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ICAR-CENTRAL INLAND FISHERIES RESEARCH INSTITUTE REACHES IN 75 GLORIOUS YEARS FOR NATION BUILDING IN INLAND FISHERIES

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Indian Council of Agricultural Research-Central Inland Fisheries Research Institute (ICAR-CIFRI), Barrackpore, Kolkata, West Bengal is a premier research Institute of pre-independence era in India catering to basic, strategic and applied research in fisheries, training, extension and developmental activities in inland open waters aiming at sustainable fisheries enhancement, ecological, and human resource management in a more pragmatic way.

The Institute

Recognizing the role of inland fisheries, GoI established a Central Inland Fisheries Research Station (CIFRS) at Calcutta on 17 March 1947, under the Ministry of Food and Agriculture. This was elevated to a full-fledged Research Institute as "Central Inland Fisheries Research Institute (CIFRI)" in 1959 with HQ at Barrackpore, and later came under the administration of the ICAR, Ministry of Agriculture (now Ministry of Agriculture and Farmers' Welfare) in 1967, New Delhi. The Institute has been striding at a very focussed manner towards development of inland fisheries functioning from its HQ at Barrackpore, West Bengal with four Regional Research Centres located at Allahabad, Guwahati, Bangalore and Vadodara, and Research Stations at Kochi and Kolkata enabling the Institute reaching to unreached even in furthest corner of the country. Five divisions are in place i) Riverine Ecology & fisheries (REF) ii) Reservoir & Wetland Fisheries Management (RWF) iii) Fisheries Enhancement & management (FEM) iv) Aquatic Environmental Biotechnology & nanotechnology (AEBN) & v) Fisheries Resource Assessment & Informatics (FRAI) addressing issues of all the inland open water fishery resources.

The Mandate

From a modest beginning as an aquaculture Institute reaching to a Natural Resource Management Institute (NRM) with the passage of time focussing on scope, utilization and enhancing fisheries from inland open water fishery resources with present mandate as i) Basic and strategic research for sustainable management of inland open water resources ii) Develop protocols for productivity enhancement in reservoirs and wetlands and aquatic ecosystems health management iii) Act as repository of information on inland open water fisheries resources & iv) Human resource development through training, education and extension

Development of Epoch-making Technology : Since its inception, CIFRI has been instrumental in developing a number of epoch-making inventions in inland fishery sector: *Induced breeding, Air-breathing fish culture, Composite fish culture, Protocols for small - and large reservoir fisheries management, Integrated wetland fisheries enhancement, Enclosure (Cage and pen) culture and feed formulation, Riverine biodiversity conservation and ranching, Fish for human health, Conservation of Hilsa, Vulnerability assessment, Climate smart fisheries,*

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Evaluating pollutants in inland waters, E-flow in Indian rivers, GIS in resource delineation, bio- & nano-technology for aquatic health management, Big Data in inland fisheries & Formulation of training modules.

Inland Fisheries Resources: Inland open water resources include rivers and canals (1,95,210 km), flood plain wetlands (1.2 million ha), reservoirs (3.51 million ha) and estuaries (0.029 m. ha) besides many derelict water bodies, contributing 20% of inland fish production and 15% of India's fish production (14.16 million metric tons in 2019-20).

Inland Fisheries Production: Immediately after independence, the inland fish production of India was very meagre with only 0.2 million metric ton (MMT) in 1950-51, while the total fish production was 0.7 MMT, which has been accentuated to 56 folds with the inland fish production reached to 11.25 MMT, with overall fish production was 14.73 MMT (2020-21, Dept. of Fisheries, GoI). During 2020-21, the inland fisheries production has been reached to all time highest in the Globe with 1.18 MMT and ICAR-CIFRI's contribution in this endeavour was phenomenal with relentless efforts in achieving this tareget.

Goals and Targets of CIFRI: CIFRI has developed state of the art research facilities and expertise in inland fisheries including reservoir and wetland ecology and fisheries, riverine and estuarine fisheries and biodiversity conservation, ecosystem and fish health, climate resilient inland fisheries, resource assessment, modelling and fisher's socio-economics, since its establishment. The Institute has accomplished significant scientific and technological progresses towards generating knowledge base for ensuring sustainability of inland open water ecology, aquatic biodiversity & fisheries, nutritional and livelihood securities.

***Addressing SDGs*:** The Institute has been addressing the Sustainable Development Goals through different programmes towards humanity and national development viz., SDG (1) End poverty, (2) Zero hunger, (5) Gender equity & women empowerment, (8) Economic growth (12) Sustainable consumption and production, (13) Climate change & (15) Biodiversity. The initiatives are: *Livelihoods improvement & income generation through demonstration & capacity building of fishers, Ensuring household nutritional security through SIFs, Women empowerment in Small scale Fisheries through culture of SIFs and rearing of fish seed culture in pen, Doubling farmers' income through cage culture and production enhancement technology of wetland, Sustainable fisheries production from inland open waters, Culture of Climate resilient species and Conservation of bio-diversity with special focus to SIFs*

***Specific Objectives of the Institute*:** 1) Understanding the aquatic ecology, habitat quality, bio-diversity and assessment of fish stocks for sustainable fisheries in rivers and estuaries 2) Formulation of ecosystem-based management plans for enhancing fish production and productivity of reservoirs and wetlands 3) Assessment and monitoring environmental health for development of mitigation plans: 4) Strengthen the support system through mapping and estimation of the aerial expanse of inland aquatic resources by GIS 5) Develop prediction models based on time series information on different inland open waters 6) Study the socio-institutional, livelihood and valuation issues in inland fisheries to address key interventions and measures for up-liftment of fisher community 7) Address training and awareness needs in the sector 8) Execute Outreach, TSP, SCSP and NEH activities towards development and propagation of technologies, especially for the tribal people and in North Eastern region

Setting the National Priorities to Achieve: "Healthy and resilient inland open waters with abundant fish stocks providing sustainable economic returns for and by the commons and governed by a **common inland open water policy integrated at local, National and International level."** Major focus was up-liftment of socio-economic status of poor fishermen (1% of total population of India) in Inland open waters. It is the only Institute working and responsible for the formulation of policy and guidelines for conservation and sustainable fisheries in Inland open waters with major focus on rivers and wetlands.

***Major Initiatives and Achievements -The First Institute*:** Initiated, performed and disseminated knowledge on Induced breeding, composite fish culture, air-breathing fish culture, enclosure culture, Tilapia Lake virus, microplastics in inland waters, scientific river ranching, arsenic in inland waters & mitigation, hilsa conservation protocol and tagging, reservoir and wetland fisheries management, SIFs and mal nutrition prevention, E-flow protocol development, assessing pollutants in inland waters and so on.

Research Highlights During Last Six Years

***Riverine Ecology and Fisheries*:** i)Study of ecology & biodiversity of major Indian rivers (Cauvery, Mahanadi, Tapti, Siang, Chaliar) ii) Fisheries vis-à-vis livelihood study in Hooghly-Matlah Estuarine system (river Ganga) iii)

Biodiversity study of river Torsa &Gandak with special reference to SIF iv) Pollution study in River Mahanadi and Gomti vis-à-vis ecosystem integrity v) Environmental flow requirements for eight Indian major rivers vi) Ranching-cum-awareness programs for restoration of fish stock in river Ganga (National Mission for Clean Ganga-Namami Gange program – NMCG)

***Reservoir Fisheries*:** i) Reservoir fisheries management for sustainable fisheries in major reservoirs of the country

ii) System specific model development for Reservoir fisheries management iii) Fisheries enhancement in small reservoirs of Odisha iv) Guidelines and development of strategic plan for fisheries development in reservoirs of India

***Wetland Fisheries*:** i)Wetland management models and policy developed for Assam & Bihar ii) Standardization of optimum stocking density for wetland fisheries enhancement iii) Participatory technological intervention in wetlands of Bihar iv) Culture of Small Indigenous Fishes (SIFs) in derelict waters of Sundarbans and development of wetland fisheries policy.

***National Mission for Protein Supplement (NMPS), Enclosure Culture and CIFRI*: NMPS under DAHD&F, GoI**, has launched cage culture developed by CIFRI for table fish production in 12 States initially with the expansion of additional 3 States diverting Rs. 100 crores targeting livelihood and nutritional security across India. A mommoth activities under enclosure culture includes: i) Standardisation & demonstration of Cage culture in

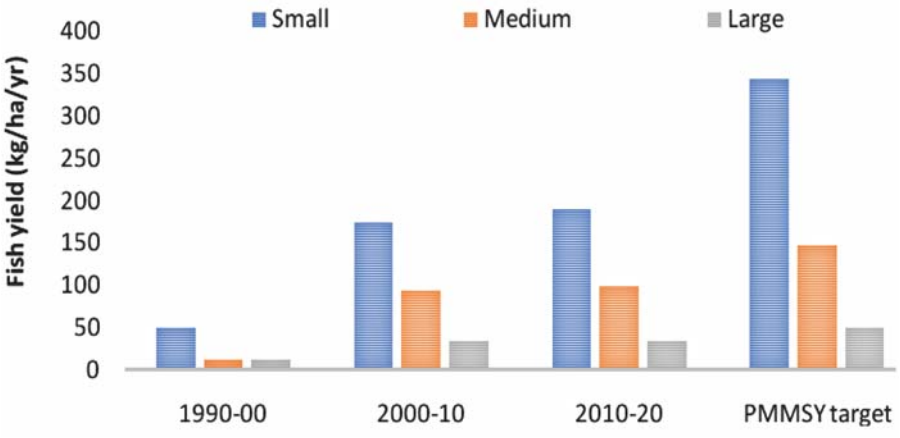
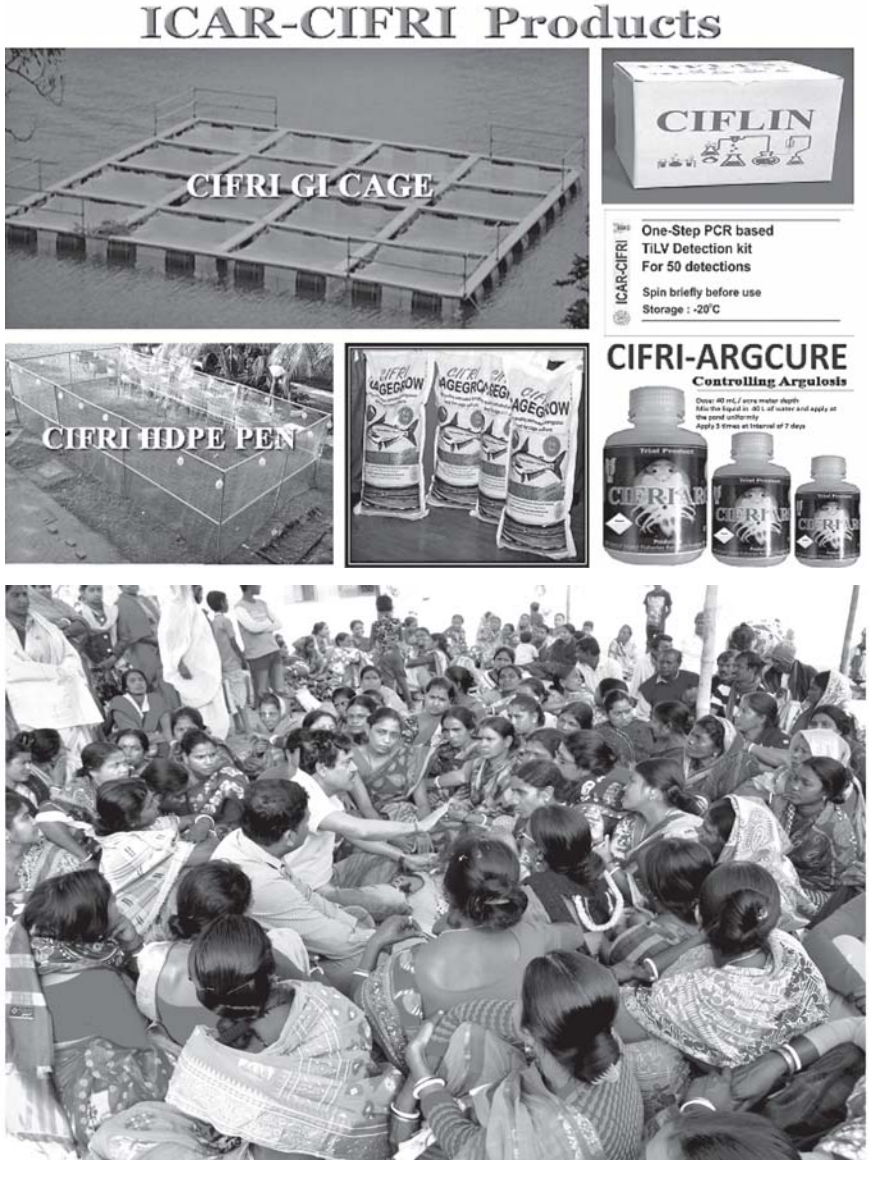


Fig. 1 Increment in fish yield through technological intervention & PMMSY targets



reservoirs and wetlands ii) Diversification of cultivable species in cage culture iii) Pen culture in NE states, Bihar, West Bengal and Uttar Pradesh iv) Low cost floating feed for cage culture in reservoirs. The impacts are: high fish production (70 kg/m^3/8 months) from cage culture of Pangas recorded in Jharkhand reservoirs. About 30,000 cages spread over 22 states are now in operation, producing more than 65,000 ton of fish and creating employment of 8.0 lakh man days/y. Cage farming at Chandil reservoir, Jharkhand has not only provided livelihood relief to about 2000 displaced families but also has become a leading employment model for communities displaced by large dams.

***Fisheries Socio-Economics*: i)**Institutional arrangements vis-à-vis sustainable inland open water fisheries ii) Database on assets of fishers' community iii) Livelihood improvement through canal fisheries iii) Socio-economic study of fisher women of Hooghly estuary iv) ITK documentation of Rabha tribes of North Bengal

***Aquatic Pollution Monitoring, Ecosystem and Fish Health Management*: i)** Pollution biomarkers developed for different types of stress ii) Genetic diversity studied for important fishes iii) Disease control of fishes in open water fish culture iv) Molecular characterization of salt stress tolerant bacteria

Pollution Biomarkers Developed for Different Types of Stress: Gene expression patterns of *CYP1AI*, *CYP1A2* and selected immune genes were assessed in *Rita rita* for evaluation of their potential in eco-toxicological monitoring of river. Expressions of *hsp60, hsp70* and hsp78 have been identified as biomarkers of long-term thermal stress and *hsp90* and *hsp110* have been identified as biomarkers of short term thermal stress

in fish. Apo-A1, Wap-65, A2ML and Transferrin been identified as potential biomarkers of as induced chronic liver disease

***Resource Assessment and Database Creation*:** i)Devising digital methods of fisheries resource assessment ii) Data driven model-based assessment for sustainable inland fisheries iii) Refinement of sampling methodology for fish catch estimation iv) Forecasting models developed for sustainable fisheries in Narmada estuary and Chilika v) A stratified sampling design for Hilsa catch estimation vi) Assessed the impact of barge induced hydrodynamic disturbances on tiny phytoplankton in National Water Way 1 of river Ganga, India vii Database creation

Climate Change and Climate Smart Fisheries Through NICRA: Inland water ecosystem and fisheries are threatened due to climate change and anthropogenic pressures, more visible during last six decades making the resources vulnerable. The Institute has been conducting research for understanding the interaction between climatic parameters and inland fisheries, imperative to develop mitigation and adaptation strategies. Last three decades observed increment in mean air temperature of Ganga basin by 0.20 - 0.47 °C with annual rainfall decreased to 257-580 mm. Significant reduction in depth and area, diversity of natural indigenous fish fauna (22.85 to 54%) in wetlands was noticed. Several research advancements have been made including development of innovative tools for vulnerability assessment and benchmarking of fish species (*Eutropiichthys vacha, Mystus cavasius, M. tengara, Johnius coitor, Channa punctata, Puntius sophore, Amblypharyngodon mola* and *Gudusia chapra*) in Ganges basin. The Institute has prioritized studies on climate change, its impact on ecology and

fisheries, heat wave studies, climate resilient fisheries and adaptation techniques, carbon sequestration potential of wetlands, development of novel approach in modelling reproductive and ecological vulnerability and impacts of extreme climatic events on inland fisheries in Chilika lagoon and backwaters of peninsular India.

PMMSY and Inland Fisheries: Aiming at doubling farmer's income by 2022, Govt. of India has launched Pradhan Mantri Masya Sampada Yojona (PMMSY), a flagship project with allocation of **Rs. 20,050 crores** for integrated, sustainable and inclusive development of marine and inland fisheries of India. Out of this, i) Rs. 11, 000 crores for activities in marine, inland fisheries and aquaculture and ii) Rs. 9,000 crores towards infrastructure –fishing harbour, cold chain, market etc. Under this, cage culture, seaweed farming, ornamental fisheries development was given priority. Rs. 600 crores have already been year marked for development of Cage culture.

Policy Formulation, Management Guidelines and Recommendations **:** i)National guidelines for cage culture ii) Conservation and management action plans for Chilika lagoon iii) Decision support tool using geo-spatial technology for reservoir stocking enhancement program iv) National Action Plan for Hilsa & West Bengal Hilsa fishery management guidelines v) Coal transportation guidelines in National Waterways No. 1 vi) Development of Roadmaps for inland open water fisheries of 13 states and vii) Strategic plan for inland fisheries development under **PMMSY.**

E-flow Requirements for Major Rivers**:** i) River Dri: 50 m^3/sec in monsoon, 37.5 m^3/sec in non-lean/ non-flow & 30 m^3/sec in lean period ii) River Tangon: 38 m^3/sec in monsoon; 27 m^3/sec in non-lean/ non-flow period; 20 m^3/sec in lean period iii) River Teesta: 10 m^3/sec for sustenance of ecological integrity in 7.3 km stretch downstream of stage-IV dam axis. iv) NyamjangChhu: 3.5 m^3/sec in lean seasons at NCC barrage site v) River Mahanadi: 30.4 Million m^3/month in lean period; 331.95 mcm/month in monsoon. E-flow requirements for breeding of *Rita rita* (424.56- 566.09 m^3/sec) and *Tor putitora* (1415.22-1556.75 m^3/sec) in Mahanadi vi) River Cauvery: 40.19 m^3/sec at Shivanasamudram vii) Estimates of e-flow for Sone at Indrapuri barrage and Ganga at Haridwar indicated critical situation of the stretches, necessitating respective minimum discharge of 18.9% and 23.1% of mean annual runoff (MAR) to sustain ecosystem functions.

National Mission for Clean Ganga (NMCG) and CIFRI: The Institute has studied in-depth about ecology & biodiversity of river Ganga under NMCG in 20 sampling sites of 2525 km. A total of 190 fish species (182 native & 8 exotics) distributed among 133 genera, 62 families and 23 orders with carps dominated (28 sps, 14.28%). Seed productions of wild IMCs (rohu, catla, mrigal & calbose) germplasm through induced breeding were started since 2017 and a total of 2 crore (approx) spawn have been produced during 2017-2020. The Institute conducted 75 river ranching programmes in Ganga during 2017-2020 releasing more than 56 lakhs of Indian Major Carps (rohu, catla & mrigal) and calbasu fingerlings produced through induced breeding, at Prayagraj, Varanasi, Sahebganj, Maharajpur, Farakka, Berhampore, Balagarh and Barrackpore to supplement depleted stock which declined drastically. Besides these, ranching programmes were also conducted at some major pilgrimage areas like *Rishikesh, Dasashwamedh Ghat, Kumbh mela, Sangam* and *Mayapur.* Mahseer stock also is dwindling in upper reaches of Ganga, which are planned to be ranched. ICAR-CIFRI conducted 53 mass awareness programmes during the project period. A total of 4390 numbers of fishers were sensitized through the awareness campaign in 4 states viz., Uttarakhand, Uttar Pradesh, Bihar and West Bengal including major pilgrimage area like *Rishikesh, Dasashwamedh Ghat, Kumbh mela, Sangam* and *Mayapur*. Institute published 15 research papers, 15 book chapters/articles, 5 books, 10 folders and 2 manuals under NMCG. A total of 9 exhibitions were conducted displaying terchnologies and activities of NMCG with two workshops. A total of 53 mass awareness programmes were conducted during the project period.

Reservoir Fisheries Enhancement:Through successful demonstration and adoption of CIFRI technology on reservoir stocking, the yield has increased substantially to **34, 98 and 190 kg/ha/y** in large, medium and small reservoirs, respectively. Fish yield level of **125 kg/ha/y** has been achieved in selected reservoirs of Chhattisgarh, MP, Jharkhand, Karnataka and Tamil Nadu through culture-based fisheries. Fish yield of 58 small reservoirs of Odisha has increased by 158% through adoption of Culture-Based Fisheries (CBF).Fish catch of Karapuzha reservoir, Kerala has increased from 18 to 150 kg/ha. Fish yield in 24 reservoirs of Chhattisgarh increased significantly from 80.43 to 374.46 kg/ha/y. Stock enhancement has increased fish yield (kg/ha/y) of large reservoirs viz, Indirasagar (60) & Gandhisagar (127) of MP and Govindsagar (149) of HP. Fish production of Rihand, UP increased from **75.02 to 297.39 t** in 1998 to 2019.

Standardization of Optimum Stocking Density for Wetland Fisheries Enhancement: ICAR-CIFRI has

recommended stocking with advance fingerlings of IMC > 100 mm @ 1500-2000/ha in wetlands of Bihar, West Bengal, Assam, Uttar Pradesh.

Co-management and Integrated Wetland Development in Bihar: CBF management in five mauns of Motihari, Bihar has resulted in more than doubling of fish yield (kg/ha/y from 180 to 675 kg in Kararia *Maun*, 190 to 320 kg in Sirsa; 70 to 140 kg in Rulhi, 60 to 120 kg in Majharia and 14 to 70 kg in Kothiya maun. The employment opportunity was increased from 58 to 153 mandays/year. This has addressed the '**ARYA**'-*Attracting Rural Youth in Agriculture* in a befitting manner minimizing the migration of the fishers from the villages to urban areas.

Culture of Small Indigenous Fish Species (SIFS) in Derelict Waters of Sundarbans: Programs were initiated towards empowering rural tribal through sustainable fisheries and utilization of derelict open waters by culturing SIFS for livelihood security in village Khan Saheber Abad and Khas Ramkarer Char, tribal dominated villages located in Sagar Island of South 24 Parganas district, West Bengal. Group of 20 families were earned Rs. 40,000-50,000/- in six months.

New Initiatives: i) Study of extreme climatic events like cyclone, flood, etc on ecology of fisheries of Chilika, Pampa, Perriyar, etc ii) Prepared fisheries management guidelines of important water bodies with documentation of their ecology and diversity iii) Prediction model prepared for catch of fish and shellfishes iv) Partnering with National Mission for Yamuna Rejuvenation and Brahmaputra river Program for fish production enhancement and sustainable management. v) Focus on Precision farming in inland fisheries management using Drone/UAV and sensor based technology vi) Development of canal fisheries in Sundarbans as a means of improving livelihood of poor fishers vii) Developed fish pass designs for dams and hydroelectric projects across rivers like Kameng, Mori, etc viii) Prepared guidelines for barge movement to minimize loss of riverine ecology, biodiversity and fishers' livelihood ix) Distribution of nano-plastic materials in water, sediment and its impact on biotic communities x) The Institute is involved in developing aptamar based nano-biosensor using various types of Nanomaterials for the detection of As, Hg, and pathogenic bacteria *Aeromonas veronii* from inland waters and diseased fishes, Developed molecular recognition elements (MRE) for the detection of pesticides from waters xi) Metagenomic analysis revealed bacterial and fungal diversity and their potential of bio-remediation from sediments of river Ganga and Yamuna; various beneficial microbiome and AMR have also been identified from these river sediments metagenome xii) Assessment of fish and fisheries in entire river stretch – documentation of fish diversity and distribution in GIS platform xiii) Socio-economic status and livelihood asset mapping of fishers in river Ganga

Management of Hilsa Fisheries: i) Hilsa has been severely declined due to obstruction in its normal migration through dams, barrages, siltation, etc. ii) Indiscriminate exploitation of brooders and juveniles along estuaries also played major role behind the decline iii) Estimated the present stock and effort and prepared management guidelines in estuarine zone iv) Generate updated information on fisheries, migration, spawning for redefining management plan v) GIS based predictive map prepared for availability of Hilsa in Hooghly estuary vi) Rational fishing / harvest strategies through modification of fishing gear for size-specific fishing vii) Prepared conservation plans based on rational fishing through mesh size regulation, reduction of fishing effort, closed seasons, protected areas, etc through participatory approach viii) Prepared plans to restore hilsa fisheries in barrage upstream ix) Played leading role for development of aquaculture protocol of this prized fish x) Helped in State and Central Government policy preparation for sustainable Hilsa fisheries.

***Re-establishing Hilsa Fisheries in Ganga Through NMCG*:** CIFRI has recently (2020-21) initiated to re-establish Hilsa fisheries in river Ganga with salient achievements: i) First Hilsa ranching station was established on the right bank of river Ganga at upstream of Farakka barrage. The ranching station was selected after thorough investigation with focus on hilsa transportation and availability in the downstream of Farakka barrage to acclimatize the Hilsa after transportation before ranching ii) So far 30, 000 nos of hilsa adult fish with av. length of 322 mm, av.weight of 210 g was ranched in upstream of the Farakka, caught by fishers of Sahebganj, Balia, Bhagalpur and Patna at size 150g to 250g though very less number (one or two) iii) 735 adult fish were tagged with Floy T-bar anchor tags to understand hilsa migration. Tagged hilsa has been recorded at Munger and Balia, Bihar iv) More than 3200 fishers of Prayagraj, Varanasi, Balia, Buxar, Patna, Bhagalpur, Rajmahal, Sultanganj and Farakka were made aware on Hilsa life cycle, conservation and tagging of Hilsa for migration study.

***Environmental Hazardous Pollutants in Inland Waters*:** River pollution induced by heavy metals and pesticides in Ganga, Gomti, Mahanadi, Kathjodi, Godavari, Krishna, Cauvery were evaluated. Pollution in water phase at a very low level with heavy metals (Zn, Cu, Cd, Pd, Cr,

Mn) in few stretches was noticed while free from those elements in other stretches. However, a moderate level of pollutants of heavy metals in sediment was noticed in Godavari and Mahanadi. Residues of pesticides were detected in water below critical limits of USEPA for aquatic life. In fishes of rivers, Residues of few pesticides in fishes were accumulated mostly within tolerance limit of FSSI. New emerging contaminants - triclosan, oxytetracycline and their metabolites in aquatic environment and their effect on biota and associated impact on human health was also assessed. Arsenic from arsenic prone area of WB down the food chain was assessed. Field-based As residue analysis revealed Grass carp as lowest (<0.05 ppm) and *Oreochromis mossambicus* (Tilapia) the highest (1 ppm) accumulation of fishes. Low as accumulating food fishes were recommended viz, mrigal, grass carp, and freshwater prawn (*Macrobrachium rosenbergii)* as candidate species for aquaculture in prone areas. Level of plastic pollution in Ganga system was first reported by the Institute revealing polyethylene, polypropylene, polyethylene-terephthalate as the most common type of plastic debris.

Threats from Exotic Fish Species in Inland Open Waters: Threats from exotic fish species in open waters were assessed and documented 15 exotic fishes with abundance index of 0.2 to 65%. *Oreochromis niloticus, Cyprinus carpio, Hypophthalmichthys molitrix, H. nobilis, Ctenopharyngodon idella* and *Clarias gariepinus* contributed upto 65% of the total catch in the Ganga and Yamuna rivers at Allahabad. In culture-based East Kolkata wetlands also exotics contributed 55-65% to the total production.

***Major Fish Pathogen in Inland Waters*:** Bacteria, *viz. Aeromonas hydrophila, Citrobacter freundii, Acinetobcter baumanii* and *Pseudomonas aeruginosa* have been identified as major fish pathogens in West Bengal and Assam. The viral disease WSSV and parasitic disease EHP have been reported from shrimp (*P. monodon, P. vannamei*) farming systems of West Bengal. Parasitic diseases like *Argulus, Myxobolus, Dactylogyrus, Larnaea* and *Diplostomum etc.* were reported from the finfish farms of West Bengal and Assam.

***Antimicrobial Resistance (AMR) in Fisheries and Aquaculture*:** CIFRI has been working towards surveillance of AMR in open waters and in aquaculture farms from four districts of WB - Howrah, N-24-PGS, Burdwan and S-24 PGS. The major activities: i) Created awareness to more than 1000 students, fish farmers and Govt. officials on the use and misuse of Antimicrobial substances in general and in the farms ii) AMR pattern for three bacteria viz. *A. hydrophilla, E. coli, S. aurius* in water, sediment and fishes have been analyzed through the WHONET and observed that these bacteria are resistance to certain antibiotics even up to 80%.

***Carbon Sequestration in Wetlands*:** Estimation of carbon (C) accumulation in wetlands is in progress with the objective of assessing their C sequestration potential which could be one of the important adaptation and mitigation strategy in inland fisheries to cope up with global warming and the climate change. Potential of primary C capture and ultimate C accumulation in the sediments leading to their sequestration in different types of wetlands in West Bengal and Assam has been worked out.

***Fish Quarantine Testing Centre*:** Institute has been identified as Fish Quarantine Testing Centre of OIE listed pathogenic fish virus, SVCV, KHV, and TLV. The test reports are being submitted to Animal Quarantine Office of GoI for export of ornamental fishes.

***Patents and Commercialization of CIFRI Technologies*:** The Institute has developed, propagated, and commercialized a number of technologies for resource assessment, ecosystem health assessment and conservation, sustainable production enhancement in inland open waters, enclosure cultures, etc. Two technologies of the Institute have obtained design registrations, namely, **CIFRI GI Cage** and **Tissue Embedding Machine**, and five technologies have got trademarks, namely **Cage Grow, CIFRI GI Cage, CIFRI Pen HDPE, Argcure** and **CIFLIN,** of which the first four have been commercialized by the Institute as well. **CIFRI Fish Tanavhari -** A unique sedative and anesthetic herbal formulation used for fish handling and hassle-free transportation under laboratory and field conditions is submitted for patent file. CIFRI Model GI Cage and CIFRI Pen HDPE have been widely adopted by the fishers' organizations and entrepreneurs across India. Two more technologies namely, CIFLIN, the formalin contamination detection kit in fish and One -Step PCR based TiLV Detection kit are under commercialization. The Institute is an ISO 9001: 2015 certified and provides world-class service standard.

***Employment Opportunities*:** Employment of the fishermen has moved upwards from 30 to 150 mandays/ fisher household/y through adoption of CBF in reservoirs and wetlands. Additional employment of 90 mandays/pen has been generated through pen culture. Pen culture in Assam has increased 50% fish production of the floodplain wetlands, enhancing the income and livelihood of the farming community. Fishers earnings have increased significantly in Dudhawa reservoir, Chhattisgarh adopting

CBF with present income of fishers is at Rs. 50,000/annum. Earnings from chaur fishers of Siwan and Gopalganj, Bihar has increased by 20% through CBF with present average income of Rs. 55,000/ annum. A total of 100 fishers' families have earned additional Rs. 10,000/- adopting Pen culture in Manipur. Canal fisheries development in resource poor Sundarbans, WB has provided nutritional security and livelihood to 1200 tribal fishers. Livelihood and employment to 12.5 million fishers is being catered through Inland fisheries.

***Development of Farmers' Friendly Apps and Documentaries*: i)** Android App for Fish Disease (Fish Disease Advisory) (https://play. google.com /store/ apps/ details?id=pathak.pratik.fishdiseaseadvisory ii) Andriod App for NutriFishIn (NutriFishApp) (https: //play. google.com /store/apps /details?id=cifri.nutrifishinapp) iii) Android App for Pension Database (Cifri Pension App) (https: //play. google. com/ store/apps/details? id=pathak.pratik. cifripension) iv) Android Application on CRT (Catch Recording Tool) http://cifri.res.in/CRT.apk v) e-Matsya (e-DAS) vi) 20 numbers of customized documentaries in Youtube which are farmers' friendly orienting to enhancing fishers income vii) *e-Atlases* of water bodies above 0.5ha of 19 States under Central Sector Scheme (CSS).

***Mapping and Digitization of Inland Water Resources of the Country*:** CIFRI through years of constant and untiring effort has estimated all the inland water resources >0.5 ha in the country using GIS and Remote Sensing technologies, as well as ground truthing. Inland water bodies in 19 states have been evaluated and e-Atlases for water bodies of these states have been prepared. The aquatic resources information prepared as *e-Atlas* in CDs have been disseminated to their respective state as well as central agencies like DAH&DF.

***Development of Road Maps for Fisheries Development*:** The Institute has prepared, in consultation with State Department of Fisheries, and published roadmaps for inland open water fisheries development of WB, Odisha, Jharkhand, Bihar and NE States (8), Telangana and Andaman & Nicobar Islands for ushering in Second Blue Revolution. The Institute has given similar policy guidelines and recommendations to NFDB, Ministry of Agriculture & Farmers Welfare, Ministry Fisheries, Animal Husbandry & Dairying, National Waterways Authority, NGT, Chilika Development Authority, State Fisheries Departments, several hydroelectric projects/Dam authorities, MoEF&CC, BoBLME, India-EU Water Partnerships Priority Area-II, etc. for fisheries development and ecosystem conservation in the country.

Initiatives for Tribal Area Development: Addressing livelihood and nutritional security to very backward tribal folk by disseminating the inland fisheries management technologies, the Institute is working at tandem. Since 2017, Institute supports livelihoods of 4,845 nos of tribal beneficiaries from 10 different states of India through technology provision. A total of 8,320 nos tribal populace were sensitized through group discussion and interactions with on-field demonstrations. Tribal population requires specific attention not only with monetary allocation but also with handful of technical and scientific inputs for their rapid socioeconomic development. And the Institute has taken initiatives through TSP for socio-economic up-liftment of the tribal community utilizing the inland fisheries resources and their management as a vehicle for social and economic changes of the tribal populace. Pen culture demonstration in 2 reservoirs of Odisha, 9 reservoirs of Jharkhand, 10 reservoirs in Chhattishgarh and 3 reservoirs of Manipur with providing training, Seed and feed for pen culture to >5000 beneficiaries.

Empowering Women: Socio-economic status and livelihood of fisherwomen of Hooghly estuary reveals fisher women of 35-55 years' age group are mainly engaged in various fishery related activities. About 58% of livelihood of fisherwomen of Hooghly estuary, WB is derived from fisheries and related activities. Under nutrition and malnutrition are quite prevalent. Even through SCSP programs also women were empowered through ornamental fisheries.

ITK Documentation of Rabha Tribes of North Bengal: Indigenous traditional knowledge's (ITKs) of Rabha tribes of Terai-Dooars region of WB in relation to fisheries was documented, in addition to agriculture, 39% of the mid-aged Rabha women are engaged in fishing activities from the rivers and streams using traditional craft and gears.

***Research Publications*:** Institute has published (2016-2021) on an average 1.5 research papers publications per Scientist per year (average 1 paper per scientist in journals having NAAS rating above 6) and the average NAAS Score per Scientist per year was 7.23. Several papers have been published in top-10 journals in their relevant fields.

***Honours, Awards and Recognition*: Sardar Patel Outstanding Research Institute Award-2020** in larger category Institutes of the ICAR was bagged by ICAR-CIFRI. The prestigious **Agri-Food Award of Excellence-2021 Empowering India** by Ministry of Food Processing Industry, GoI, New Delhi also received. Dr. B. K. Das, Director was adjudged with **Rafi Ahmed Kidwai Award** for

his outstanding Research. ICAR **Best Annual Report Award 2018-19** in**"Large Institute"** category was received by CIFRI. First "**Cashless ICAR Institute Award**" in 2016 received by CIFRI. Institute also received the First Prize of **Ganesh Shankar Vidyarthi Hindi Krishi Patrika Purashkar 2017** for its publication ***Neelanjali*** by ICAR. Dr. V.G. Jhingran, former Director, received the ***Padma Shri*** **Award** in 1977. GoI released a special postage stamp of 5 Paise denomination in 1979 as a token of recognition of the pioneering work of CIFRI. Dr. B. K. Das, Director was awarded ***Fellow of NAAS*** in 2019 in Fisheries Science.

COVID-19 Guidelines by ICAR-CIFRI: Covid-19 pandemic (2020-21) that spread all across the globe leading to lockdown, has significantly affected the fisheries & aquaculture sectors in a multitude of ways in the country. Besides the disruption of fishing activities from open-water, and aquaculture in freshwater system, several associated activities have been greatly impacted. The Institute took lead in developing and issuing advisories, for safety of the workers and preventing the spread of the disease and prepared advisories for the stakeholders involved in fishing activities in rivers, estuaries, reservoirs and wetlands in 7 different regional languages, besides in English and Hindi, released advisories for fishers of these resources. These advisories were popularized through print & electronic media, circulated to DoF of different States, developmental agencies, NGOs & SHGs, and also through social media. *Recognizing the importance of these timely advisories, the* ***FAO, Rome has recommended these advisories prepared by ICAR-CIFRI by including them as Voluntary Guidelines for Securing Sustainable Small-Scale Fisheries under the Asia-Regional initiatives for the benefit of fisheries sector across the globe*** (Webpage: http://www.fao.org/3/ca8959en/ca8959en.pdf), a huge acknowledgement of the efforts by the Institute.

The HR of Institute: Mammoth activities of CIFRI are being managed through very dedicated team of only 201 nos. staff including 84 scientists and 52 technical personnel. Even, CIFRI's presence is felt in furthest corner of HP to 'Serlui B' reservoir, Mizoram. The team has been focussed in their stipulated works under able leadership. Besides, CIFRI is the Nodal Pension Authorising Unit of 13 ICAR Institutes of WB, Bihar, A&N Islands including NE Regions.

Strong Leadership Behind CIFRI's Achievements: Need-based and timely support extended by Dr. Trilochan Mohapatra, Secretary, DARE and DG, ICAR coupled with untiring guidance in executing all the project activities including outreach by Dr. J. K. Jena, DDG (Fy. Sc), ICAR, New Delhi with relentless effort in meticulously performing all the mandated activities of the Institute by Dr. B. K. Das, Director, ICAR-CIFRI has made the Institute in its present shape with hardworking, focussed and dedicated team of Scientists, technical and administrative personnel. Fulfilling our future target of works for this vibrant fisheries sector with changed mandate of the Institute needs more endeavour towards doubling farmers'income in the days to come.

Swachh Bharat and CIFRI: The Swachh Bharat Mission was launched on 2 October, 2014, commemorating the 150th birth anniversary of Mahatma Gandhi with aptly redefined 'C***leanliness is next only to Godliness',*** envisioning a clean India. Prime Minister had evoked a nationwide call to every citizen of India to make the mission successful. Responding to the call, CIFRI has been endeavouring in making clean India making 'Swacch Bharat' program as an in-build component of all on-field programs of the Institute across India reaching more and more people addressing self as well as cleanliness of the individual surroundings. Besides, every year the Institute has been fervently observed 'Swacch Bharat Pakhwada' imbibing local people towards cleanliness.

Mera Gaon Mera Gaurav (MGMG) Program and CIFRI: MGMG is a Flagship program of ICAR with an objective to propagate scientific knowhow to the farmers/ fishers by the Scientists of ICAR Institutes in their surrounding areas for uplifting livelihood to the farmers. Under this program, 50 villages were covered with 56 Scientists covering 700 beneficiaries since 2015. Pond Health Cards, Soil Health cards including Wetland Health Cards were distributed under this program ensuring outputs and outcome from these valued resources.

Reaching to Unreached: Reaching to the outreach is the key strength of the Institute for sustainable development of inland fisheries sector. Imparting knowledge support and capacity building to the ultimate beneficiaries through handful of technologies has been meticulously being performed by the Institute even in lockdown phase also on regular basis. The Institute has organized 405 vocational training programs on different aspects of inland fisheries management and development imparting training to 10,500 fish farmers, officials and students (9300 male and 1200 female participants) of Bihar, West Bengal, Odisha, Assam and Tripura. During 2016-21, 900 Nehru Yuva Kendra volunteers (rural youth) were also trained. Around 1500 fish farmerstrained by CIFRI have started scientific fish culture in different districts of Bihar.

These programs were further strengthened through customized Apps on Nutrifis, GIS, Fish Disease, e-DAS, and 20 numbers of documentaries in Youtube, which are farmers, students, youths & entrepreneurs friendly. The Institute took active part in number of awareness programs across India and has reached to more than 50,500 farmers under various extension programmes.

Preamble: Celebrating 75th year of untiring service to the Nation by ICAR-CIFRI, Barrackpore addressing PMMSY- a Flagship Yojona of Govt. of India for all round development of marine and inland fisheries including aquaculture towards 'Doubling Farmers' Income' across India ensuring livelihood and nutritional security of vast array of people specially to malnourished. Ushering fisheries enhancement in reservoirs and wetlands, pollution benchmarking in Indian rivers in GIS platform coupled with maintaining e-flow in the rivers besides addressing hidden hunger through SIFs have been explored in the days to come to make India Atmanirbhar in Indian health of rural mass by 2025. □