2.1 Experimentation on fish migration with different suitable methodologies

Fish migration is one of the fundamental mechanisms of behavioral physiology, for the purpose of feeding, breeding and their growth. Understanding the basic mechanisms such as feeding and breeding ground identification, suitable habitat location and identification of migratory path is extremely critical for developing the conservation plans and measures by the researchers or the policy makers to declare as protected zone or sanctuary or reserved areas. The best and most suitable methodology to trace the migration is tagging. Fish tagging followed by recapturing is a convenient technique to study fish migratory behavior (Bhaumik, 2013 & 2015). For an effective study, tags must stay with fish and it should not create lethal/injury to the fish. Different types of tags are used to understand the migratory behavior of fish. Usually tags are grouped into three main categories: passive, electronic and biological. Passive tags are those which do not have an inbuilt battery, they often involve a visual marking of the fish, and they are primarily used for identification of individuals or groups once they are recaptured or within site. Passive tags include external marks (e.g. adipose fin clips), external visual tags such as T-bar anchor tags e.g. Carlin, Floy, Peterson Disk, Cinch tags.

Tagging experiment was done to understand the migratory pattern of hilsa in the upstream of the Farakka barrage. In the present study Floy T-bar anchor tags of standard size with serial number printed on them were used for the tagging experiment. The tags were inserted with the help of scissor grip and pistol grip tagging gun (Fig. 14), The Floy T-bar anchor tags were procured from Tag manufacturing Inc., Seattle, Washington, 98105, U.S.A. Prior to tagging, short experiment was carried out in confined water bodies to find out the size and feasibility of the tagging experiment. From the experiment, the study concluded that fish of more than 100 g are suitable for the tagging purposes. Fishes were caught directly from the downstream of the Farakka barrage through experimental fishing using specially designed net operation. Proper care were taken to reduce the stress during the transportation and tagging processes. These included adequate oxygen supply, quick tagging, reduced time of transportation and proper handling of live hilsa. Length weight of individual fish before tagging was recorded (Fig. 15). After tagging 10% (PVP-I) solution is applied at the injection site as disinfectant before ranching (Fig. 16). Tagging was done both on board as well as the site of ranching station. Detailed physiology and stress parameters were studied after the tagging. The result indicated that the elevated stress factors comes to the near normal level

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after 45 to 60 min of tagging. Looking this results, tagged fishes were released in river after acclimatization in separate circular FRP tank containing 350 - 400 litre of clean river water for 30 - 40 minutes (Fig. 17). Total 403 numbers of fishes were tagged to assess the upstream migration of hilsa starting from the month of October 2019 to December, 2019. The detailed information on the number, length, weight and tag number of tagged hilsa ranched during October to December at upstream of Farakka barrage are mentioned in Table 1. While, Fig. 10 showed that highest number of hilsa were tagged during the month of October as compared to the months of November and December. This clearly indicates the availability and better survival during these months.

The hilsa tagging programme was widely circulated through various means of communications such as creating mass awareness, placing posters/pamphlets ,and published news item in the local news paper all along the stretch from Prayagraj to Farakka. Alongwith the awareness programme, tagged hilsa fish recovery report was collected from the local fishermen and fish seller from the fish markets. Fishermen, handing over the tagged hilsa were rewarded with additional price.

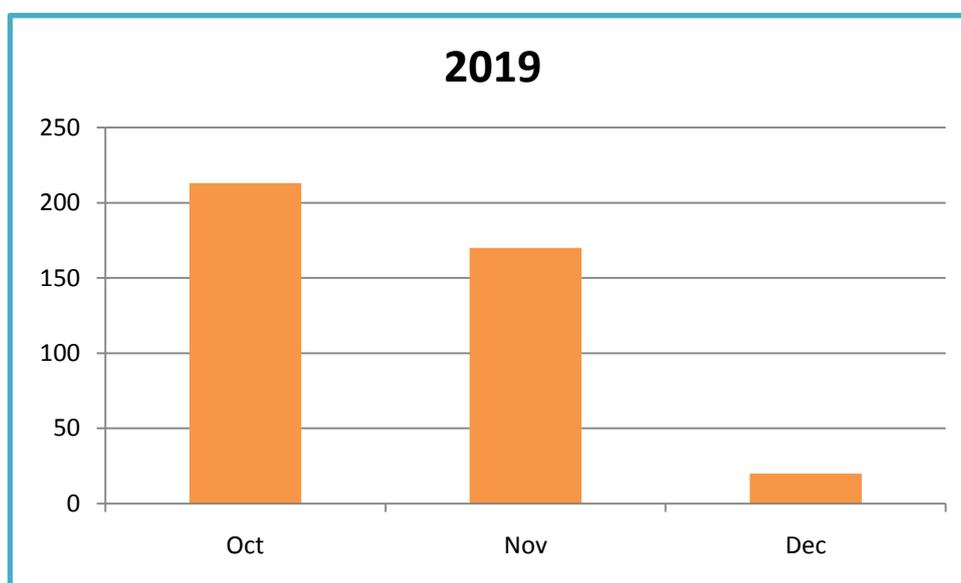


Fig. 13 Tagged hilsa ranched at the upstream of the Farakka barrage



Fig. 14 A) Scissor grip tagging gun B) pistol grip tagging gun & C) floy T-Bar anchor tag



Fig. 15 A) Manual aeration in the tub before transportation B) length and weight measurement of live hilsa was taken before ranching



Fig. 16 A) T-bar anchor tags inserted into the body of hilsa B) Disinfection by using 10% (PVP-I) solution in the tagged fish



Fig. 17 A) Tagged hilsa ranched at the ICAR- CIFRI ranching station B) Ranched tagged hilsa by ICAR-CIFRI through speed boat

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Table : 1 Detailed Tagged information on *Tenulosa ilisha* ranched in the Upstreams of the Farakka Barrage

October'2019				
Sl. No.	Species Name	Tag No.	Length (in cm)	Weight (in gm)
1.	<i>T. ilisha</i>	36	20.7	99
2.		39	24	159
3.		41	22.8	130
4.		42	20.6	99
5.		43	20.7	99
6.		44	28.4	454
7.		45	26.4	208
8.		46	20.2	102
9.		47	24.7	182
10.		48	24.3	146
11.		49	25.7	152
12.		50	18.2	75
13.		51	23.9	122
14.		52	25.4	99
15.		53	18.1	75
16.		54	24.3	146
17.		55	24.7	182
18.		56	20.2	102
19.		57	26.4	208
20.		58	28.4	454
21.		59	20.7	99
22.		60	20.6	99
23.		61	18.1	75
24.		62	20.1	105
25.		63	23.2	254
26.		64	22.7	127
27.		65	23.2	128
28.		66	22	212
29.		66	25.5	164
30.		67	23.7	133
31.		68	24	159
32.		69	25.6	456
33.		70	24.1	134
34.		71	20.1	105
35.		72	23.2	254
36.		73	21.4	113
37.		74	25	164
38.		75	24	259
39.		76	22.2	124
40.		77	24.1	134

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Sl. No.	Species Name	Tag No.	Length (in cm)	Weight (in gm)
41.	<i>T. ilisha</i>	78	22.8	130
42.		79	23.5	132
43.		80	23.2	128
44.		81	22	212
45.		82	23.7	133
46.		83	24	159
47.		84	25	164
48.		85	23.6	132
49.		86	22.3	131
50.		87	24	159
51.		88	25.5	164
52.		89	22.3	131
53.		90	25.4	450
54.		91	26.4	208
55.		92	25.4	454
56.		93	21.3	101
57.		94	22.8	130
58.		95	25.5	138
59.		96	24.1	126
60.		97	22.3	125
61.		98	23.7	133
62.		99	24	159
63.		100	25	164
64.		102	22.3	131
65.		106	22	112
66.		112	22.3	125
67.		113	23.9	122
68.		114	25.4	99
69.		115	18.1	75
70.		116	20.1	105
71.		117	22.2	124
72.		119	24.2	119
73.		123	25.4	99
74.		124	23.9	122
75.		125	24.7	173
76.		126	21.8	114
77.		127	26.4	208
78.		128	23.7	133
79.		129	24.1	134
80.		130	20.2	102
81.		131	23.5	158
82.		132	22	134
83.		133	23.5	227
84.		134	27.5	412
85.		135	17.6	56
86.		136	21	100
87.		137	22.6	135
88.		138	24.3	139
89.		140	23.2	151
90.		141	21.3	110
91.		142	20.3	100

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92.		143	19.5	89
93.		144	24.7	410
94.		145	21.2	114
95.		146	20.5	115
96.		147	21.5	116
97.		148	25	164
98.		149	22.6	132
99.		150	22.3	131
100.		151	18	75
101.		152	20.1	105
102.		153	20	105
103.		154	22.2	124
104.		155	26.4	208
105.		156	24.1	134
106.		157	24.1	134
107.		158	22.8	130
108.		159	24.7	182
109.		159	22.3	125
110.		160	23.5	132
111.		161	20.9	120
112.		162	20.2	102
113.		163	23.8	156
114.		164	27.5	412
115.		165	20.7	99
116.		166	24	159
117.		167	25.5	164
118.		168	22.3	131
119.		169	26.4	208
120.		170	28.4	454
121.		171	21.3	101
122.		172	24.1	134
123.		173	22.8	130
124.		174	25.5	138
125.		175	24.1	126
126.		201	24.1	134
127.		202	22.3	131
128.		203	22.8	130
129.		204	23.8	156
130.		205	24	159
131.		206	23.5	132
132.		207	23.2	128
133.	<i>T. ilisha</i>	208	27	412
134.		209	20.7	99
135.		210	24	259
136.		211	25	164
137.		212	22.3	131
138.		213	26.4	208
139.		214	25.4	454
140.		215	21.3	101
141.		217	22.8	130
142.		218	23.5	138
143.		219	24.1	126

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144.		220	22.3	125
145.		226	18.1	75
146.		227	25.5	164
147.		228	22.8	130
148.		229	20.1	105
149.		230	22.3	131
150.		231	22.2	124
151.		232	24.1	134
152.		233	24.4	208
153.		234	23.5	132
154.		235	23.2	128
155.		236	24.2	131
156.		237	24.3	146
157.		238	24.7	182
158.		239	20.2	102
159.		240	26.4	208
160.		241	20.2	102
161.		242	26.4	208
162.		243	26.3	208
163.		244	28.4	454
164.		245	20.7	99
165.		246	24.1	134
166.		247	24.7	173
167.		248	22.8	130
168.		249	23.5	132
169.		250	25	164
170.		251	18.1	75
171.		278	19.1	85
172.		279	17.6	56
173.		280	21	100
174.		281	22.6	135
175.		282	18.1	75
176.		283	20.1	105
177.		284	22.2	124
178.		285	24.1	134
179.		286	22.8	130
180.	<i>T. ilisha</i>	287	23.5	132
181.		288	23.2	128
182.		289	27	412
183.		290	20.7	99
184.		291	22.2	124
185.		292	24.1	134
186.		293	22.8	130
187.		294	18.1	75
188.		301	22.7	139
189.		302	23.8	276
190.		303	20.2	103
191.		304	19.3	86
192.		305	24.8	430
193.		306	23.2	254
194.		307	25.6	456
195.		308	21.4	113

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196.		309	27	412
197.		310	20.7	99
198.		311	24	259
199.		312	25	164
200.		313	22.3	131
201.		314	22	112
202.		315	23.7	133
203.		316	24	159
204.		317	25	164
205.		318	21.8	114
206.		319	26.4	208
207.		320	23.7	133
208.		321	23.5	132
209.	<i>T. ilisha</i>	322	20.9	120
210.		323	20.2	102
211.		324	23.8	156
212.		325	27.5	412
213.		325	20.6	99
Tagged Hilsa Fish (<i>Tenualosa ilisha</i>) in month of November'2019				
Sl. No.	Species Name	Tag No.	Length (in cm)	Weight (in gm)
214.	<i>T. ilisha</i>	326	22.6	125
215.		327	24.7	182
216.		328	20.2	102
217.		329	26.4	208
218.		330	20.2	102
219.		331	26.4	208
220.		332	26.9	210
221.		333	28.4	454
222.		334	20.7	99
223.		335	20.1	105
224.		336	22.2	124
225.		337	24.1	134
226.		338	20.2	102
227.		339	22.8	130
228.		341	23.5	132
229.		342	23.2	128
230.		343	22	212
231.		344	23.7	133
232.		345	24	159
234.		346	25	164
235.		347	22.3	131
236.		348	24.4	208
237.		349	25.4	454
238.		350	24.3	139
239.		352	21.3	101
240.		353	22.8	130
241.		354	25.5	138
242.		355	24.1	126
243.		356	23.9	210
244.		357	24.1	134
245.		358	22.8	130
246.		359	23.5	132

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247.		360	22.6	135
248.		361	21	100
249.		362	22.6	135
250.		363	24.1	134
251.		364	22.8	130
252.		365	23.5	132
253.		366	25.5	138
254.		367	26.4	208
255.		368	23.5	158
256.		369	22	134
257.		370	17.6	56
258.		372	21	100
259.		373	22.6	135
260.		374	24.3	139
261.		375	23.2	151
262.		376	21.3	110
263.		377	20.3	100
264.		378	24	259
265.		379	25	164
266.		380	22.3	131
267.		381	22	112
268.		382	27.8	182
269.		383	24.2	119
270.	<i>T. ilisha</i>	384	28.5	227
271.		385	24.7	173
272.		386	22.8	130
273.		387	23.5	132
274.		388	18.2	75
275.		389	25.7	152
276.		390	24.3	146
277.		391	24.7	182
278.		392	20.2	102
279.		393	26.4	208
280.		394	28.4	454
281.		395	20.7	99
282.		396	20.6	99
283.		397	20.6	99
284.		398	18.1	75
285.		399	26.4	208
286.		400	23.5	158
287.		402	22	134
288.		403	20.3	100
289.		404	23.5	132
290.		405	20.9	120
291.		406	20.2	102
292.		407	23.8	156
293.		408	27.5	412
294.	<i>T. ilisha</i>	409	20.7	99
295.		410	24	159
296.		411	24.3	139
297.		412	23.2	151
298.		413	21.3	110

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299.		414	23.7	133
300.		415	24.1	134
301.		416	20.2	102
302.		417	23.5	158
303.		418	22	134
304.		419	17.6	56
305.		420	20.2	102
306.		421	23.8	156
307.		422	21.5	120
308.		423	26.4	208
309.		424	23.5	158
310.		425	22	134
311.		426	17.6	56
312.		427	21	100
313.		428	24.3	139
314.		429	22.6	135
315.		430	20.6	99
316.		431	18.1	75
317.		432	20.1	105
318.		433	22.2	124
319.		434	24.1	134
320.		435	24.3	139
321.		436	23.2	151
322.		437	21.3	110
323.		438	20.6	99
324.		439	20.2	102
325.		440	22.9	137
326.		441	25	164
327.		442	23	130
328.		443	19	80
329.		444	17.6	56
330.		445	21	100
331.		446	22.6	135
332.		447	20	100
333.		448	23.7	133
334.		449	24.1	134
335.		450	24.3	148
336.		451	23.8	129
337.		452	24.3	158
337.		453	22	134
338.		454	17.6	56
339.		455	21	100
340.		457	22.6	135
341.		458	24.3	139
342.		459	23.2	151
343.		460	23.2	128
344.		461	22	212
345.		462	23.7	133
346.		463	24	159
347.		465	25	164
348.		466	22.9	137
349.		467	23	130

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350.	<i>T. ilisha</i>	468	19	80
351.		469	17.6	56
352.		470	18.5	78
353.		471	26.4	208
354.		472	28.4	454
356.		473	20.7	99
357.		474	20.6	99
358.		475	18.1	75
359.		476	20.1	105
360.		477	22.2	124
361.		478	24.1	134
362.		479	22.8	130
363.		480	21.3	107
364.		481	22.9	137
365.		482	23	130
366.		483	19	80
367.		484	17.6	56
368.		485	21	100
369.		486	22.6	135
370.		487	20	100
371.		488	20.2	102
372.		489	26.4	208
373.		490	28.4	454
374.		491	20.7	99
375.		492	20.6	99
376.		493	18.1	75
377.		494	26.4	208
378.		495	23.5	158
379.		496	22.9	137
380.		497	20.2	102
381.		498	24.3	139
382.		499	22.6	135
383.		500	20.6	99

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Tagged Hilsa (<i>Tenualosa ilisha</i>) in month of December'2019				
Sl. No.	Species Name	Tag No.	Length (in cm)	Weight (in gm)
384.	<i>T. ilisha</i>	551	22.6	135
385.		552	25.7	152
386.		555	24.3	146
387.		556	24.7	182
388.		557	20.2	102
389.		558	26.4	208
390.		559	28.4	454
391.		560	20.7	99
392.		561	20.6	99
393.		562	20.2	102
394.		563	24.3	139
395.		564	22.6	135
396.		565	20.6	99
397.		566	19.1	85
398.		567	17.6	56
399.		568	21	100
400.		569	26.4	208
401.		570	28.4	454
402.		571	20.7	99
403.		572	26.4	208

4.2.2 Recovery of Tagged hilsa from Pryagraj to Farakka

Tagging followed by release and recovery has proved to be one of the most convenient methods for understanding fish behavior including migration, swimming speed and breeding ground. Earlier during 1962, CIFRI studies in the lower stretches of river Ganga at Nawadip showed that 70% recovery within 15 days of the release. Further it has been recorded that 80% recovery within the month. The experiments revealed that trend of upstream migration starts in August and continues upto October. Furthermore, the authors have observed that hilsa can migrate even 61 to 71 km in a day. While, our recovery report of tagged fish showed that hilsa adult migration was 49 km per day. In our investigation, total recovery % within the stipulated period was 3.8% within 120 days. Our study showed that maximum travel was around 640 km in 120 days. While within 15 days, fishes were recovered from Sahebganj (84 km) and Kahalgaon (120 km). The detailed recovery of tagged hilsa was presented in Table 2.

Table : 2 Recovery report collected from the upstream region

Sl No.	Place & month of ranching	Place & month of recovery	Dist. Farakka (km)	No. of fish recovered
1	Upstream of Farakka barrage in October, 2019	Deer forest in November 2019	10.8	2
2	Upstream of Farakka barrage in November, 2019	Rahmahal in December (2 nd wk) 2019	43.3	1
3	Upstream of Farakka barrage in December, 2019	Kahalgaon in December (2 nd wk) 2019	120	2
		Sahebganj in December (2 nd wk) 2019	84	3
		Bhagalpur in January & February 2020	151	5
		Ballia in March 2020	640	2

4.2.3. Awareness on Hilsa fishery and hilsa conservation among the fishermen

After the commissioning of Farakka barrage (1975), hilsa landing has drastically declined even reached to nil in the middle stretch of Ganga River above Farakka barrage at Allahabad, Buxar and Bhagalpur, while at the downstream of barrage the landing has increased. To improve the hilsa fisheries in this selected stretch, public awareness particularly fishermen awareness on hilsa fisheries was observed to be the key success. Though hilsa is not available in the middle stretch, the work activities taken up by ICAR-CIFRI to improve the hilsa fisheries dissemination is important. Realizing the importance, the awareness programme on Hilsa conservation at the upstream of the Farakka Barrage were conducted by ICAR-Central Inland Fisheries Research Institute, Barrackpore from Farakka to Allahabad which covers almost 770 km. Main objective of the awareness programme was to sensitize all the fishermen communities in the vicinity of river Ganga (upstream of Farakka barrage) about the conservation of Hilsa. The awareness programme was carried out in Farakka, Rajnagar (Malda), Deer forest, Atgama, Rajmahal Gudara Ghat (Jahaj Ghat), Shakuntala Ghat, Sahib Ganj (Jharkhand), Kagjitola, Kahalgaon, Gouritala Ghat (Bhagalpur), Jahagiru (Sultanganj), Narbatpur-Chausa (Buxar), Collector Ghat (Ghazipur), Bahadurpur Chadauli (Paraw), Barna (Banaras), Mirzapur (Uttar Pradesh), New Bridge Balughat Chunar, Gopalpur, Madgura (UP), Sadiapur (Allahabad). During the awareness programme all the fishermen were sensitized regarding how to increase Hilsa in their native water bodies. All the fishermen were advised to release the live hilsa if it is captured at the time of fishing and not to catch Hilsa for next one year and allow them to grow. It is also advised not to use below 100 mm mesh sized net for their better survival rate. Fish tagging is an important aspect to study the migration pattern. Fishermen were asked to report if they get any tagged hilsa during their fishing activity in river Ganga. They also assure they will get a token amount of money for the information. During the awareness programme, detailed information on socio-economics including the sex, education and major and alternative job/work information were collected. This information lead us to prioritize the scientific based approaches towards creating awareness such as if the age group of fish catching is 30 to 40 year. Our approach focused on mass media, whatsapp and facebook. We have created both such social media taking more than 100 fishermen and with frequent interaction on the hilsa information. Detailed locations are provided in Table 3.

ICAR-CIFRI-NMCG-Phase-I Final Report

Table : 3 The GPS locations of awareness program regarding hilsa conservation from Farakka to Prayagraj

Sl No.	Place	Latitude	Longitude
1.	Farakka barrage	24°48'14.93"N	87°55'55.69"E
2.	Deer Forest	24°49'24.49"N	87°54'39.01"E
3.	Simultala	24°24'4.40"N	88° 9'16.07"E
4.	Atgama (Pagla ghat)	25° 1'53.62"N	88° 0'4.66"E
5.	Rajnagar, Malda	25°14'57.77"N	88°20'40.64"E
6.	Manikchak	25° 4'51.25"N	87°53'53.08"E
7.	Jagannathpur	24°45'39.56"N	87°55'34.36"E
8.	Rajmahal	25° 2'39.45"N	87°50'9.25"E
9.	Shakuntala Ghat	25°14'55.31"N	87°38'32.66"E
10.	Sahibganj	25°14'32.45"N	87°38'15.05"E
11.	Kajitola, Kahalgaon	25°15'57.30"N	87°13'34.32"E
12.	Gouritala ghat	25°16'11.99"N	87° 1'26.56"E
13.	Sultanganj	24°51'43.53"N	87°58'10.13"E
14.	Lohar Ghat , Patna	25°36'52.24788"N	85°11'57.82812"E
15.	Parvati Ghat, Bhagalpur	25°16'7.62312"N	87°1'31.0368"E
16.	Kamarpur	25°33'44.49"N	83°56'2.51"E
17.	Chausa, Balia	25°30'38.31"N	83°53'30.76"E
18.	Narbatpur	25°30'53.41"N	83°52'58.53"E
19.	Bhitti	25°34'39.75"N	83°35'0.79"E
20.	Bahadurpur	25°19'23.73"N	83° 3'4.30"E
21.	Kotwa/Barna	25°19'58.59"N	83° 3'10.28"E
22.	Chota Mirzapur	25°13'50.63"N	83° 1'55.67"E
23.	Bedauli	25° 7'49.80"N	82°52'49.92"E
24.	Vindhyachal	25°10'1.04"N	82°30'13.96"E
25.	Sadiyapur, Allahabad	25°25'26.69"N	81°49'31.61"E

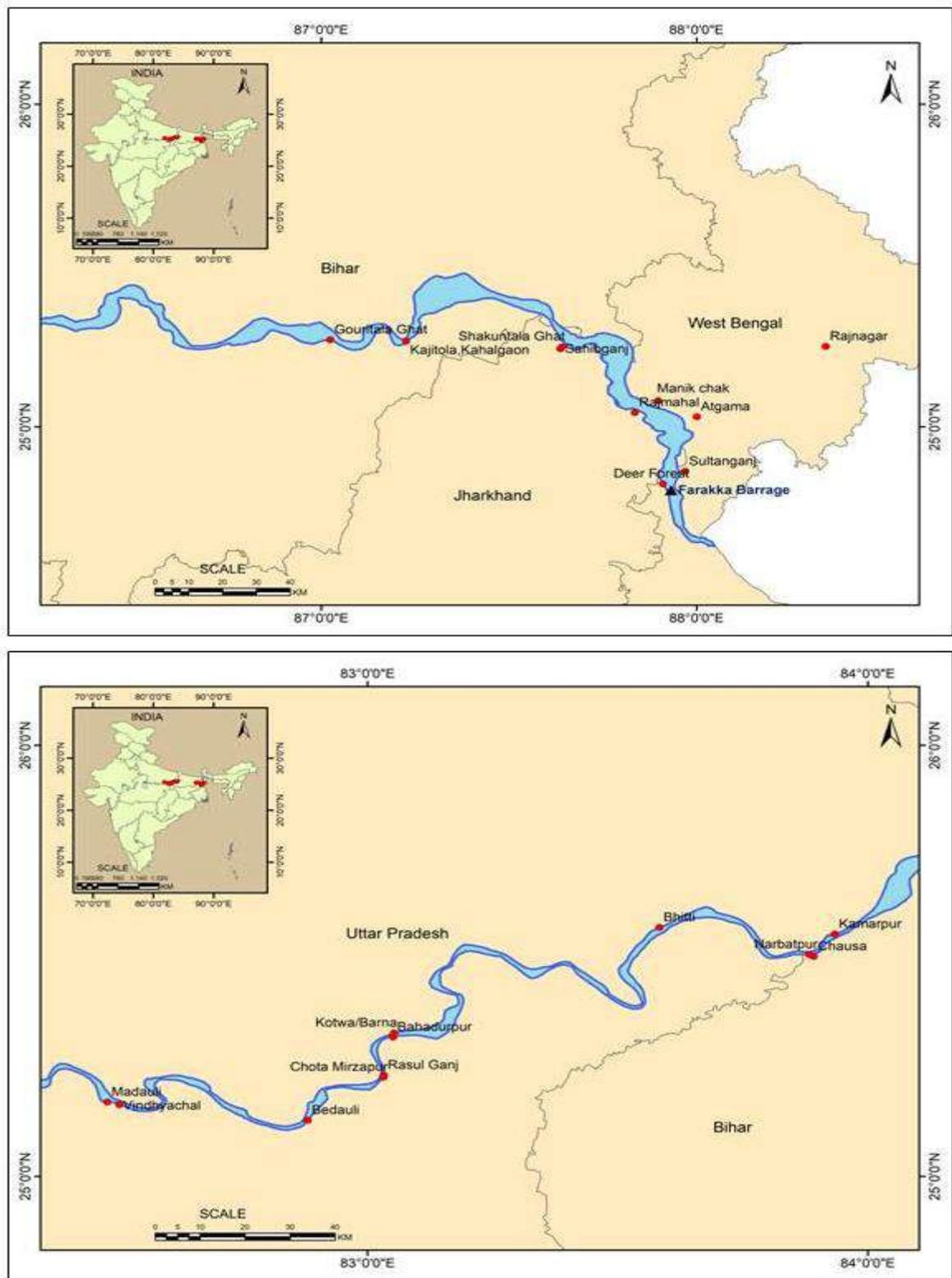


Fig. 18 GIS Map representing the areas covered during awareness programme on hilsa conservation

ICAR-CIFRI-NMCG-Phase-I Final Report

Table : 4 Details of awareness programme held during 2019

Sl no.	Purpose of awareness	Place	Month	Total Number of Participants	Male Participants	Female Participants	
West Bengal							
1	Fishermen sensitization for hilsa conservation to increase hilsa population	ICAR-CIFRI, Matsya Samridhi Mela	March	300	240	60	
		Deer Forest	Apr & Oct,	105	93	12	
2		Simultala	Apr & Oct,	60	46	14	
3		Atgama ,WB	Apr & Oct,	73	68	5	
Jharkhand							
4		Rajmahal, Jharkhand	Apr & Oct,	97	97	0	
5		Shakuntala Ghat	Apr & Oct,	89	89	0	
6		Sahibganj	Apr & Oct,	134	123	11	
7		Sultanganj	Apr & Oct,	110	110	0	
Bihar							
9		Kajitola,Kahalgaon	Apr & Oct,	73	66	7	
10		Gouritala ghat	Apr & Oct,	215	189	26	
11		Lohar Ghat , Patna	Apr & Oct,	127	110	17	
12		Parvati Ghat, Bhagalpur	Apr & Oct,	200	200	0	
13		Kamarpur	Apr & Oct,	59	49	10	
Uttar Pradesh							
14		Chausa, Balia	Apr & Oct,	154	154	0	
15		Narbatpur	October	43	36	7	
16		Bhitti	October	51	51	0	
17		Bahadurpur	October	78	78	0	
18		Kotwa/Barna	October	85	85	0	
19		Chota Mirzapur	October	72	68	4	
20	Bedauli	October	81	81	0		
21	Vindhyachal	October	83	71	12		
22	Sadiyapur	October	11	11	0		

ICAR-CIFRI-NMCG-Phase-I Final Report

Table : 5 Fishermen perceptions received during the awareness programme

Sl. No.	Place	Perceptions
1	West-Bengal	Hilsa is not available in their fishing zone even in season time. They are doing fishing along with some part time jobs or business. Female members of the families are mainly engaged in “Biri bandha” work getting 25 rupees for 125 Biri.
2	Jharkhand	According to the information provided by the available fishermen; Hilsa were very rare to found in their fishing zones. Most of the fishermen prefer outside work along with fishing.
3	Bihar	According to the information provided by the available fishermen; no Hilsa were found in their fishing zones. Fishermen catch other fishes available in the river. Most of the fishermen prefer outside work along with fishing.
4	Uttar Pradesh	According the fishermen no hilsa found in the fishing zone, they depend on other catches. Many of them are engage in to other part-time jobs. Some of the fishermen moved to nearer cities to find jobs for livelihood.

4.2.3.1 Socio-Economic Status of Hilsa (*Tenualosa ilisha*, Hamilton 1822) Fishermen

An investigation was carried out on the economic status differences between the fishermen having hilsa catch stretch *vis-a-vis* fishermen without hilsa catch stretch. The findings were interesting. Upstream of Farakka considered was as stretch without Hilsa and Lower stretch Hooghly-bhagirathi was stretch with Hilsa. During our study period, hilsa availability was nil in the upstream of the Farakka barrage. While, in the lower stretch of the Farakka barrage, hilsa catch was contributing a major fishery. In this stretch, Hilsa are mainly available in two seasons monsoon (August to October) and winter (January to March). Hence, these two seasons are the major income generation period for the fishermen. In other time the fishermen are involved in different activities such as fabrication of fishing gears and net repair and other secondary occupation such as working as daily wage labourers. Maximum fishermen (almost 87%) catch other fish like Phasa (*Setipina phasa*), Small prawns and Koi (*Anabas testudineus*), Shawl (*Channa striata*), Aor (*Sperata aor*) etc., during the off season. While, in the upper stretch (Without hilsa stretch), fishermen are involved as daily wage workers as secondary occupation and sell in the local market. The detailed parameters explained as given below

Education: 82% Hilsa fishers of Farakka in the upper stretch of Ganga river have no formal education. However in the lower stretch 65% fishers were educated till primary level. In the upper stretch only 18% had primary education but in the lower stretch 30% fishermen had primary education, 4% and 1% attained secondary and graduation level studies respectively.

Community: Hilsa fishermen in South 24 PGS, representing extreme lower stretch of river Ganga was dominated by Schedule Caste (SC) community. In lower stretch, in Murshidabad, mainly in the adjacent area of Farakka barrage, 89% were dominated by SC communities, 7% were other backward class (OBC) and 2% were Muslim communities.

Age of the fishermen: The age of Hilsa fishers were wide ranges from 20 to 70 years in the upper stretch fishermen were quite younger than lower stretch and ranges from 41 to 50 years and in the lower stretch, the age range is from 51 to 60 years were dominated.

Income: The monthly income of Hilsa fishers in the lower stretch was higher than those in the upper stretch. In Godakhali, fishers monthly income is INR 25,000 – 30,000 during the peak season of the hilsa fishery. In the upper and middle stretch, income from hilsa catch is nil but income from other fish catch is approximately INR 10,000 to 15,000 per month.

Fishing crafts and gears: Catching Hilsa with gill net is the most prevalent in Hilsa fishery among the lower stretch of Ganga. Fishing operation with engine boats were dominating in Murshidabad district (almost 93.7%). Traditional non-motorized boats dominated in South 24 pgs., North 24pgs. and Kolkata.

Sex: All the Hilsa fishers were male in both the stretches. While, Godakhali lower stretch showed highest i.e 96.7% male. While, 3.3% were women Hilsa fishers who are mainly involved in selling Hilsa in the market.

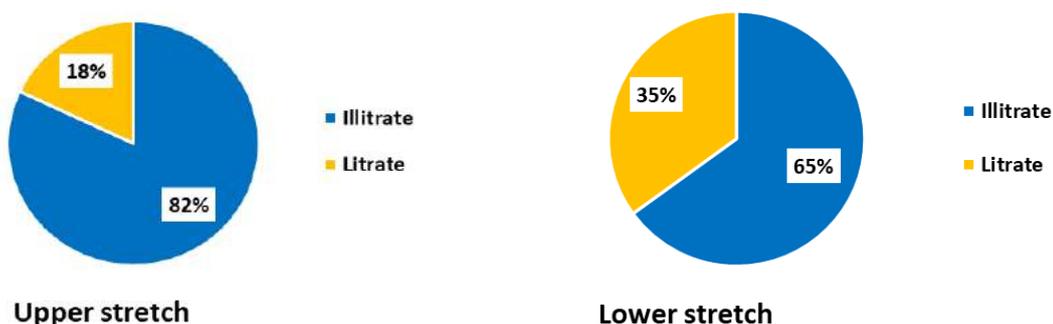


Fig. 19 Literacy status of fishermen from both the stretches

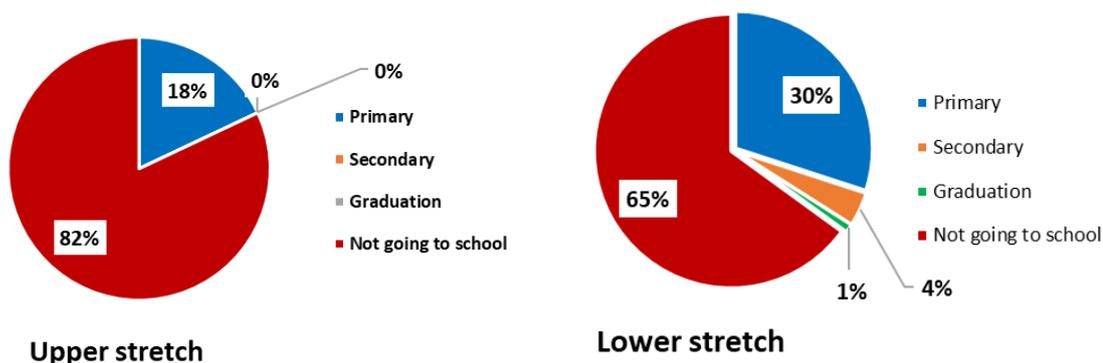


Fig. 20 Educational status of fishermen from both the stretches

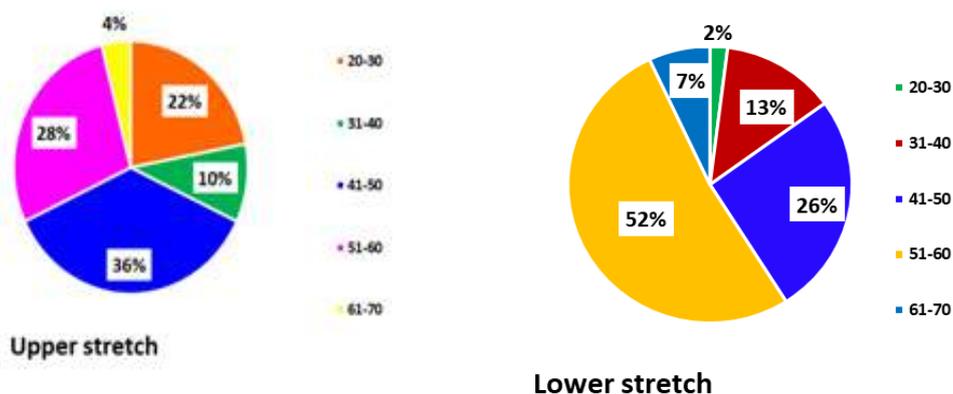


Fig. 21 Age group of fishermen from both the stretches

5.0 Hilsa improvement facilities developed at Farakka

During the project period 2018-2019, following developmental facilities have been created towards hilsa fisheries improvement at Farakka in river Ganga

1. Hilsa ranching station was developed for research and developmental activities towards Hilsa improvement in river Ganga. This station is of its first kind in the country towards Hilsa improvement. The station's major objective is to carry out hilsa development activities including understanding migration, breeding, spawning, reproduction and feeding behaviour. The station has facilities for hilsa holding tanks, rearing and breeding. In addition, this station provides live demonstration and training to the fishermen, students and general public on hilsa conservation and production.
2. Hilsa rearing unit was established to hold the live hilsa and other associated indigenous fishes from river Ganga for both research and demonstration purposes. The rearing unit consists of two FRP tanks of 5000 lt with continuous aeration facilities. Design was developed to maintain the water current continuously. This would provide the fish like staying in the natural condition.
3. Fiber reinforced plastic (FRP) built boat for carrying hilsa adults and juveniles was developed. This boat helped in carrying the live hilsa to a distance of 10-15 km away from the Farakka barrage for the successful ranching.
4. With the support from the Farakka Barrage Authority (FBA), Farakka, ICAR-CIFRI has developed a Hilsa laboratory inside the residential campus. The laboratory helps in regular monitoring, analysis and data recording facility on the water quality, fish diversity and other biotic like plankton and macrobenthic invertebrates.

6.0 Conclusions

The study on “Hilsa Fisheries Improvement in River Ganga” under National Mission for Clean Ganga with a major focus to improve the hilsa fisheries in the middle stretch of river Ganga between Prayagraj to Farakka was carried out during 2018 to 2019. During the study period significant activities such as ranching of adult hilsa at upstream of Farakka barrage, understanding migratory path of the hilsa through tagging and awareness programme on hilsa fisheries among the the fishermen all along the selected stretch were taken up. The following are the major significant achievement made through the project

1. First hilsa ranching station was established in India particularly in river Ganga to facilitate hilsa and other indigenous gangetic fish research and development activities.
2. One year hilsa observation data showed that during September to December adult hilsa are available in large quantity at the downstream of the Farakka barrage and they are unable to migrate to the upstream due to the barrage. Furthermore, the species were also available during February to April though the size is small.
3. Suitable sites for live hilsa collection were identified. Three sites Beniagram, (2 km downstream of barrage), Dhulian (12 km below the barrage), Feeder canals were found suitable for adult hilsa availability. Among these, Beniagram was most suitable for transport of the adult hilsa.
4. In the present study open type transportation of live fishes was followed. It has been showed that 10 lt per fish of 150 g with continuous aeration showed minimal stress for a transportation of 30 min. During the transportation period of 30min, mortality shows 8-10%, while transportation period for more than 1 hr showed 50% mortality were recorded.
5. A total number of 3274 hilsa adult/brood fish of was ranched in the upstream of the barrage. Ranching was made into two groups i) ranching of adult hilsa (>150 g) ii) ranching of hilsa juveniles (50 g to 100 g). Adult hilsa were at different stages of maturity. While, major maturity stages were identified as stage IV and V.

6. A total of 403 adult hilsa fishes were tagged to understand their migration. The tagging was done with the help of scissor grip and pistol grip tagging gun with Floy T-bar anchor tags. Prior to tagging, short experiment was carried out in confined water bodies to find out the size and feasibility of the tagging experiment and found that within 45 min the stress parameters comes to near normal.
7. The recovery of tagged hilsa fish showed that adult hilsa could migrate 49 km per day. Furthermore, the study showed that maximum upstream travel distance was around 640 km in 120 days indicating that the hilsa could migrate to the Prayagraj and much above if proper and suitable ecosystem is provided.
8. In our investigation, total recovery of tagged hilsa within the stipulated period was 3.8% i.e within 120 days. While within 15 days, fishes were recovered from Sahebganj (84 km) and Kahalgaon (120 km). This percentage of recovery could be enhanced through the adopting advanced tagging methods including sensor based tags and PIT tags.
9. Based on the fishermen interaction and awareness programme, it was recorded that the ranched hilsa has reached to Balia, Uttar Pradesh from the Farakka. While, few Tagged fish has been recovered from near to Patna. This concludes that hilsa could establish their earlier breeding ground if proper ecosystem is provided.
10. Though hilsa fishes are not available in the middle stretches of the river Ganga since more than four decades, fishermen from these stretches were much interested, as they were getting much profit and livelihood from the hilsa during 1970s. Therefore, understanding the fishermen's views on Hilsa during early days and the livelihood dependent upon could help us in establishing the economy of the hilsa fish contribution in this stretch. Based on this, more than 2000 fishermen from Farakka to Prayagraj were aware on the Hilsa fisheries life cycle, conservation of hilsa and tagging of Hilsa for the migration study. The fishermen were enthusiastic that hilsa will return and will improve their livelihood in future through the current activities under NMCG.

11. An investigation was designed to establish the fishermen economic status facts between hilsa catch stretch (5 km) *vis-a-vis* without hilsa catch stretch (5 km). The findings were interesting. The monthly income of Hilsa fishers in the lower stretch was Rs. 25,000 to Rs. 30,000 during the peak season of the hilsa fishery only and the income goes to Rs. 35,000 to 40,000 if combined with other fish species. While without hilsa catch stretches (Farakka to Prayagraj) the income due to Hilsa catch is nil but income from other fish catch is approximately INR 8,000 to 10,000 per month. This clearly indicates, hilsa fishery could significantly improve the economy and livelihood of fishermen in the middle stretches of the river Ganga, if this species could re-establish in the middle stretch of river Ganga (Farakka to Prayagraj).

7.0 References

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**8.0 Glimpses of Awareness Programme
on
HILSA conservation in River Ganga
(Prayagraj to Farakka)**



Fig. 22. Awareness Programme on Hilsa Conservation in Matsya samridhi mela of ICAR-CIFRI



Fig. 23 Awareness Programme on Hilsa Conservation in Matsya samridhi mela of ICAR-CIFRI



Fig. 24 Hilsa awareness programme at A) Simultala & B) Atgama (Pagla ghat), West Bengal



Fig. 25. Hilsa awareness programme at A) Manikchak & B) Deer forest, West Bengal



Fig. 26 Hilsa awareness programme at A) Sahibganj, Jharkhand & B) Parvarti ghat, Bihar



Fig. 27 Hilsa awareness programme at A) Lohar Ghat, Bihar & B) Sultanganj, Jharkhand



Fig. 28 Hilsa awareness programme at A) Narbatpur & B) Bahadurpur, UP



Fig. 29 Hilsa awareness programme at A) Barna & B) Balia, UP



Fig. 30 Hilsa awareness programme at A) Vindychal , UP & B) a meeting with Patna state fishery officer regarding mass fishermen awareness

9.0 Publications and Media coverage

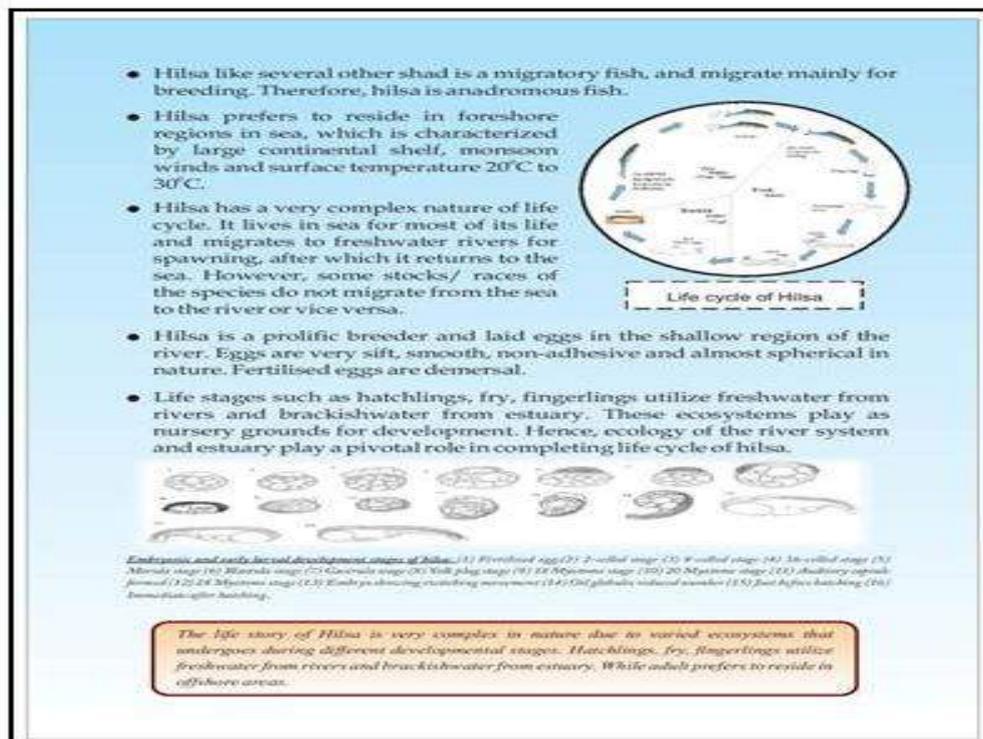
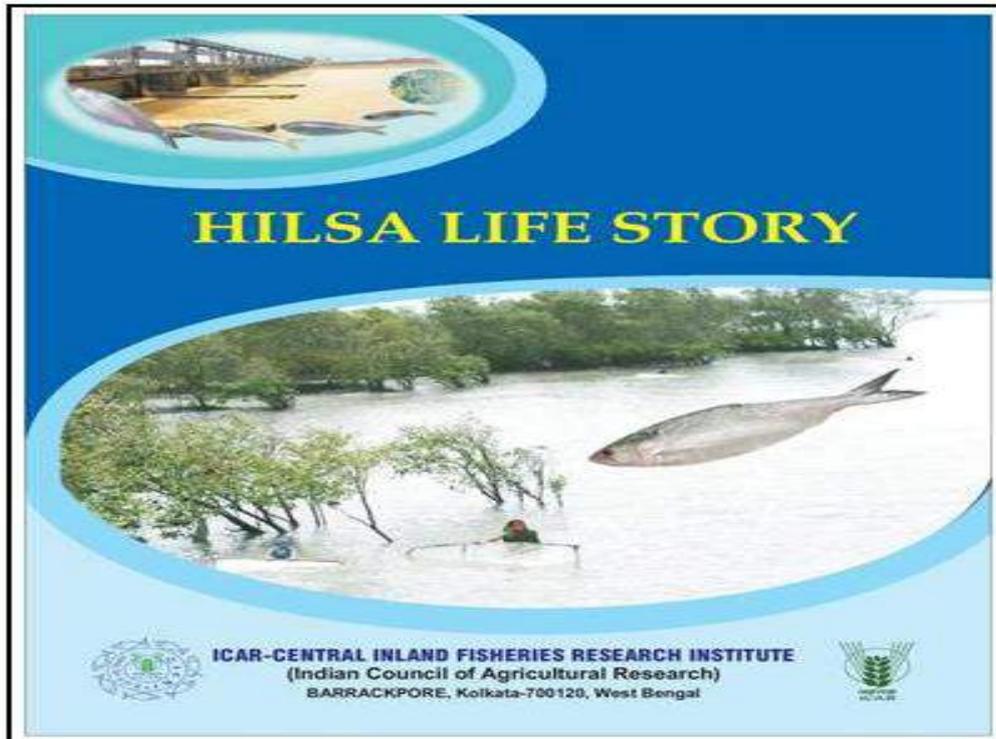


Fig. 31 Folders on HILSA live cycle used for awareness programme

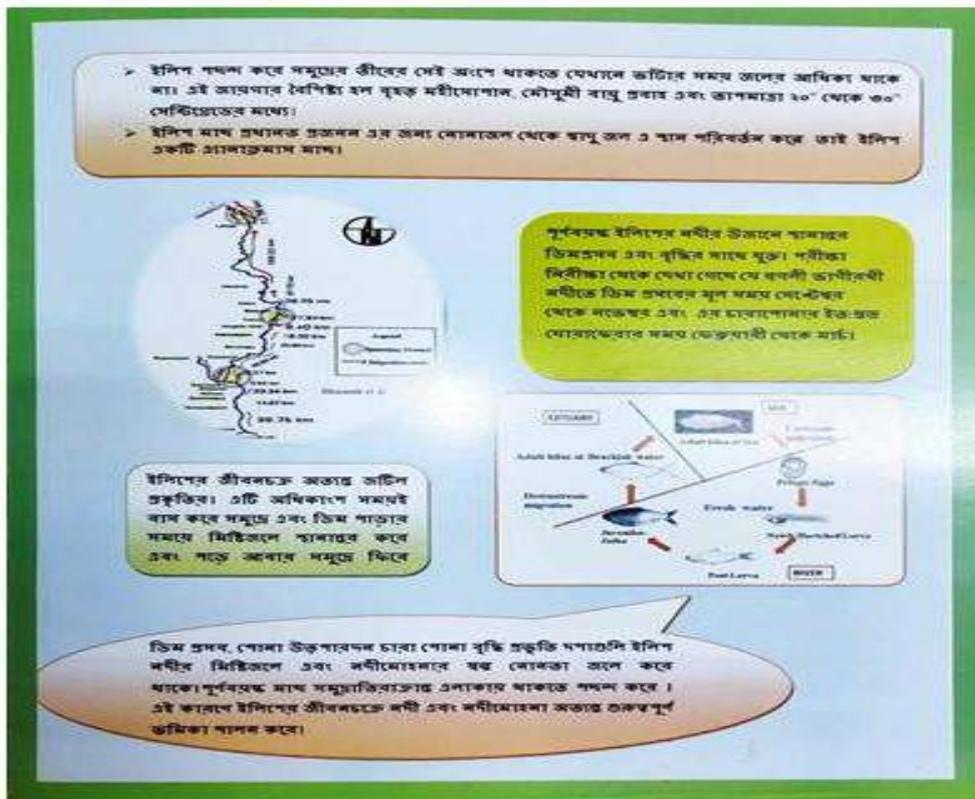
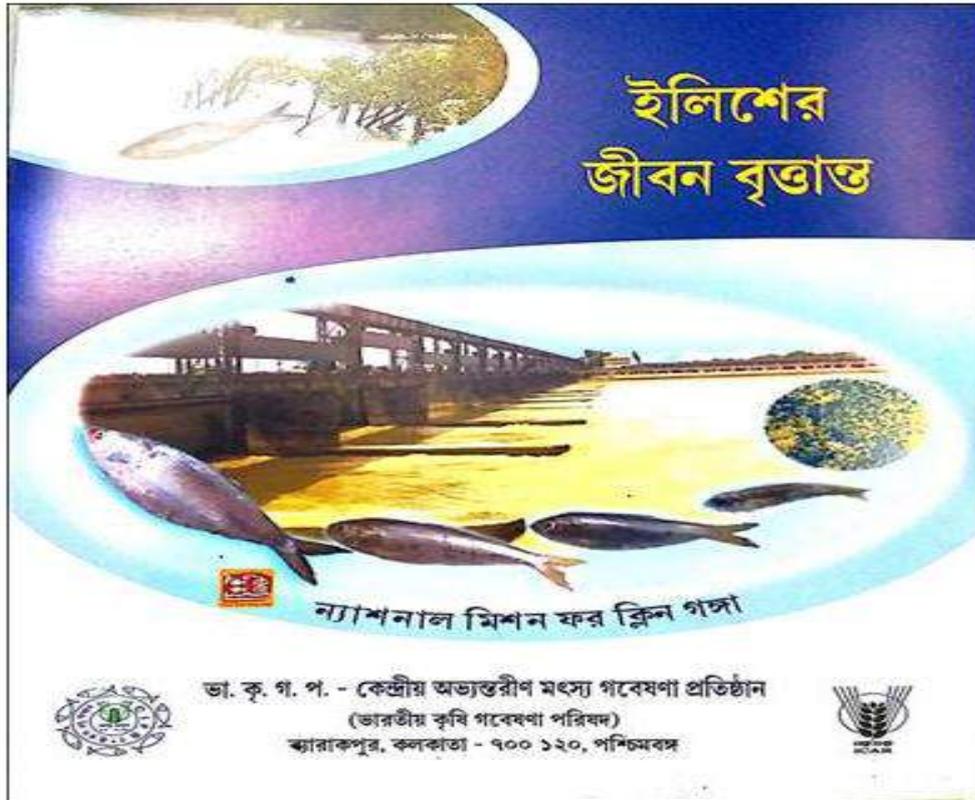


Fig. 32 Hilsa information in local language (Bengali) used for awareness programme



The banner features logos of ICAR, NMCG, and CIFRI at the top. The central text is in Bengali and English, with a background image of a boat and two fish. The text includes the title 'Hilsa Conservation Awareness Programme' and the organization 'ICAR - Central Inland Fisheries Research Institute, Barrackpore'.

ইলিশ সংরক্ষণ সচেতনতা কর্মসূচী
AWARENESS PROGRAMME ON HILSA CONSERVATION
NATIONAL MISSION FOR CLEAN GANGA (NMCG)
ভা.কৃ.অনু.প.- কেন্দ্রীয় অন্তর্স্থলীয় মৎস্য গবেষণা সংস্থা, ব্যারাকপুর
ICAR - Central Inland Fisheries Research Institute, Barrackpore



The banner features logos of ICAR, NMCG, and CIFRI at the top. The central text is in Bengali and English, with a background image of two fish and a row of five small photos showing fish handling. The text includes the title 'Hilsa Conservation Awareness Programme' and the organization 'ICAR - Central Inland Fisheries Research Institute, Barrackpore'.

হিলসা সংরক্ষণ পর জাগরুকতা কার্যক্রম
AWARENESS PROGRAMME ON HILSA CONSERVATION
NATIONAL MISSION FOR CLEAN GANGA (NMCG)
ভা.কৃ.অনু.প.-কেন্দ্রীয় অন্তর্স্থলীয় মাৎস্যিকী অনুসন্ধান সংস্থান, বৈরকপুর
ICAR - Central Inland Fisheries Research Institute, Barrackpore

Fig. 35 Banners on hilsa conservation and tagging used for awareness programme

Namami Gange • Follow
22 Oct at 2:01 PM

In last 2 days, CIFRI under the Namami Gange Project has tagged and released 340 Hilsa fish upstream of Farakka Barrage. This will enhance the understanding of the upstream migration of Hilsa fish in Ganga.

Accordingly, policy decision may be taken to see the possibility of repairing the fish ladder in Farakka which is not in operation since 1997 & also see the possibility of the Hilsa migration through the Inland Waterways project at Farakka from Hugli river. As per CIFRI research team in the field, Hilsa is now been sighted/reported from Buxar.



THE TIMES OF INDIA, KOLKATA
SATURDAY, FEBRUARY 9, 2019

After 40 years, the hilsa will swim up to Allahabad again

Barrage Lock Redesigned For Smooth Migration



New Delhi: In June 2018, 30,000 hilsa were released out of Rs 22,00,000 for a big hilsa in West Bengal's Buxar. The fish, that had swam down from Myanmar was indeed a prize catch. It's rare to find hilsa that large.

The price the whiting fish fetched at the bustling wholesale market was the ultimate gastronomic measure of how far a fish lover would go to have the hilsa on his plate.

Now, after a gap of over 40 years, the hilsa will be able to swim down the Ganga all the way up to Allahabad this monsoon. That had been possible till a barrage was built across the Ganga at Farakka in Bengal in the 1970s. The barrage came with a navigational lock that blocked the free movement of hilsa.

Shipping and water resources minister Nitin Gadkari said on Friday that this was being done as a part of efforts to preserve the biodiversity of Ganga. This lock has now been redesigned to ensure smooth and safe migration of the hilsa should during the three mating seasons, particularly during monsoon. A navigational lock is a device that is used to raise and lower boats and ships between stretches of water on a river.

"We will open the gates for only 10m and between 1am and 5am, which is the preferred time when hilsa seeks passage. This provision has been made in consultation with ICAR, Central Inland Fisheries Research Institute, Central Waterways Commission and Farakka Barrage Project Authority. We have designed this to help us and have saved about 100 crore," Inland Waterways Authority of India vice-chairman Pravin Pandey told TOI.

Hilsa has a history of migrating from Bangladesh to Allahabad down the Ganga. Though it's a salt-water fish, it migrates from the Bay of Bengal to the sweet waters of the Ganga. It travels upstream during the mating season and returns to its natural abode after spawning. The hatchlings head to marine water, and the cycle goes on.

"Fish often disperse widely over large areas while feeding and spawning. This hilsa migration will lead to an increase in its production in the region. This will also increase the river's biodiversity and boost the economy of local fishermen," a shipping ministry spokesman said.

রূপালি শস্যের তল নামবে গঙ্গায়

ফরাক্কায় ইলিশ ট্যাগিংয়ে চলছে গবেষণা

অর্পণ চক্রবর্তী • ফরাক্কা

১৯ নভেম্বর : গঙ্গার উপত্যকায়, নদীর মধ্যভাগে কীভাবে ইলিশের উপপলন ব্যতীত অন্য কোনো মাছ, তা নিয়ে সৌখিনভাবে পরীক্ষামূলক গবেষণায় নেমেছে সেন্ট্রাল ইনস্টিটিউট অফ ফিশারি রিসার্চ ইন্সটিটিউট (সিআইআইএফআরআই) ও ব্যারাকপুর কিশোরী ফরাক্কায় চলা সেই গবেষণা সফল হলে আয়ামিদিনে গঙ্গায় রূপালি শস্যের তল নামবে বলে মনে করা হচ্ছে।

ফরাক্কা ব্যারাজের কাছে একটি আয়না বেয়ে সেখানে কিশোরী গাড়িট তৈরি করে ইলিশের গায়ে ট্যাগ লাগিয়ে এই গবেষণার কাজ শুরু করা হয়েছে। এখনও পর্যন্ত সাতটি ডিন হাফারের বেশি মাছ সেই গাড়িতে ছাড়া হয়েছে। এখনও প্রতিদিন গড়ে ডিনেশের বেশি মাছ সেখানে ছাড়া হচ্ছে। ডিন-ওয়েল ২২৩ থেকে ৩৩৫ মিলিমিটার সৈন্যবিশিষ্ট ইলিশ মাছের গায়ে সিরিয়াল নম্বর দিয়ে ট্যাগ লাগানো হচ্ছে। সেন্ট্রাল ইনস্টিটিউট অফ ফিশারি রিসার্চ ইন্সটিটিউট (সিআইআইএফআরআই) সূত্রে জানা গিয়েছে, গঙ্গার অধঃস্থ নদীর মধ্যভাগে ইলিশের উপপলন ব্যতীত অন্য কোনো মাছের গায়ে ট্যাগ লাগানো হচ্ছে। এই গবেষণার আওতায় উৎকৃষ্ট হলে ফরাক্কা থেকে এলাহাবাদ পর্যন্ত এলাহাবাদ গঙ্গার ইলিশের পরিবর্তী পর্যায়ক্রমে উপপলন করা। তবে অন্য ফরাক্কায় নই হয়ে যাওয়া সিআইআইএফআরআই কীভাবে মাছের গায়ে অসুবিধা নতুন করে নির্মাণ করা যায়, তাও ভেবে দেখা হচ্ছে। এর পাশাপাশি বেঙ্গল ও গাঙ্গার মুঠি দল ফরাক্কা থেকে এলাহাবাদ পর্যন্ত গঙ্গার দু'পাশের বিভিন্ন বাজা, বিশেষ করে পশ্চিমবঙ্গ, ক্যান্ডাখ, বিহার ও উত্তরপ্রদেশের বিভিন্ন এলাহাবাদ অঞ্চল ও সুলতানপুত্র, রামমহল, ফাগলপুর, পান্ডিত, কলার, বাসিয়া, বেনারস, প্রয়াগরাজ প্রভৃতি এলাহাবাদ মানুষকে ইলিশের জীবনব্যয় সম্পর্কে সচেতন করছে। বিশেষত মৎস্যজীবী ও ব্যবসায়ীদের ইলিশ নিয়ে বেশি সচেতন করা হচ্ছে।

এপ্রসঙ্গে সিআইআইএফআরআই (সিআইআইএফআরআই) সূত্রে জানা গিয়েছে, ফরাক্কায় ইলিশের ট্যাগিং-এর মধ্যে দিয়ে আমেরা গঙ্গার উপত্যকায় নদীর মধ্যভাগে ইলিশের মাইগ্রেশন সম্পর্কে জানতে পারবে। ইলিশের গায়ে উপপলন করতে অর্থাৎ এলাহাবাদে মাছ কতটা ডিন রাখা করেছে তাও জানা যাবে।

এসব মাছের স্টক ব্যতীত অন্য উপপলন বৃদ্ধিতেও কাজে লাগবে। প্রজননকালে ইলিশের গায়ে গঙ্গার উপত্যকায় অর্থাৎ বিশেষ করে পরাগে ডিন, এই গবেষণার মাধ্যমে আমেরা তা জানতে পারবে। ফরাক্কায় অসুবিধা মুক্তে ন্যাশনাল মিশন অব ট্রিন গঙ্গার উপত্যকায় গায়ে সেসটির থেকে এই কাজ শুরু হয়েছে। সেন্ট্রাল ইনস্টিটিউট অফ ফিশারি রিসার্চ ইন্সটিটিউট (সিআইআইএফআরআই) সূত্রে জানা গিয়েছে, ফরাক্কায় ইলিশের ট্যাগিং-এর মধ্যে দিয়ে আমেরা গঙ্গার উপত্যকায় নদীর মধ্যভাগে ইলিশের মাইগ্রেশন সম্পর্কে জানতে পারবে। ইলিশের গায়ে উপপলন করতে অর্থাৎ এলাহাবাদে মাছ কতটা ডিন রাখা করেছে তাও জানা যাবে।

এসব মাছের স্টক ব্যতীত অন্য উপপলন বৃদ্ধিতেও কাজে লাগবে। প্রজননকালে ইলিশের গায়ে গঙ্গার উপত্যকায় অর্থাৎ বিশেষ করে পরাগে ডিন, এই গবেষণার মাধ্যমে আমেরা তা জানতে পারবে। ফরাক্কায় অসুবিধা মুক্তে ন্যাশনাল মিশন অব ট্রিন গঙ্গার উপত্যকায় গায়ে সেসটির থেকে এই কাজ শুরু হয়েছে। সেন্ট্রাল ইনস্টিটিউট অফ ফিশারি রিসার্চ ইন্সটিটিউট (সিআইআইএফআরআই) সূত্রে জানা গিয়েছে, ফরাক্কায় ইলিশের ট্যাগিং-এর মধ্যে দিয়ে আমেরা গঙ্গার উপত্যকায় নদীর মধ্যভাগে ইলিশের মাইগ্রেশন সম্পর্কে জানতে পারবে। ইলিশের গায়ে উপপলন করতে অর্থাৎ এলাহাবাদে মাছ কতটা ডিন রাখা করেছে তাও জানা যাবে।

Fig. 36 Media coverage in different newspaper & Namami Gange website/Face book page

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First Hilsa Ranching Station established by ICAR-CIFRI

24th January, 2019, Barrackpore

Shri Babul Supriyo, Union Minister of State (Ministry of Heavy Industry & Public Enterprises), inaugurated the Hilsa (*Tenualosa ilisha*) Ranching Station at Farakka, established by ICAR-Central Inland Fisheries Research Institute, Barrackpore here today.

The Minister also emphasized to replicate such ranching facilities in large scale to make its impacts visible. He also suggested installing floating cages at suitable locations to rear the hilsa juveniles prior to ranching in the river Ganga.

The ceremony marked the presence of administrative and management personnel from different water stakeholders, including Farakka Barrage Authority (FBA), Inland Waterways Authority of India (IWAI), Central Water Commission (CWC) and Fishermen societies under the National Mission for Clean Ganga (NMCG).

Dr. B.K. Das, Director, ICAR-Central Inland Fisheries Research Institute discussed about the ranching of a total number of 117 hilsa fish having an average length of 255 mm and average weight of 165 g from the station at the upstream of Farakka barrage in river Ganga. He also assured of achieving the target within the stipulated time frame.

Earlier, the station was conceived based on a short study carried out on hilsa population in the river Ganga funded by NMCG, Ministry of Water Resources, River Development & Ganga Rejuvenation, Government of India. The study indicated that migration failure is the major cause for decline of hilsa population in the upper stretch of river Ganga.

(Source: ICAR-Central Inland Fisheries Research Institute, Barrackpore)



Fig. 37. Hilsa ranching station in ICAR Website

ICAR-CIFRI tags Hilsa Broodfishes



The ICAR-Central Inland Fisheries Research Institute, Barrackpore has ranched 586 of Hilsa Broodfish in the upstream of Farakka barrage for improving the Hilsa Fisheries in the middle stretches of the River Ganga. The initiative was carried out under the National Mission for Clean Ganga (NMCG), Ministry of Jal Shakti, Government of India during the month of September to October, 2019.

During the process, a total of 372 fishes out of 586 Hilsa were tagged with a size range 223mm to 345 mm with Floy T-bar Anchor Tags of standard size with serial numbers printed. The tagged fishes were observed and showed fully active during the release indicating the suitability of the tags used.

The main objective of the tagging is to understand the current migration pattern of Hilsa Broodfish in the middle stretches of the River Ganga, particularly, from the Farakka to the Prayagraj (Allahabad) and above, under the background of current non-functional of Fish pass existing in the Farakka barrage.

Simultaneously, the ICAR-CIFRI team created the awareness among the fishermen on the reporting of tagged Hilsa and Hilsa conservation from Farakka to Prayagraj, all along the River Ganga namely Sultanganj, Rajmahal, Bhagalpur, Patna, Buxar, Balia, Varanasi, and Prayagraj covering the states of West Bengal, Jharkhand, Bihar, and Uttar Pradesh. The fishermen were distributed the information on *Hilsa Life Story* and Leaflets on *Hilsa Conservation for future* in Hindi and Bengali for better understanding on the work activities. The team is carrying out the detailed activities under the guidance of Dr. B.K. Das, Director, ICAR-CIFRI.

Fig. 38 Hilsa report in ICAR Website



During the Year - 1962, the ICAR-CIFRI conducted the Hilsa tagging for the first time at Allahabad, Varanasi and Buxar with an objective on understanding the migratory behavior of the Hilsa.

Further, the recent studies recorded that the Hilsa congregation in large number below the barrage and forming a good fishery ground. Therefore, the ranching and tagging of Hilsa Broodfish would support the current understanding on the Hilsa migration pattern after the Year - 1975. Accordingly, the policy decision could be taken to see the possibility of re-establishing/designing of fish passes or exploring other possibilities for upstream migration ensuring Hilsa fisheries improvement in the middle stretches of the River Ganga.

(Source: ICAR-Central Inland Fisheries Research Institute, Barrackpore)

Fig. 39 Hilsa mass awareness report in ICAR-CIFRI website

