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ARTICLE

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A JOINT INITIATIVE TOWARDS RESEARCH AND DEVELOPMENT IN HILSA FISHERIES BY ICAR- CIFRI

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The Hilsa (Tenualosa ilisha) is considered an indicator species of the Ganga River and is considered as the state fish of West Bengal. This iconic species is now facing serious anthropogenic stress over the past few decades, leading to a decline in population. Recent studies have shown that the Hilsa population has reduced both upstream and downstream of the Farakka barrage. In view of their biological significance, the present article provides information related to initiatives taken up by ICAR-CIFRI under the National Agricultural Science Fund (NASF) and the National Mission for Clean Ganga (NMCG).

Keywords: *Tenualosa Ilisha, ICAR-CIFRI, NMCG, NASF*

Introduction

The Hilsa (*Tenualosa ilisha*) is an economically significant fish species in the Indo-Pacific region, particularly in India. It is a priced fish that is rich in Ω-3 and Ω-6 fatty acids, where it sustains millions of livelihoods and provides huge economic returns and harvested in large quantities from Ganga, Brahmaputra, Mahanadi, Godavari, Krishna, and Cauvery, but the riverine catch has declined due to hindrance in migration routes by the construction of dams and barrages, habitat degradation, climate changes, and unregulated fishing[1].

Though India and Bangladesh are the major contributors to Hilsa catch, the majority of catches come from the Ganga-Brahmaputra river system[2]. However, it led to the decline of Hilsa populations in the river system due to recruitment failures and indiscriminate exploitation of adults and juveniles[3]. Various studies have been conducted on determining the age, growth and relative condition factor of Hilsa in different locations and at different life stages[4]. In terms of socio-economic aspects, the Hilsa fishery is considered a profitable livelihood opportunity for the fishers, but alone, it is not sufficient to sustain the livelihood of artisanal fishers[5]. To cater to these needs, ICAR-CIFRI has initiated projects funded by ICAR-National Agricultural Science Fund (NASF), New Delhi, and National Mission for Clean Ganga (NMCG), Ministry of Jal Shakti, Govt. of India, New Delhi, for the captive breeding and stock enhancement of Hilsa.

Methodology

Tenualosa ilisha was collected from different sampling sites along the Hooghly-Bhagirathi River. Data was collected for a period of 2012 to 2024 from the completion report of projects funded by ICAR-National Agricultural Science Fund (NASF), New Delhi and from 2018 to 2023 for the projects funded by National Mission for Clean Ganga (NMCG), Ministry of Jal Shakti, Govt. of India, New Delhi. The completion report (2012- 2017) on 'Stock characterization, captive breeding, seed production and culture of Hilsa (*Tenualosa ilisha*)', completion report (2021-2024) on 'Captive Breeding of Hilsa, *Tenualosa ilisha*: Phase II', final report (2018- 2019) on 'Hilsa fisheries

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Table 1 Project title, its duration, funding agency and fund allocated towards ICAR-CIFRI

Sl.no.	Project name	Funding Agency	Duration	Fund allocated
1.	Stock characterization, captive breeding, seed production and culture of Hilsa (*Tenualosa ilisha*)	NASF	31st October 2012 to 30th November 2017	₹ 362.43 lakhs
2.	Captive Breeding of Hilsa, *Tenualosa ilisha*: Phase II	NASF	1st March 2021 to 29th February 2024	₹ 143.92 lakhs
3.	Hilsa fisheries improvement in river Ganga	NMCG	2018- 2019 to 31-10-2020	₹ 127.60 lakhs
4.	Fish stock enhancement including Hilsa and livelihood improvement for sustainable fisheries and conservation in river Ganga	NMCG	2020 to 2023	₹ 13,51,39,928/-

improvement in river Ganga' and final report (2020-2023) on 'Fish stock enhancement including Hilsa and livelihood improvement for sustainable fisheries and conservation in river Ganga' were followed. All other projects regarding Hilsa fisheries conservation and development are mentioned in Table 1.

Results

Major Findings on Hilsa through NASF: Projects under ICAR-National Agricultural Science Fund (NASF), New Delhi, were carried out in 2 phases. In Phase I and Phase II, Stock characterization, captive breeding, seed production and culture of Hilsa (*Tenualosa ilisha*) were accomplished in the period of 2012 to 2017 and 2021 to 2024 respectively. Following are the major initiatives taken by NASF during that tenure-

- Hilsa breeding grounds along the Hooghly estuary, such as Farakka, Kalna, Balagarh, Bichulighat, Dakshinaswar, Kolaghat, and Godakhali, were identified. The brackish water tidal zone was found to have the highest breeding activity, followed by the freshwater tidal stretch, while the marine zone was the least significant.
- Stock assessment of Hilsa and estimates of the maximum sustainable yield (MSY), spawning stock biomass, and fishable limit were also made. The mean catch of 35,428 t shows an MSY that exceeds the required level.
- The major food items include phytoplankton (*Spyrogyra* sp., *Coscinodiscus* sp., *Gleocapsa* sp., *Pleurosigma* sp., *Aulacosiera* sp., *Ulothrix* sp., *Biddulphia* sp., *Nitzschia sp., Asterionella* sp., *Thalassiothrix* sp.) and zooplankton (rotifers and copepods).
- The studies on reproductive biology revealed that there were more males than females in the population. The maximum frequency of mature females was found during September- October & February and maximum availability in Godakhali, Kolaghat and Balaghar stations.
- The gears used along Hooghly River are mostly gill nets of 40 to 110 mm mesh size at the size of 5 mm difference that is being used by fishers for catching Hilsa.
- Captive breeding, seed production, and culture systems for Hilsa were developed.
- Domestication of Hilsa was carried out in circular cages and concrete tanks. The fingerlings produced through rearing were stocked in concrete ponds for grow-out rearing and to raise brood. Grow-out rearing practises were also conducted in floating rectangular cages. Table size Hilsa can be produced through freshwater and brackishwater pond culture, achieving 20% and 30% survival, respectively.
- At Farakka, Hilsa stocks were maintained in ICAR-CIFRI designed 16-m-diameter circular cages. There, 181 fish were stocked in cages and fed supplementary feed with CP 42% and 6% fat.
- The optimal dose of anaesthetics, viz. Eugenol, 2-Phenoxyethanol (2-PE), and Tricaine Methanesulfonate (MS-222) on Hilsa were standardised for all the anaesthetic and recovery stages, and MS 222 was found to be best for recovering the stress from different culture systems.
- ICAR-CIFRI has developed a unique cryopreservation methodology for Hilsa milt using the techniques pioneered by ICAR-NBFGR. The technology is unique for Hilsa breeding. The hatchlings were raised in tanks before being put out in the culture ponds.

Major Findings on Hilsa through NMCG:

Projects funded under the National Mission for Clean Ganga (NMCG), Ministry of Jal Shakti, Govt. of India, New Delhi, were carried out in 2 phases. During Phase I (2018-2019) to (2020-2021), 'Hilsa fisheries improvement in river Ganga' was accomplished. Major objective of the project was to increase the natural stock of Hilsa in river Ganga (upstream of Farakka barrage) through ranching of Wild collected Hilsa seed and to study and monitor Hilsa migration across the Farakka barrage in the main river Ganga. The following are the major initiatives taken during that tenure-

- A ranching station was established upstream of the Farakka barrage to improve the Hilsa fisheries in the river Ganga. The primary goal of the ranching station was to carry live Hilsa for an extended period, acclimatize them, and breed them artificially at the station. Three potential locations for collecting live Hilsa were identified: Beniagram (2 km downstream of the barrage), Dhulian (12 km downstream), and the feeder canal. To increase the natural stock of Hilsa in the middle section of the river, 3274 adult Hilsa with total length and weight of 20 to 24.5 cm and 150 to 350 g, respectively, were ranched 5 to 10 km upstream of the Farakka barrage in 2018–2019.
- To determine the migratory path, the floy T bar anchor tag was used to identify individual Hilsa. According to the data, 100% survival was demonstrated, and the stress caused by tagging returned to normal after 45 to 60 minutes. The tagged Hilsa was found within 15 days of ranching in 2018–2019 in Sahebganj (84 km) and Kahalgaon (120 km). This indicates that Hilsa could re-establish in the middle section of the Ganga, even though the recovery percentage of tagged Hilsa was 3.8%.
- During 2018–2019, ICAR-CIFRI conducted several public awareness and sensitization programs on Hilsa conservation in the upstream region from Farakka to Prayagraj, involving 1200 fishermen from 25 villages across four states (U.P., Bihar, Jharkhand, and West Bengal). They were asked to follow the proper guidelines to increase the number of Hilsa in their native place and to report to the institution if they encountered any tagged Hilsa during fishing operations.

During Phase II (2020- 2023), 'Fish stock enhancement including Hilsa and livelihood improvement for sustainable fisheries and conservation in river Ganga' was carried out. The main objective during the tenure was to improve Hilsa fisheries in the river Ganga's middle stretch (Prayagraj to Farakka).

- During this period, approximately 22,47,000 to 23,57,00 eggs, 16,900 Hilsa spawns, and 91,209 Hilsa fish were released upstream of the Farakka barrage, with 15,100 Hilsa in 2020–2021, 50,055 in 2021–2022, and 26,054 in 2022–2023. The number of ranched live Hilsa was nearly 3.3 times higher in the second year of the phase II project than in the first year, but it was 1.7 times higher in the third year.
- Length-weight relationship (LWR), fishes condition factor, and growth parameters are important in fisheries management. For these, more than 31,867 Hilsa shads were used in the population study and its LWR revealed a negative allometric growth for male, female and pooled Hilsa population in Farakka. As the fish species showed negative allometric growth, it can be assumed that the fish becomes slenderer as it increases in weight.
- Reproductive biology was carried out during monsoon and late winter months. According to monsoon migrations, the initial breeding period usually occurs between September and October, during the late monsoon season. The second breeding season occurs in late winter, notably in February and March. Approximately 188 Hilsa in all were used for breeding between November 2021 and April 2023, with 60 males and 18 females in Farakka and 121 males and 67 females in Godakhali.
- Absolute fecundity of female Hilsa was determined by fecundity studies conducted during the period. Between September and November, fecundity varied between 81,454 and 7,37,100. Between February and March, when the Hilsa migrates for the winter, the absolute fecundity of female Hilsa varied from 27,084 to 2,79,665. The absolute fecundity of female Hilsa varied from 18,311 to 7,37,100 during the course of the year. Remarkably, among Hilsa specimens, the highest fertility occurred in September and March.
- From November 2021 to April 2023, 188 Hilsa (121 males and 67 females) in Farakka and 78 Hilsa (60 men and 18 females) in Godakhali were used for artificial breeding. The fertilisation rates from both locations varied from 72 to 80% and 57 to 60%, respectively.

- Domestication of Hilsa was carried out at the Hilsa ranching station at Farakka, where fertilized Hilsa seed was grown out under various captivity conditions and fed with live fish food organisms, particularly green algae (Chlorella), while physicochemical parameters were regularly monitored.
- At Farakka, West Bengal, experimental designs for the captive rearing of Hilsa were conducted in various confined spaces, including an earthen pond, a pen in a river, a raceway, and circular FRP cages.
- To develop Hilsa brood stock, one circular cage was erected in 2021–2022, and two more were added in 2022–2023. In cages, I, II, and III, 243 Hilsa brooders were produced. Although the body weight of the cage-reared Hilsa increased by 58%, the fish's mortality rate during the rearing phase was equally significant, reaching 87.5% of the supplied Hilsa. A total of 72 Hilsa brooders in raceways (32 × 12.5 × 1.5 feet) were housed in two pens in the Ganga at the upstream end of the Farakka Barrage. These pens measured 69 × 36 and 36 × 33 feet in length and width. The experimental pond (6 × 6 × 1.5 feet) was supplied with 600 Hilsa spawn and 30 juveniles. Further, 400 spawns were stocked to produce Hilsa broodstock in captive conditions.
- To evaluate their upstream migration, 3,065 Hilsa were tagged between 2020 and 2023. 3.34% of the adult Hilsa, out of the 91,209 total ranched Hilsa, were tagged and released over the project's duration. Over 7.8% of all tagged adult Hilsa were collected from various areas from the point of release. While 17% of adult Hilsa recovered from the feeder canal from Aduha to Baidyabati, West Bengal, more than 50% of Hilsa recovered from the middle section of the Ganga. In the districts of Beniyagram, Jafarganj, Hossenpur, and Dhuliyan in Murshidabad, where the Ganga flows downstream of the Farakka Barrage toward Bangladesh, 27% of the Hilsa was recovered.
- Additionally, from 2020 to 2023, 493 awareness programs were held at various locations in Farakka, educating 14,317 fishermen and entrepreneurs about Hilsa conservation.
- The total fish ranching efforts from 2018 to 2024 amounted to 148.97 lakh individuals, showing significant conservation activity. Explicitly focusing on Hilsa, the ranching of adult Hilsa reached 1.42 lakh individuals, while the ranching of Hilsa spawn accounted for 39.59 lakh individuals. These highlight the importance of Hilsa ranching initiatives in fisheries management and sustainability.

Recommendation for Hilsa Conservation

- Pollution and industrial waste are some of the main reasons for habitat changes in Hilsa. Therefore, it is of utmost importance to control industrial discharge in the Ganga River.
- Population estimation and stock assessment of Hilsa are conservation approach. Further, studies on age and growth distribution could also be helpful in conservation purpose.
- Restoration of estuarine and spawning habitats through ecological interventions can lead to habitat restoration.
- Strengthen policy, laws and legislation on illegal fishing and encroachments in critical habitats to develop conservation and management plans.
- Enforce seasonal fishing bans during breeding periods to allow natural stock rejuvenation.
- Regulate fishing gears to minimise the capture of juveniles and broodstocks.
- Organise campaigns, public awareness, and community participation about the ecological and economic importance of Hilsa that can sensitise people.

Conclusion

The collaborative efforts under the National Agricultural Science Fund (NASF) and the National Mission for Clean Ganga (NMCG) have led to significant advancements in the conservation and enhancement of Hilsa fisheries. Through comprehensive stock characterization, breeding, and habitat restoration initiatives, these projects have addressed critical challenges in Hilsa conservation, including artificial breeding, ranching, and domestication. Ranching programs upstream of the Farakka Barrage have shown promising outcomes, with measurable increases in Hilsa populations and evidence of successful migration and reproduction. Further, studies on reproductive biology, nutritional composition, and feeding habits have provided valuable insights for developing

sustainable aquaculture practices. Efforts to improve captive breeding, feed standardization, and grow-out systems have demonstrated the potential for Hilsa domestication under controlled conditions. Awareness programs and community engagement have further strengthened conservation efforts by involving stakeholders across multiple states. Therefore, integrated management approaches combining scientific research, policy implementation, and community participation are helpful in the capacity building of fishermen. With continued investment and collaboration, these initiatives pave the way for the sustainable management of Hilsa populations, supporting biodiversity conservation and the livelihoods of riverine communities.

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