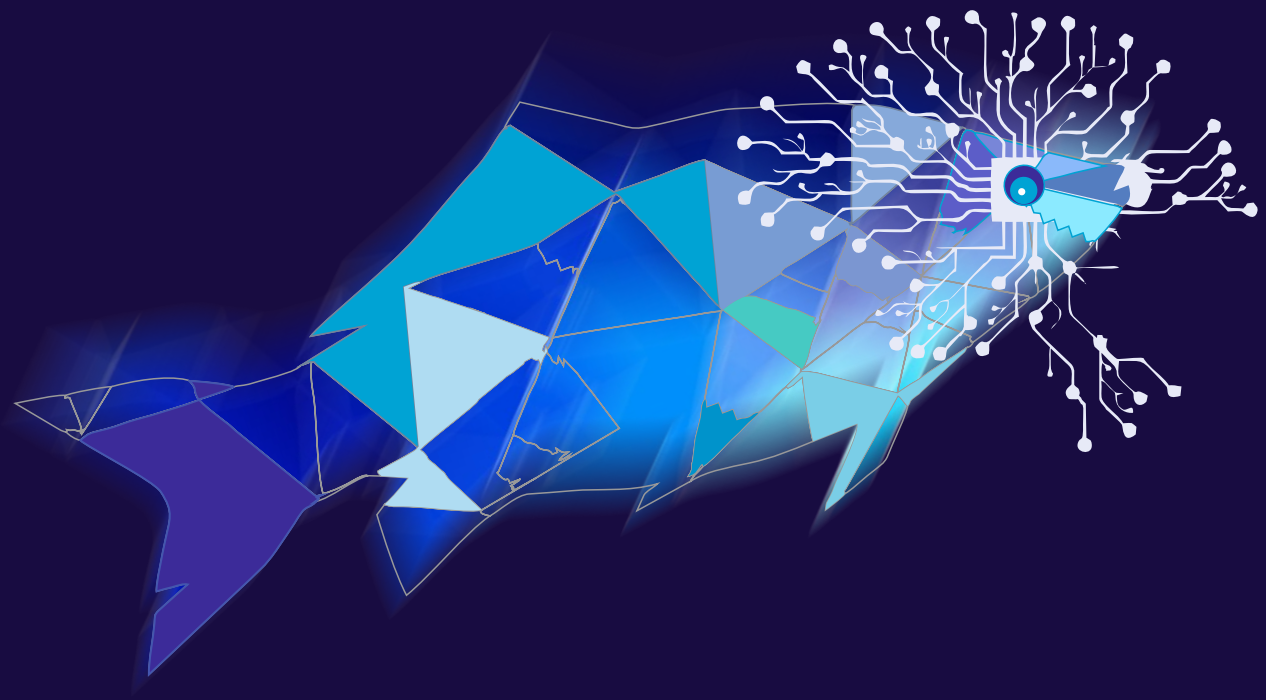
वार्षिक प्रतिवेदन
ANNUAL REPORT
2022



ICAR-CIFE
Mumbai

Certificate of Registration

This is to certify that

ICAR-CENTRAL INSTITUTE OF FISHERIES EDUCATION

PANCH MARG, OFF YARI ROAD, VERSOVA, ANDHERI (WEST), MUMBAI – 400061, MAHARASHTRA, INDIA

has been independently assessed by QRO

and is compliant with the requirement of:

ISO 9001:2015

Quality Management System

For the following scope of activities:

TO DEVELOP QUALIFIED HUMAN RESOURCES IN THE SPECIALIZED FIELD OF FISHERIES

Date of Certification: 18th November 2022
1st Surveillance Audit Due: 17th November 2023
2nd Surveillance Audit Due: 17th November 2024
Certificate Expiry: 17th November 2025

Certificate Number: 305022111814Q

Head of Certification

Validity of this certificate is subject to annual surveillance audits to be done successfully on or before 365 days from date of the audit.
(In case surveillance audit is not allowed to be conducted; this certificate shall be suspended / withdrawn).
The Validity of this certificate can be verified at www.qrocert.org
This certificate of registration remains the property of QRO Certification LLP, and shall be returned immediately upon request.

India Office : QRO Certification LLP
142, IInd Floor, Avtar Enclave, Near Paschim Vihar West Metro Station, Delhi-110063, (INDIA)
Website : www.qrocert.org, E-mail : info@qrocert.org

वार्षिक प्रतिवेदन
ANNUAL REPORT
2022

ICAR-Central Institute of Fisheries Education -
Mumbai-India -

Credits

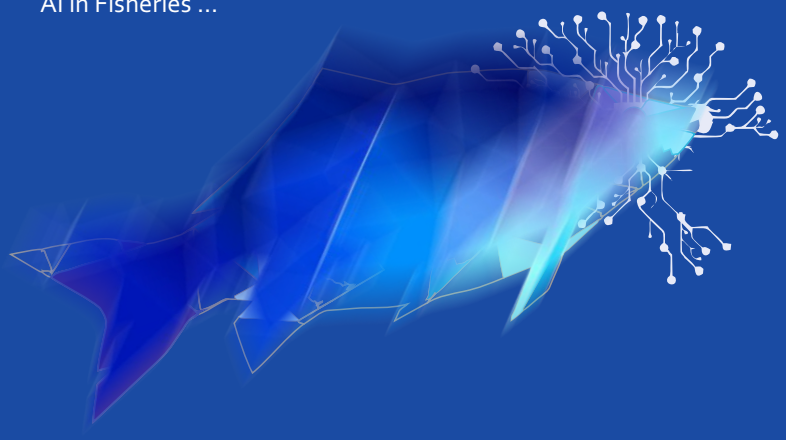
Citation:
ICAR-CIFE Annual Report (2022). ICAR-Central Institute of Fisheries Education, Mumbai, pp340

Published by
Dr Ravishankar C.N.
Director, ICAR-CIFE, Mumbai

Compiled and Edited by
Mr. Dayal Devadas
Mr. Abuthagir Iburahim. S
Dr. Shamna N.
Dr. Neha Wajahat Qureshi
Dr. Madhuri S. Pathak
Mr. Angom Lenin Singh
Dr. Saurav Kumar
Dr. Gouranga Biswas
Dr. Dasari Bhoomaiah
Dr. Ananthan P.S

Graphic Design and Photography
Dr. Dasari Bhoomaiah

Cover Page Picture
AI in Fisheries ...



Contents

Foreword

I am pleased to present the Annual Report of the Institute for the year 2022, an eventful year in the tradition of excellence in academics, research and outreach. Being **one of the top Agricultural Universities**, it continues to be the most preferred destination for fisheries graduates from across India and the Afro-Asian countries.

The Institute gives impetus to the overall development of students through national and overseas exposure. CIFE has organized several programmes that academically benefit students and expose them to wider aspects of science. Student accomplishments are duly rewarded by endowment awards and travel grants instituted in CIFE. The quality education and training conferred on students by CIFE is aptly reflected in their performances. CIFE scholars continue to corner most of the Assistant Professor placements in the NARS while making their presence felt across the globe through participation in many international conferences and prominent labs. Several other students are placed as fishery development officers, fisheries inspectors, assistant directors of fisheries in state government

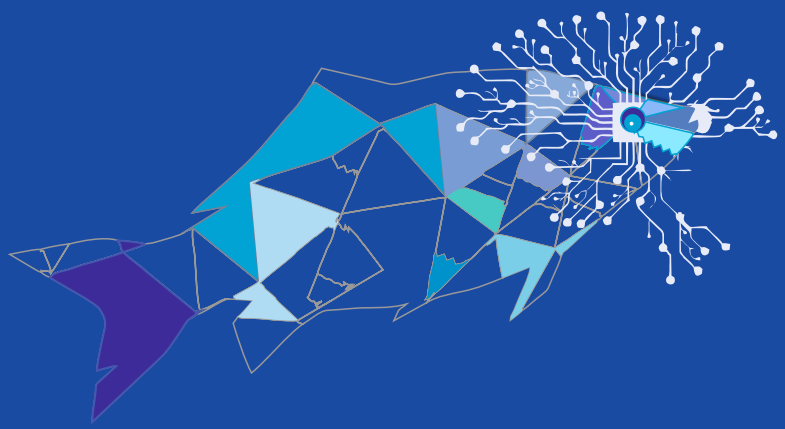
departments, teaching faculty in state fisheries colleges, private universities and in banking sector. CIFE has been engaged in frontline fisheries research with magnificent research contributions this year. Fourty two institutional and 11 externally funded projects were in operation during 2022. The institutional projects are on pertinent subjects intended to solve the problems of fisheries sector such as developing bioflocs using multiple carbon sources for high-yielding and organic small-scale aquaculture systems; package of practices for application of biochar in inland saline aquaculture system; cost-effective recirculatory aquaponic system (*Pangasius* grown with Spinach) for small-scale farmers/ households; Use of novel biofilter - *natural zeolite balls* – for GIFT tilapia based RAS; developed an *inactivated vaccine* against *F. columnare* using local field isolate of *F. columnare* and a *dual vaccine* against *F. columnare* and *E. tarda (patent filed);* developed TaqManquantitative real-time PCR - based diagnosis of assays for WSSV *(patent granted)* and hepatopancreatic parvovirus (HPV) for shrimp viral diseases, captive broodstock development, breeding and seed production technology of *Anabas testudineus, s*ignificant research and development on Indian magur genetics, selective breeding, genomics, and proteomics, accounting and valuation of human capital in Indian fisheries higher education. The quality of research efforts is evident from the publications in high impact journals. In 2022, the Institute has published 183 research papers in reputed national and international journals, 37 book chapters, 34 popular articles, 18 training manuals and 21 extension materials. The findings of laboratory research and the faculty expertise in various fields of fisheries has been disseminated downhill to the sector through skill development programmes, CAFT and short-term training programmes.

The fast-developing fisheries sector is in dire need of skilled workforce. Being an academic institute, CIFE has always given utmost priority to impart training in various aspects of fisheries. Short-term Training Programmes (STP) and Skill Development Programmes (SDP) are regularly conducted at CIFE headquarter as well as at its Centres. During 2022, 21 SDPs were organized which benefitted 586 farmers and youth across the country. Under Tribal Sub Plan & SCSP components 1807 tribal people were trained under 40 training programmes. We believe that the skill development trainings will empower the youth in terms of better employability and fulfil the needs of aquaculture and fish processing industries. The Institute actively pursues its endeavor to introduce youngsters into fisheries entrepreneurship through Agribusiness Incubation (ABI) Center. Other training and awareness programs conducted at ICAR-CIFE are included under North-East-Hill (NEH) region programme and various need based training programs.

In the pursuit of excellence, we sincerely acknowledge the support, guidance and continuous encouragement by Dr. Trilochan Mohapatra, Former Secretary (DARE) & Director General (ICAR) and Dr. Himanshu Pathak, Secretary (DARE) & Director General (ICAR) in all our endeavors. We are grateful to Dr. J. K. Jena, Deputy Director General (Fisheries Science) for his encouragement and support in all our activities. We thank other colleagues from the Fisheries Division for their co-operation and support. Our sincere thanks are due to the Members of Board of Management, Chairman and Members of Research Advisory Committee, Members of Academic Council, Institute Research Council, Extension Council, Board of Examiners and other institute-level committees for their cooperation and support. I especially acknowledge the support of Team CIFE and congratulate the publication team for bringing out this wonderful compilation of our activities.

(Ravishankar C. N.)
Director & Vice-Chancellor

Executive Summary
कायकारी साराश



ICAR-CIFE is an esteemed academic institution renowned for its outstanding teaching and research in the realm of fisheries science. Over the past six decades, it has made significant contributions to the advancement of the fisheries sector, meeting the requirements of both industry and academia since its establishment in 1961. The Institute has transformed from a training centre to a Deemed-to-be University and currently offers postgraduate programs in 11 specialized fields of fisheries science, employing highly qualified scientific and technical personnel. This year, 163 postgraduate students (96 MFSc and 67 Ph.D.) were admitted to the Institute through national-level entrance examinations. ICAR-CIFE has state-of-art research infrastructure and laboratory facilities at its headquarters and its five Centres, providing ample opportunities for scientists and students to translate their research concepts into practical solutions for the challenges in the fisheries sector. The institute remains committed to produce trained human resources who will continue to contribute to the development of the fisheries sector in diverse capacities as entrepreneurs, scientists, educators, consultants, and trainers.

After two years of grappling with COVID-19, the CIFE adapted well to the new normal. The virtual mode that was adopted during the pandemic evolved into a hybrid mode, paving the way for exploring new opportunities to ensure optimal utilization of resources. This transformation enabled the Institute to achieve its goals with minimal drawbacks. Although regular educational activities, such as teaching, examinations, evaluations, etc., were conducted offline, many programs, external *viva voce,* and result declarations were completed in a hybrid mode.

CIFE boasts an extensive academic breadth, spanning 6 specialized departments and 5 Centres equipped with up-to-date laboratories and farm facilities. The Institute has a diverse and distinguished faculty, with over 90% of them holding a Ph.D. and hailing from the best universities in India and leading universities worldwide. CIFE prides itself on being a progressive and genuinely multicultural institution, with students and faculty from all corners of India, and international students adding to the already colorful cross-cultural experience on campus. The Institute's alumni, including over 2500 trailblazers, are driving the aquaculture engine across the globe as a part of excellent research teams. CIFE maintains an excellent faculty-student ratio with a focus on one-to-one interaction and student accomplishments. While full-time degree courses remain the flagship, the institute also offers need-based customized programs such as the Professional Development Program (PDP), Entrepreneurial Development Program (EDP), and short-term demand-driven and customized Skill Development Programs (SDPs) that create a pool of competent para-professionals and confident entrepreneurs. In 2022, 140 theses were submitted, including 47 Ph.D. and 93 M.F.Sc theses.

CIFE's research initiatives aim to achieve two objectives: scientific progress and stakeholders' welfare. As of 2022, a total of 53 research projects were operational, with 11 being externally funded with a budget outlay of about INR 30 crores, while 42 were institutionally funded. These projects concentrated on fisheries-related areas that resulted in significant progress, such as publishing research papers or developing technological solutions. One such solution is CIFE's technological package for shrimp aquaculture in inland saline areas, which is transforming the degraded ecosystem in Haryana, Punjab, and Rajasthan by creating wealth from waste and providing sustainable livelihoods. CIFE has also made notable progress in various areas, such as developing biofloc, creating a package of practices for biochar application, and designing a cost-effective aquaponic system for small-scale farmers. Additionally, CIFE has filed patents for developing a protein concentrator, RAS integrated portable live-worm rearing system, leather fabric from fish-skin using unique chemical process, and processes for microencapsulation of chemical and biological products for input use efficiency. Furthermore, copyright has been filed for CIFE's new methodology on human capital valuation in Indian fisheries higher education while copyright has been granted for Gender Analysis Tool for Fisheries and Aquaculture. Lastly, CIFE's research work on Indian magur genetics, selective breeding and genomics have produced significant outcomes. The basket of laurels included transfer of four technologies to the industry and entrepreneurs namely medicated feed against fish lice, the first-ever fish vaccine against bacterial disease Edwardsillosis and Columnaris, Photobioreactor for microalgae biomass production, and a unique prawn pickle recipe.

During 2022, publications by CIFE scientists and student-scholars reached a new high: a total of **183 peer reviewed research articles** with **122** in **international and 59** in **National** journals with an all time high **average NAAS Score of 8** (NAAS>10= 43 papers, NAAS (10<6.0)= 99, NAAS (<6.0) = 41. Further, 8 books, 37 book chapters, 34 popular articles, 1 policy paper, 18 training manuals, and 21 extension materials. The faculty delivered 54 invited talks in national and international fora.

CIFE and its Centres conducted **21** skill development programs (SDPs) in 2022 benefiting **586 trainees** from different parts of the country. The training programs covered diverse topics encompassing both basic areas and advanced themes such as geospatial analysis using open-source software, prospects of biofloc technology in aquaculture, advanced computational tools for molecular genetics, molecular biology and bioinformatics, IPR in fisheries sector, microbiological quality testing of seafood, spirulina biomass production and utilization, health management in freshwater aquaculture, ISO/IEC 17025-Competency for testing and calibration of laboratories, fish taxonomy and biology, and fish and prawn culture.

Under the SCSP and TSP components, CIFE conducted **40** training programmes in Maharashtra, Haryana, Punjab, Rajasthan, Bihar, Jharkhand, Andhra Pradesh, Kerala, West Bengal, Assam, Tripura, Manipur and Sikkim benefiting as many as 1,807 rural men, women and youth from marginalised communities. It focused on aquaculture based livelihood development and consisted of introductory courses on freshwater aquaculture basics, feed based fish farming, farm-made aquafeed preparation using leaf meal and locally available ingredients, ornamental fish breeding & culture, cage farming in reservoirs as a potential livelihood option for tribal communities, integrated fish farming, biofloc technology in aquaculture, zero-waste aquaculture, and value-added fish products. Besides, 10 training programmes were conducted with a special focus on north eastern states covering Arunachal Pradesh, Tripura, Manipur, Assam, Nagaland, Mizoram and Nagaland that benefitted 419 participants.

The year 2022 has been an eventful year for ICAR-CIFE, as it celebrated 15th Convocation on 23rd April, 2022 that was graced by the Shri Parshottam Rupala, Hon'ble Minister of Fisheries, Animal Husbandry and Dairying. Alongside, CIFE celebrated Alumni meet - **VariSmriti**, a cultural event - **Swar Sangam,** and one of its kind and the first boutique fish festival - **FISH SWAD -** showcasing different fish cuisines from across Indian states. We organised ***Directors Conclave****: Energising Pathways for Fisheries Development* during 4-5th November 2022, bringing together Directors and representatives of as many as 25 State/UT DoF on a single platform to discuss developmental challenges and identify actionable strategies at Mumbai, with the support of National Fisheries Development Board (NFDB). **Shri Jatindra Nath Swain,** Secretary, Fisheries, GoI called it a *path breaking* initiative to strengthen the extension system and reorient the development support to achieve the ambitious targets under PMMSY.

ICAR-CIFE not only has a record of impressive accomplishments, but also prioritizes eco-friendly practices such as conserving water resources through rainwater harvesting and wastewater utilization for aquaculture, optimizing energy with solar street lights and LED bulbs, adopting green building concepts, and implementing Swacchta Action Plan for fish markets. Additionally, the University values maintaining greenery and diversity of plants by planting indigenous species and prohibiting the use of single-use plastic in the Campus. The University conducted its statutory meetings namely Research Advisory Committee (RAC), Institutional Research Committee (IRC), Academic Council, Extension Council and Board of Management with rigour. The Institute observed the vigilance awareness week, International Yoga day, Swachhta Abhiyaan, Hindi *Pakhwada*, Industry Day, Farmers' Day, Constitution Day, National Science Day, Republic Day, and Independence Day with spirit.

ICAR-CIFE is deeply committed to the national goals of promoting fisheries and aquaculture while ensuring sustainability and improving the livelihoods and income of fishers and farmers. The University believes that in order to achieve strong and sustained development of fisheries, quality education and its translation in the field are a necessity. With the help of dedicated faculty, administration, and ICAR's support, the Institute will continue to contribute to the betterment of the fisheries sector and society.

कार्यकारी सारांश

भाकृअनुप-के.मा.शि.सं. मात्स्यिकी विज्ञान के क्षेत्र में अपने उत्कृष्ट शिक्षा एवं अनुसंधान के लिए प्रसिद्ध एक सम्मानित शैक्षणिक संस्थान है। पिछले छह दशकों में, अर्थात इसने 1961 में अपनी स्थापना के बाद से उद्योग और शिक्षा दोनों की आवश्यकताओं को पूरा करते हुए मत्स्य पालन क्षेत्र की उन्नति में महत्वपूर्ण योगदान दिया है। संस्थान एक प्रशिक्षण केंद्र से एक समतुल्य विश्वविद्यालय में बदल गया है और वर्तमान में मत्स्य विज्ञान के 11 विशेष क्षेत्रों में स्नातकोत्तर कार्यक्रम संचालित करता है, जिसमें अत्यधिक योग्य वैज्ञानिक एवं तकनीकी कर्मचारी कार्यरत हैं। इस वर्ष, 163 स्नातकोत्तर छात्रों (96 एमएफएससी और 67 पीएचडी) को राष्ट्रीय स्तर की प्रवेश परीक्षाओं के माध्यम से संस्थान में प्रवेश दिया गया। भाकृअनुप-के.मा.शि.स. के मुख्यालय और इसके पांच केंद्रों में अत्याधुनिक अनुसंधान संरचना और प्रयोगशाला सुविधाएं हैं, जो वैज्ञानिकों और छात्रों को मत्स्य पालन क्षेत्र में चुनौतियों के व्यावहारिक समाधान में अपनी शोध अवधारणाओं को साकार करने के लिए पर्याप्त अवसर प्रदान करती हैं। संस्थान प्रशिक्षित मानव संसाधन तैयार करने के लिए प्रतिबद्ध है, जो उद्यमियों, वैज्ञानिकों, शिक्षकों, सलाहकारों और प्रशिक्षकों के रूप में विभिन्न क्षमताओं में मत्स्य पालन क्षेत्र के विकास में योगदान देना जारी रखेंगे।

COVID-19 से जूझने के दो साल बाद, CIFE ने अच्छी तरह से अपने को अनुकूलित किया है। महामारी के दौरान अपनाया गया वर्चुअल मोड हाइब्रिड मोड में विकसित हुआ, जिससे संसाधनों का इष्टतम उपयोग सुनिश्चित करने के लिए नए अवसरों की खोज का मार्ग प्रशस्त हुआ। इस त्वरित परिवर्तन ने संस्थान को कम से कम कमियों के साथ अपने लक्ष्यों को प्राप्त करने में सक्षम बनाया। यद्यपि नियमित शैक्षिक गतिविधियाँ, जैसे कि शिक्षण, परीक्षा, मूल्यांकन आदि, ऑफ़लाइन आयोजित की गईं, कई कार्यक्रम, बाहरी मौखिक परीक्षा, और परिणाम घोषणाएं हाइब्रिड मोड में पूरी की गईं।

के. मा. शि॰ सं. के 6 विभागों एवं 5 उपकेंद्रों में फैला हुआ यह एक व्यापक शैक्षणिक संस्थान है, जो अद्यतन प्रयोगशालाओं और कृषि सुविधाओं से सुसज्जित है। संस्थान के विविध एवं प्रतिष्ठित संकाय जिनमें से 90% से अधिक पीएच.डी. और भारत के सर्वश्रेष्ठ विश्वविद्यालयों और दुनिया भरके अग्रणी विश्वविद्यालयों से सम्मानित संकाय सदस्य हैं । के. मा. शि॰ सं. भारत के सभी कोनों से छात्रों और शिक्षकों के साथ एक प्रगतिशील और वास्तविक रूप से बहुसांस्कृतिक संस्थान होने पर गर्व करता है, और अंतर्राष्ट्रीय छत्रों को पहले से ही रंगीन क्रॉस-सांस्कृतिक अनुभव से जोड़ता हैं। संस्थान के पूर्व छात्र, जिनमें 2500 से अधिक ट्रेलब्लेज़र शामिल हैं, उत्कृष्ट अनुसंधान टीमों के एक भाग के रूप में दुनिया भर में एक्काकल्चर इंजन चला रहे हैं। के. मा. शि॰ सं. एक-से-एक आपसी संबाद एवं छात्र उपलब्धियों पर ध्यान देने के साथ एक उत्कृष्ट संकाय-छात्र अनुपात बनाए रखता है जबकि पूर्णकालिक डिग्री पाठ्यक्रम , संस्थान व्यावसायिक विकास कार्यक्रम (पीडीपी), उद्यमशीलता विकास कार्यक्रम (ईडीपी), और अल्पकालिक मांग-संचालित और अनुकूलित कौशल विकास कार्यक्रम (एसडीपी) जैसे आवश्यकता-आधारित अनुकूलित कार्यक्रम भी प्रदान करता है जो सक्षम पैरा-पेशेवरों और आत्मविश्वासी उद्यमियों का एक पूल तैयार करता है। 2022 में, 140 शोध प्रबंध प्रस्तुत किए गए, जिनमें 47 पीएच.डी. और 93 एम.एफ.एससी थीसिस थे ।

के. मा. शि॰ सं. की अनुसंधान पहलुओं का लक्ष्य दो उद्देश्यों को प्राप्त करना है: वैज्ञानिक प्रगति एवं हितधारकों का कल्याण। 2022 तक, कुल 53 अनुसंधान परियोजनाएं चालू थीं, जिनमें से 11 परियोजनाओं को 30 करोड़ रुपये के बजट परिव्यय के साथ बाह्य रूप से वित्त पोषित किया गया था, जबकि 42 को संस्थागत रूप से वित्त पोषित किया गया था। ये परियोजनाएँ मत्स्य-संबंधी क्षेत्रों पर केंद्रित थीं, जिसमे परिणामस्वरूप महत्वपूर्ण प्रगति हुई, जैसे शोध पत्र प्रकाशित करना या तकनीकी समाधान विकसित करना। ऐसा ही एक समाधान अंतर्देशीय लवणीय क्षेत्रों में झींगा पालन के लिए सीआईएफई का तकनीकी पैकेज है, जो कचरे से संपत्ति बनाकर और स्थायी आजीविका प्रदान करके हरियाणा, पंजाब और राजस्थान में विकृत हुए पारिस्थितिकी तंत्र को बदल रहा है। के. मा. शि॰ सं. ने विभिन्न क्षेत्रों में भी उल्लेखनीय प्रगति की है, जैसे कि बायोफ्लॉक विकसित करना, बायोचार अनुप्रयोग के लिए प्रथाओं का एक पैकेज तैयार करना, और छोटे पैमाने के किसानों के लिए लागत प्रभावी एक्वापोनिक प्रणाली डिजाइन करना। इसके अतिरिक्त, के. मा. शि॰ सं. ने इनपुट उपयोग दक्षता के लिए एक प्रोटीन सांद्रक, RAS एकीकृत पोर्टेबल लाइव-वर्म पालन प्रणाली, और रासायनिक और जैविक उत्पादों के माइक्रोएन्कैप्सुलेशन के लिए प्रक्रियाओं को विकसित करने हेतु पेटेंट दायर किया है। इसके अलावा, भारतीय मात्यिसिकी उच्च शिक्षा में मानव पूंजी मूल्यांकन पर के. मा. शि॰ सं. की नई कार्यप्रणाली के लिए कॉपीराइट दायर किया गया है। अंत में, भारतीय मागुर आनुवंशिकी, चयनात्मक प्रजनन, जीनोमिक्स, अपशिष्ट उपयोग, जलवायु परिवर्तन और प्रोटिओमिक्स पर के. मा. शि॰ सं. का शोध कार्य महत्वपूर्ण रहा है। उपलब्धि की टोकरी में और अधिक सम्मान जोड़ते हुए, चार तकनीकों को हितधारकों को हस्तांतरित किया गया; झींगा अचार, मछली के जूँ के खिलाफ औषधीय फ़ीड, जीवाणु रोग एडवर्ड्सिलोसिस और कॉलमनेरिस के खिलाफ पहली बार मछली का टीका, और सूक्ष्म शैवाल बायोमास उत्पादन के लिए फोटोबायोरिएक्टरपर करी किया गया।

रिपोर्टाधीन वर्ष में, के. मा. शि॰ सं. ने 181 शोध लेख प्रकाशित किए, 122 अंतर्राष्ट्रीय और 59 राष्ट्रीय सहकर्मी-समीक्षित पत्रिकाओं में 8 के औसत NAAS स्कोर (NAAS>10= 43 पेपर, NAAS (10<6.0)= 98, NAAS) के साथ (<6.0) = 40. आगे, के. मा. शि॰ सं. से 8 पुस्तकें, 37 पुस्तक अध्याय, 34 लोकप्रिय लेख, 01 नीति पत्र, 18 प्रशिक्षण नियमावली, और 21 विस्तार सामग्री भी प्रकाशित की गईं। के. मा. शि॰ सं. के संकाय सदस्यों ने राष्ट्रीय और अंतरराष्ट्रीय स्तर पर 54 आमंत्रित वार्ताएं कीं ।

2022 के दौरान, के. मा. शि॰ सं. एवं इसके केंद्रों ने 18 कौशल विकास कार्यक्रम (SDPs) आयोजित किए, जिसमें देश के विभिन्न हिस्सों से 393 प्रशिक्षुओं ने भाग लिया। प्रशिक्षण कार्यक्रमों में ओपन-सोर्स सॉफ्टवेयर का उपयोग करते हुए भू-स्थानिक विश्लेषण, एक्काकल्चर में बायोफ्लोक प्रौद्योगिकी की संभावनाएं, सीफूड का माइक्रोबायोलॉजिकल गुणवत्ता परीक्षण- उपकरण और तकनीक, स्पिरुलिना बायोमास उत्पादन और उपयोग के लिए तकनीकी ज्ञान, मीठे पानी की मछली पालन में स्वास्थ्य प्रबंधन जैसे विविध विषयों को शामिल किया गया। , मछलियों के वर्गीकरण और जैविक अध्ययन के लिए बुनियादी उपकरण, आणविक आनुवंशिकी के लिए बुनियादी और उन्नत कम्प्यूटेशनल उपकरण, आणविक जीव विज्ञान और जैव सूचना विज्ञान उपकरण और अनुप्रयोग, मत्स्य पालन क्षेत्र में बौद्धिक संपदा अधिकार, परीक्षण

और अंशांकन प्रयोगशालाओं की क्षमता के लिए आईएसओ/आईईसी17025-सामान्य आवश्यकताएं भाकृअनुप-के.मा.शि°सं.काकीनाडा केंद्र में मछली और झींगा पालन हेतु किया गया।

एससीएसपी घटक के तहत, के. मा. शि° सं. ने एस.सी. समुदाय के विकास के लिए कई प्रशिक्षण कार्यक्रम आयोजित किए हैं। 2022 के दौरान केरल, पश्चिम बंगाल, आंध्र प्रदेश, झारखंड, बिहार, हरियाणा, राजस्थान और पंजाब में कुल 23 प्रशिक्षण कार्यक्रम आयोजित किए गए, जिनमें 1191 प्रतिभागी लाभान्वित हुए। प्रशिक्षण कार्यक्रमों में जैसे विषय शामिल थे; -- फ़ीड आधारित मछली पालन, फार्म-निर्मित एक्काफ़ीड की तैयारी और फार्म-फ़ीड प्रबंधन, सजावटी मछली प्रजनन और पालन,आजीविका में सुधार के लिए बुनियादी एक्काकल्चर प्रथाओं, मीठे पानी के एक्काकल्चर के आधुनिक तरीके, फ़ीड आधारित एक्काकल्चर और ऑन-फ़ार्म पर पत्ते के भोजन का प्रदर्शन और तैयारी मछली पालकों के लिए आहार प्रबंधन, मछली प्रसंस्करण और मूल्य वर्धित मछली उत्पाद और आजीविका विकल्पों के रूप में एक्काकल्चर तकनीकें आदि।

टीएसपी के अंतर्गत 2022 के दौरान महाराष्ट्र, त्रिपुरा, मणिपुर, सिक्किम, दार्जिलिंग, झारखंड और पश्चिम बंगाल में कुल 17 प्रशिक्षण कार्यक्रम आयोजित किए गए, जिससे 616 प्रतिभागियों को लाभ हुआ। इसमे कवर किए गए क्षेत्र थे; बेहतर आय सृजन और आजीविका में सुधार के लिए मत्स्य फ़ीड तैयार करने के लिए स्थानीय रूप से उपलब्ध सामग्री का उपयोग, जनजातीय समुदायों के लिए एक संभावित आजीविका विकल्प के रूप में जलाशयों में पिंजरे की खेती, मीठे पानी के एक्काकल्चर में फ़ीड और फीडिंग के तरीके, सजावटी मछली प्रजनन और संस्कृति,

एकीकृत मछली पालन, जलीय कृषि में बायोफ्लोक प्रौद्योगिकी, मछली किसानों के लिए मीठे पानी की जलीय कृषि में प्रगति, मछली का शून्य-अपशिष्ट उपयोग और मीठे पानी की जलीय कृषि के आधुनिक तरीके आदि।

2022 के दौरान भाकृअनुप-के.मा.शि°सं ने एनईएच योजना के तहत कई प्रशिक्षण कार्यक्रम आयोजित किए। लॉन्च वर्कशॉप सहित अरुणाचल प्रदेश, त्रिपुरा, मणिपुर, असम, नागालैंड, मिजोरम और नागालैंड में कुल 10 प्रशिक्षण कार्यक्रम आयोजित किए गए। कुल 419 प्रतिभागी लाभान्वित हुए इसमे कवर किए गए क्षेत्र थे; मूल्य वर्धित मछली उत्पादों के लिए बाजार नेटवर्किंग, टिकाऊ जलीय कृषि प्रथाओं में प्रगति, मछली आधारित एकीकृत कृषि प्रणाली में अपस्केलिंग और मछली स्वास्थ्य प्रबंधन, सतत जलीय कृषि के आधुनिक तरीके, मूल्य वर्धित मछली उत्पादों की तैयारी और पैकेजिंग, एकीकृत मछली पालन और सतत मीठे पानी जलकृषि प्रणाली।

वर्ष 2022 भाकृअनुप-के.मा.शि°सं के लिए एक घटनापूर्ण वर्ष रहा है, इसने 23 अप्रैल, 2022 को 15वां दीक्षांत समारोह मनाया। मत्स्य पालन, पशुपालन और डेयरी मंत्री, भारत सरकार, माननीय श्री पुरुषोत्तम रूपाला समारोह के मुख्य अतिथि थे। डॉ. त्रिलोचन महापात्र, सचिव, कृषि अनुसंधान एवं शिक्षा विभाग (डेयर), भारत सरकार के और महानिदेशक, भारतीय कृषि अनुसंधान परिषद (ICAR) ने समारोह की अध्यक्षता की। डॉ. जे. के. जेना, डीडीजी (मत्स्य) आईसीएआर, विधायक माननीय श्री गोपाल शेट्टी और स्थानीय विधायक डॉ. भारती लावेकर ने इस अवसर पर सम्मानित अतिथि के रूप में शिरकत की। इसके बाद भारत के विभिन्न मछली व्यंजनों का जश्न, राष्ट्रीय मत्स्य विकास बोर्ड (NFDB), हैदराबाद के सहयोग से 24 अप्रैल, 2022 को पूर्व छात्रों की बैठक- वरिस्मृति, एक सांस्कृतिक कार्यक्रम- स्वर संगम तथा पहला और अनूठा मछली उत्सव (FISH SWAD) का आयोजन हुआ। घरेलू मछली की खपत में वृद्धि करना और प्रधान मंत्री मत्स्य संपदा योजना (पीएमएसएसवाई) के बारे में जागरूकता पैदा करना, मत्स्य स्वाद महोत्सव-2022 का उद्घाटन श्री जतीन्द्र नाथ स्वैन, आईएएस, सचिव, मत्स्य पालन विभाग, सरकार द्वारा किया गया। भारत सरकार, डॉ. सी. सुवर्णा, मुख्य कार्यकारी, राष्ट्रीय मत्स्य विकास बोर्ड (एनएफडीबी), हैदराबाद, और डॉ. जे. के. जेना, उप महानिदेशक, मात्स्यिकी, भारतीय कृषि अनुसंधान परिषद, नई दिल्ली के कर–कमलों से किया गया।

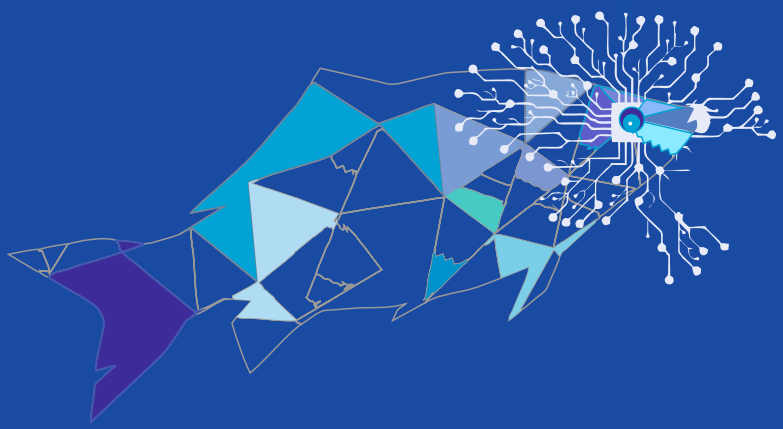
भाकृअनुप-के.मा.शि.सं. ने मुंबई में 4-5 नवंबर 2022 के दौरान एक पथ प्रवर्तक निदेशक सम्मेलन: मत्स्य विकास के लिए ऊर्जावान रास्ते कार्यक्रम का आयोजन किया। भारत सरकार के मत्स्य विभाग के सचिव श्री जतिंद्रनाथ स्वैन ने इसे एक पथप्रदर्शक बैठक बताते हुए सीआईएफई में दो दिवसीय निदेशक सम्मेलन में उपस्थित राज्य मत्स्य विभागों के निदेशकों और उनके प्रतिनिधियों से आग्रह किया कि वे विस्तार प्रणाली को मजबूत करें। 2025 तक प्रधानमंत्री मत्स्य संपदा योजना (पीएमएमएसवाई) के तहत निर्धारित महत्वाकांक्षी लक्ष्यों को प्राप्त करें। भा कृ अनु प –केंद्रीय मात्स्यिकी शिक्षा संस्थान , मुंबई ने राष्ट्रीय मत्स्य विकास बोर्ड (एनएफडीबी) के साथ संयुक्त रूप से 25 राज्य/केंद्र शासित प्रदेशों के निदेशकों और प्रतिनिधियों को एक साथ लाया। विकासात्मक चुनौतियों पर चर्चा करने और कार्रवाई योग्य रणनीतियों की पहचान करने के लिए डीओएफ एक मंच पर आए।

भाकृअनुप –के.मा.शि.सं के पास न केवल प्रभावशाली उपलब्धियों का रिकॉर्ड है, बल्कि वर्षा जल संचयन और जलीय कृषि के लिए अपशिष्ट जल उपयोग के माध्यम से जल संसाधनों के संरक्षण, सौर स्ट्रीट लाइट और एलईडी बल्बों के साथ ऊर्जा का अनुकूलन, हरित भवन अवधारणाओं को अपनाने और कार्यान्वयन जैसे पर्यावरण के अनुकूल प्रथाओं को भी प्राथमिकता देता है। अपशिष्ट प्रबंधन और खाद के अतिरिक्त, संस्था स्वदेशी प्रजातियों को लगाकर और परिसर के भीतर एकल-उपयोग प्लास्टिक के उपयोग पर रोक लगाकर हरियाली और पौधों की विविधता को बनाए रखने को महत्व देता है।

2022 में, संस्थान ने अनुसंधान सलाहकार समिति (RAC), संस्थागत अनुसंधान समिति (IRC), अकादमिक परिषद, विस्तार परिषद और प्रबंधन बोर्ड जैसी वैधानिक बैठकें आयोजित कीं। संस्थान ने सतर्कता जागरूकता सप्ताह, योग दिवस, स्वच्छता अभियान, हिंदी पखवाड़ा, उद्योग दिवस, किसान दिवस और गणतंत्र और स्वतंत्रता दिवस मनाया।

भाकृअनुप –के.मा.शि.सं स्थिरता सुनिश्चित करते हुए और मछुआरों/किसानों की आजीविका और आय में सुधार करते हुए मत्स्य पालन और जलीय कृषि को बढ़ावा देने के राष्ट्रीय लक्ष्यों के लिए गहराई से प्रतिबद्ध है। संस्थान का मानना है कि मत्स्य पालन के मजबूत और निरंतर विकास को प्राप्त करने के लिए गुणवत्तापूर्ण शिक्षा और अनुसंधान ज्ञान को विकास की जड़ों तक पहुँचाने की आवश्यकता है। समर्पित संकाय, प्रशासन और भा.कृ.अनु.प., नई दिल्ली के समर्थन से संस्थान विशेष रूप से मत्स्य क्षेत्र और सामान्य रूप से समाज की बेहतरी में निरंतर योगदान देना जारी रखेगा।

01 Introduction



ICAR-CIFE: Educating Excellence

ICAR-Central Institute of Fisheries Education (ICAR-CIFE), Mumbai, is the first and leading national University imparting quality Fisheries Education under the ambit of Indian Council of Agricultural Research. It has gained a reputation as a prestigious Institution in the field of fisheries education and research over the past 60 years, producing a talented group of specialized professionals, pioneering researchers, and practical technological solutions for the benefit of fishers, fish farmers, industry and entrepreneurs. CIFE boasts state-of-art facilities in a peaceful setting and has established five regional Centres across different aqua-climatic regions in Rohtak (Haryana), Kolkata (West Bengal), Powarkheda (Madhya Pradesh), Kakinada (Andhra Pradesh), and Motihari (Bihar). Initially established in 1961 under the Ministry of Agriculture, Government of India with support from FAO/UNDP, its mandate was to strengthen the capacity of state fisheries departments and their personnel. In 1979, it became part of Indian Council of Agricultural Research (ICAR), and in 1989, it transformed into a university dedicated to education, research, and extension. The University has educated more than 2500 prominent scholars and developed the professional skills of over 5000 development professionals from India and the Afro-Asian region with a strong focus on quality education. ICAR-CIFE offers post-graduate programs in 11 specialized disciplines in fisheries and aquaculture sciences with around 100 Masters and 75 doctoral seats every year, as well as demand-driven diploma programs, certificate courses, and customized short-term training programs. ICAR-CIFE has developed an ecosystem of teaching and research excellence, making it a preferred destination for students and scholars. Its broad range of disciplines, advanced facilities, research networks within and beyond the country, and supportive work environment provide unparalleled opportunities for exploration, excellence, and leadership in shaping the future of the fisheries sector.

Mission

To achieve academic and research excellence

Vision

To be a world-class organisation providing leadership in fisheries education and research

Mandate

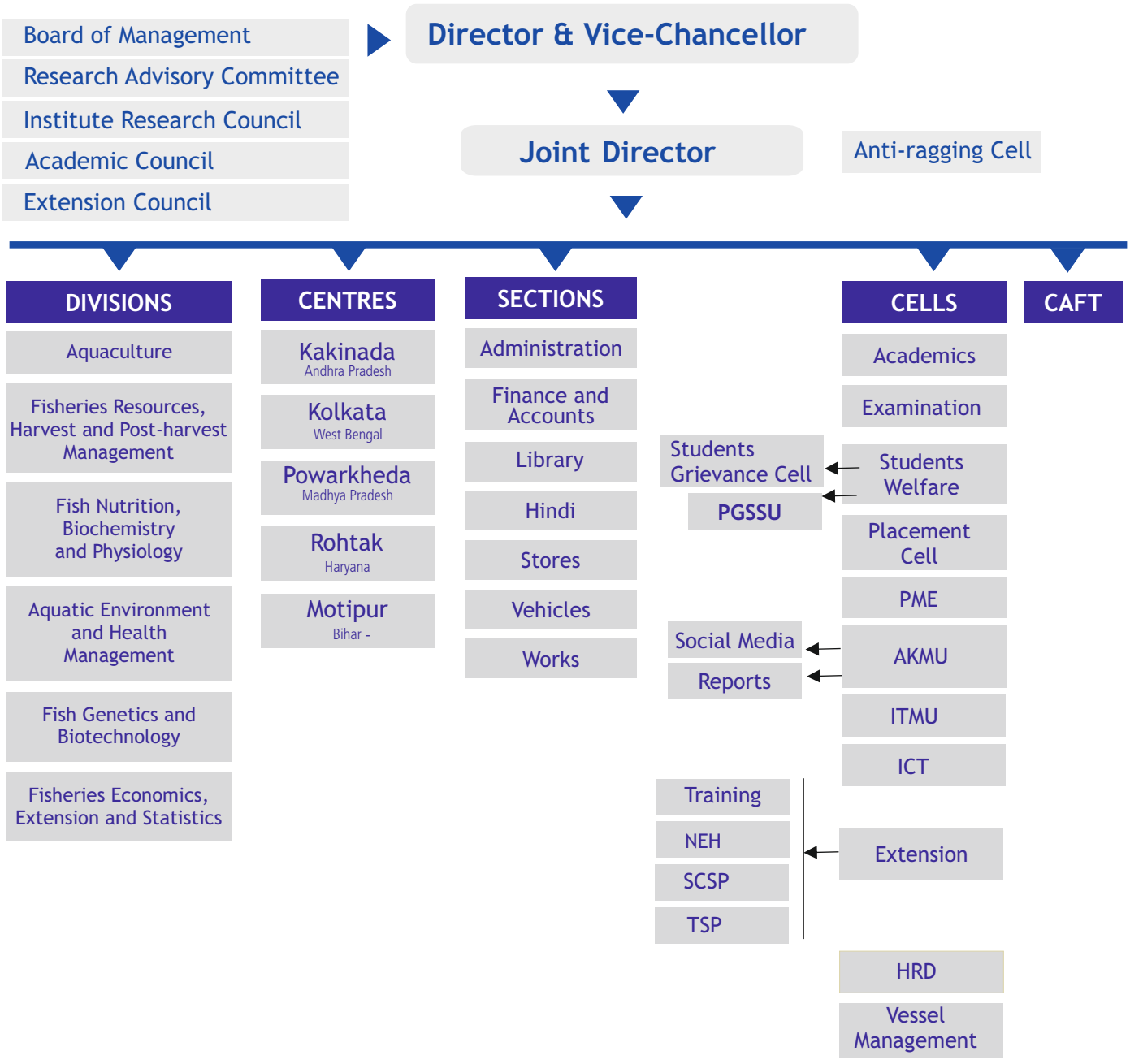
Conduct post-graduate programmes in fisheries science

Basic and strategic research in frontier areas of fisheries science

Human Resource Development, capacity building and skill development through training, education & extension

Organogram

ICAR-CIFE, Mumbai



Board of Management

Chairman
Dr. Ravishankar C.N., Director, CIFE

Members
Shri Eknath Dawale
Shri S.K.Singh
Dr. N.P. Sahu
Dr. K.V. Rajendran
Dr. S.N. Ojha
Dr. B.B. Nayak
Dr. Kishore Kumar Krishnani
Dr. Aparna Chaudhari
Dr. S. Jahageerdar
Dr. Subodh Gupta
Dr. Parimal Sardar
Dr. K. Pani Prasad
Dr. Gayatri Tripathi
Dr. R.C. Srivastava
Dr. A. Gopalakrishnan
Dr. Basanta Kumar Das
Dr. G. Gopikrishna
Dr. R.K. Singh
Shri B. Kishore Kumar Kundapura
Shri Dinesh Prakash Kulkarni
Shri R.K. Singh

Member Secretary
Shri Rajeev Lal

Extension Council

Chairman
Dr. Ravishankar C.N., Director, CIFE

Members
Dr. Kuldeep Kumar Lal
Dr. A.K.Singh
Dr. N. P. Sahu
Dr. K. V. Rajendran
Dr. N. K. Chadha
Dr. S. N. Ojha
Dr. B. B. Nayak
Dr. Aparna Chaudri
Dr. N.S.Nagpure
Dr. G.H.Pailan
Dr. S.Dasgupta
Dr. Sanath Kumar
Dr. Murlidhar Ande
Dr. Sunil Kumar Nayak
Dr. Md.Aklakur
Dr. Basanta Kumar Das
Dr. Shivaji Argade

Member Secretary
Dr. Arpita Sharma

*RAC

Chairman
Dr. K. Gopakumar

Members
Dr. J. K. Jena
Dr. E. Vivekanandan
Dr. Ravishankar
Dr. Rina Chakrabarti
Dr. C.G. Joshi
Dr. K.M. Shankar
Dr. Gopal Krishna

Member Secretary
(Dr. K. Pani Prasad (Member Secretary)

*Research Advisory Committee

Academic Council

Chairman
Dr. Ravishankar C.N. ,Director, CIFE

Members
Dr. R.C. Agrawal,
Dr. N.P. Sahu,Joint Director,CIFE
Dr. K.V. Rajendran
Dr. Swadesh Prakash
Dr. B.B. Nayak
Dr. Kishore Kumar Krishnani
Dr. Aparna Chaudhari
Dr. S.N. Ojha
Dr. S. Jahageerdar
Dr. Subodh Gupta
Dr. G.H. Pailan
Dr.Arpita sharma
Dr. Pani Prasad
Dr. R.P. Raman
Dr. Parimal Sardar
Dr. Rupam Sharma
Dr. Gayatri Tripathi
Dr. Ashutosh D. Deo
Dr. Babitha Rani A.M
Dr. Sonwane Arvind Asaram
Dr. Gouranga Biswas
Dr. K. Syamala
Dr. Arun Sharma
Dr. T.I. Chanu
Dr. Nazir Ah. Ganai
Dr. A. K. Singh
Dr. G. Sugumar
Dr. K. K. Lal
Dr. P.K. Sahoo
Dr. Triveni Dutt
Dr. S.D. Sawant
Mr. Arphit Acharya
Mr. Ramjanul Haque
Ms. Dave Chandani

Member Secretary
Shri Rajeev Lal

3.3. Staff Position (2022)

Category Wise

CIFE Staff	Sanctioned	In position	Vacant
RMP	02	02	00
Scientific	107	83	24
Technical	104	39	65
Administrative	80	38	42
Skilled Supporting	46	32	14
Total	**339**	**194**	**145**

3.4. Budget (2022)

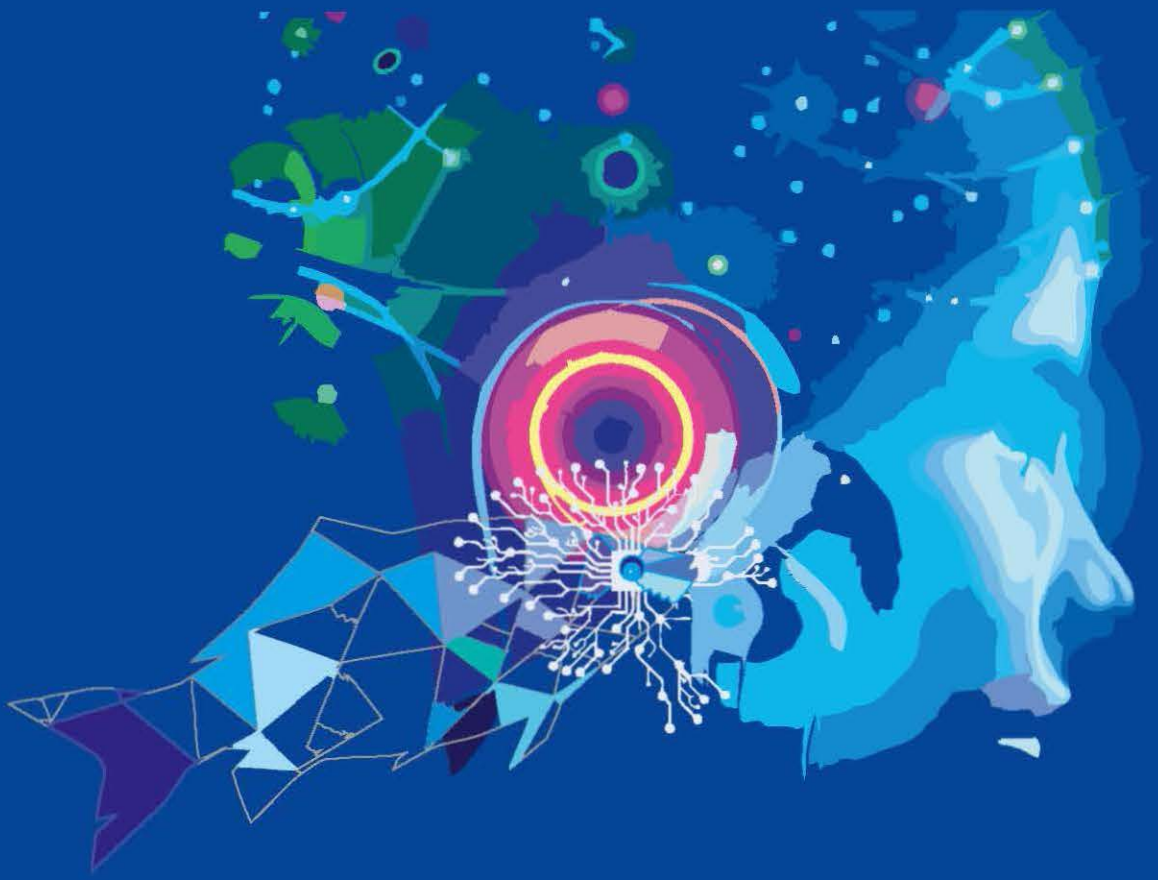
Rs. in Lakhs

S. No.	Head	Sanctioned/ Balance C/f	Received	Expenditure Incurred r
1.	Institute Expenditure		9131.85	8358.41 r
2.	CAFT r	-	-	-
3.	SDU r	-	17.00	2.84 r
4.	Library Strengthening (SDAE)	-	-	-
5.	Scheduled Caste Sub-Plan (SCSP)	-	186.00	54.92 r
6.	NAHEP	428.32	-	149.44 r
7.	Externally Funded Projects	254.19	60.04	38.86 r
	Total	**682.51**	**9394.89**	**8604.47** r

Revenue Generation (Rupees in lakhs)

Financial Year	Revenue Target	Revenue Generation
2021-22	57.00	111.35
2022-23 (Upto 31.01.23)	120.18	127.88

2 Academic Achievements



Highlights

Number of Students Enrolled During the Year 2022 (1 January-31 December, 2022)

M.F.Sc. 96

Ph.D. 67

Number of Successful Students During the Year 2022 (1 January-31 December, 2022)

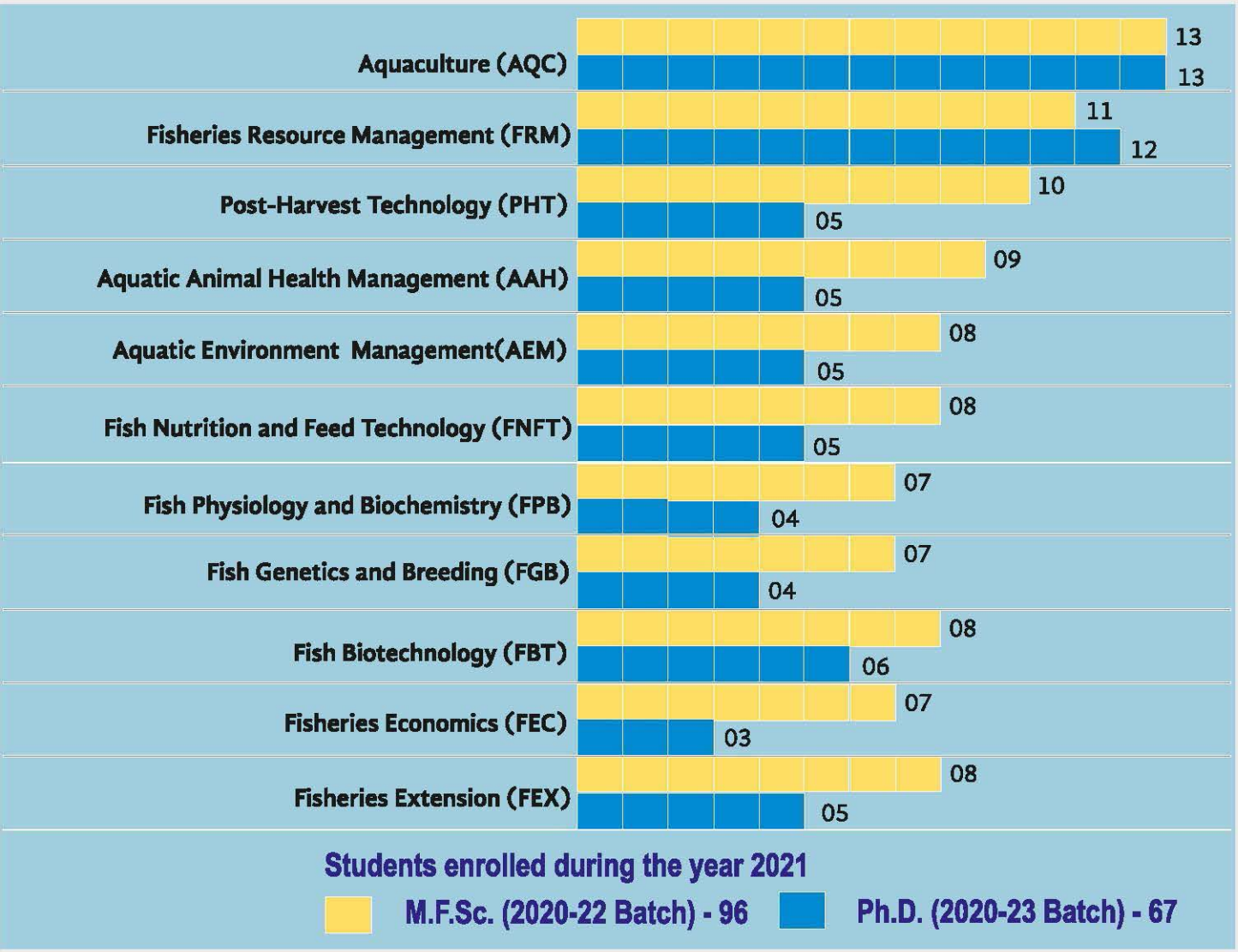
M.F.Sc. 93

Ph.D. 47

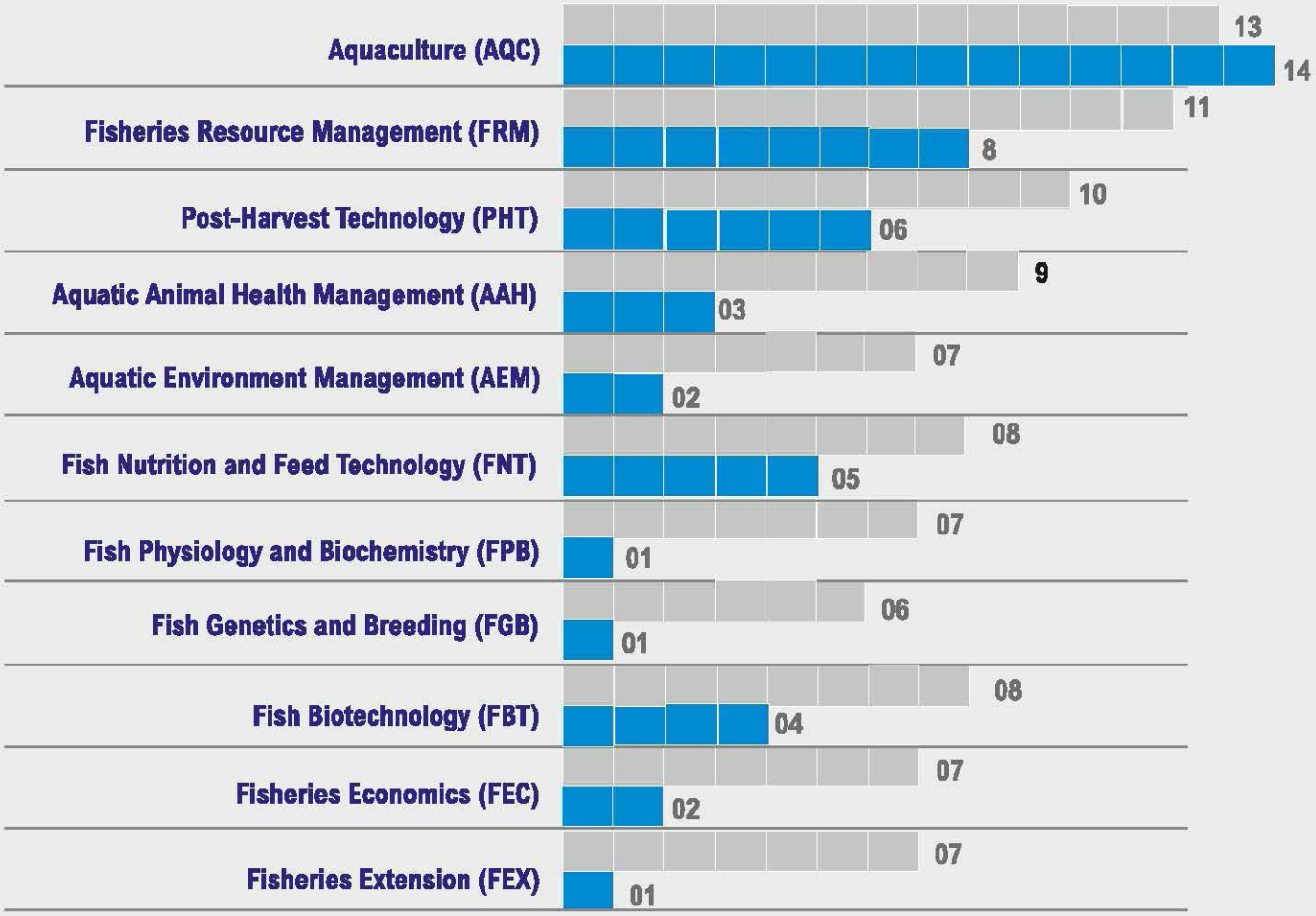
11	15	103	54
Guest Lectures	Awards Received by Students	Papers Presented by Students in Conferences/ Symposia etc.	Placement

2.1 Enrollments

A total of 96 students have enrolled for the programme and 67 have enrolled for the doctoral programme.



2.2 Results



List of dissertations submitted by M.F.Sc. students (Batch 2020-2022): 93

No. of students awarded Ph.D. degree during 1 January - 31 December 2022: 47

2.3. Students awarded M.F.Sc. and Research Titles (2021)

Fisheries Resource Management

1. Rajesh Kumar (FRM-MB0- 03)
   Identification of Ichthyoplankton of Selected Creeks of Mumbai, Maharashtra
   Major Advisor: Dr. Shashi Bhushan
2. Silpa . R (FRM-MB0-05)
   An Appraisal on the Larval Morphogenesis and Allometric Variations in Hatchery Reared Larvae of Silver Pompano, *Trachinotus Blochii* (Lacépède, 1801)
   Major Advisor: Dr. Asha .T. Landge
3. Aiswarya S (FRM-MB0-01)
   Spatial Prediction of Fish Abundance in The Vembanad Lake Using Geostatistical Tools
   Major Advisor: Dr Asha T Landge
4. Meenatchi S (FRM-MB0-02)
   Diversity of Artemia Along North Coastal Districts of Maharashtra
   Major Advisor: Dr. B. B. Nayak
5. Sagar Ronad (FRM-MB0-04)
   Abundance and Characteristics of Microplastics in *Sardinella longiceps* (Valenciennes, 1847) and *Cynoglossus macrostomus* (Norman, 1928) Along The West Coast Of India.
   Major Advisor: Dr. Shashi Bhushan
6. Sudipta Barman (FRM-MB0-06)
   Impact of Culture Conditions on Growth and Biochemical Composition of Selected Brown Algae
   Major Advisor: Dr. Geetanjali Deshmukhe
7. Swagatika Sahoo M (FRM-MB0-07)
   Lipid Enhancement in *Ulva* Species through Media Intervention for Biodiesel Production
   Major Advisor: Dr. Geetanjali Deshmukhe
8. Thanga Anusya S (FRM-MB0-08)
   Biology of *Osteobrama vigorsii* (Sykes, 1839) From Bhima River Basin, Maharashtra, India
   Major Advisor: Dr. Karankumar K. Ramteke
9. Vineeth P (FRM-MB0-09) Diversity Of Freshwater Catfishes (Siluriformes) In Selected River Systems of Maharashtra
   Major Advisor: Dr A K Jaiswar
10. Zaheer Abass (FRM-MB0-10)
    Comparative Evaluation of Mesh Size Panel to Improve Fish Catch Composition of Dol Net
    Major Advisor: Dr. Karan Ramteke
11. Samir Kumar Chand (FRM-MB0-11)
    Study on Diversity of *Puntius* Hamilton, 1822 (Cyprinidae: Smiliogastrinae) in Selected River Systems of Maharashtra
    Major Advisor: Dr. A. K. Jaiswar

Aquaculture (AQC)

12. Aatira Farooq (AQC-MB0-01)
    Iron Supplementation Effect on Growth of *Pangasianodon hypophthalmus* (Sauvage, 1878) and *Spinacia oleracea* (Linnaeus, 1552) in Aquaponics
    Major Advisor: A.K. Verma
13. Banlam Jingshai Marbaniang (AQC-MB0-02)
    Study on Captive Broodstock Development and Evaluation of Habitat Manipulation on Reproductive Biology of Scarlet badis, *Dario dario* (Hamilton, 1822)
    Major Advisor: Dr. Gouranga Biswas
14. Christina Khundrakpam (AQC-MB0-03)
    Evaluation of artificial habitats for optimizing captive maturation of the indigenous ornamental Zebra Loach, *Botia striata* (Rao, 1920)
    Major Advisor: Dr. Paramita Banerjee Sawant
15. Divya Mehta (AQC-MB0-04)
    Study of the green slime associated bacteria of *Labeo rohita* (Hamilton 1822) and its effect on physicochemical, bacteriological and the growth parameters
    Major Advisor: Dr. Kishore Kumar Krishnani
16. P. Bharathi Raja (AQC-MB0-05)
    Filtration Rate Optimization in RAS with Trickling Biofilter Using FRP Rings for Rearing of GIFT Tilapia
    Major Advisor: Dr. Chandrakant M H
17. Parvathi Priya (AQC- MB0- 06)
    Effect of Dietary Algal Oil Supplementation on Growth Performance and Physio-Metabolic Changes in *Channa striata* (Bloch, 1793)
    Major Advisor: Dr. Thongam Ibemcha Chanu
18. Pooja Chithira (AQC-MB0-07)
    Dietary Biofloc Supplementation in Grey Mullet, *Mugil cephalus* (Linnaeus, 1758) Fingerlings: Effect on Growth and Physio-Metabolic Responses
    Major Advisor: Dr.Karthireddy Syamala
19. Ramya.V (AQC-MB0-08)
    Assessment of Chromium Toxicity on Growth and Physiological Responses of

Etroplus Suratensis (Bloch 1790) Juveniles
Major Advisor: Dr. Madhuri.S. Pathak

20. Rozirani Behera (AQC-MBO-09)
Bioaugmentation of Aquaculture Waste in *Pangasianodon hypophthalamus* (Sauvage,1878) Rearing Medium Using Combination of Selected Microbes and Enzymes
Major Advisor: Dr. Upasana Sahoo

21. Sagar Vitthal Shinde (AQC-MB0-10)
Assessment Of Production Performance of Genetically Improved Farmed Tilapia In Freshwater Integrated Multi-Trophic Aquaculture System
Major Advisor: Dr. Kapil Sukhdhane

22. Sourav Bhadra (AQC-MB0-11)
Modulation of Non-Specific Immune Response, Growth and Disease Control Through Dietary Supplementation of Herbal Therapeutic Agents, *Curcuma longa* and *Allium sativum* in Biofloc Based Culture System of Tilapia
Major Advisor: Dr. Babitha Rani A.M.

23. Treasa Merin Pious (AQC-MB0-12)
Analysis of the Antagonistic Potential of Green Slime Bacteria of Euryhaline Fish, *Etroplus suratensis* (Bloch, 1970) in Freshwater
Major Advisor: Dr. Kishore K. Krishnani

24. Sourav Roy (AQC-MB0-13)
Dietary Supplementation of Fermented Palm Kernel Cake for Growth and Nutrient Utilization of *Penaeus vannamei* (Boone, 1931)
Major Advisor: Dr. Muralidhar P. Ande

Post Harvesting Technology

25. Payel Debbarma (PHT-MB0-01)
Bioactive Properties of Fucoidan Hydrolysate Obtained from Brown Seaweeds Along The West Coast Of India
Major Advisor: Dr. Layana P.

26. Pragati Shetty (PHT-MB0-02)
Physiological Characterization of Fish Scale Degrading Bacteria from the Marine Environment
Major Advisor: Dr. Sanath Kumar H.

27. Sandhiya V (PHT-MB0-03)
Effect of Salt on The Microplastics Abundance in Different Forms of Salt Dried Fish
Major Advisor: Dr. K.A. Martin Xavier

28. Santosh Kumar panda (PHT-MB0-04)
Incidence and Characterization of Non-Lactose Fermenting Enterobacterales in Fresh Seafood
Major Advisor: Dr. Manjusha L.

29. Sharath S P (PHT-MB0-05)
Functional Characterization of Mudskipper Muscle Proteins and Its Processing Waste Utilization
Major Advisor: Dr. Layana P

30. Sousruti Kar (PHT-MB0-06)
Feasibility of using Fish Waste-Derived Peptone as A Growth Media Component for Laboratory Cultivation of Bacteria
Major Advisor: Dr. Sanath Kumar

31. Suguna P (PHT-MB0-07)
Abundance of Microplastics in Cured Fishes Along the Eastern States of India
Major Advisor: Dr. Martin Xavier K A

32. Tanushree Sardar (PHTMB0-08)
Effect 0f Drying on the Quality and Stability of Small Fish "Bhat Masali"
Major Advisor: Dr. A.K. Balange

33. Veeranki Sai Krishna (PHTMB0-09)
Enumeration of *Arcobacter butzleri* from Seafood by using Fluorescent In-situ Hybridization.
Major Advisor: Dr. B.B. Nayak.

34. Itishree Das (PHT-MB0-10)
Biochemical Composition and Bioactive Properties of Selected Brown Seaweeds
Major Advisor: Dr. A.K. Balange

Fish Genetics and Breeding

35. Deepak Kumar (FGB-MB0-01)
Identification and Phenotyping of Different Geographical Populations of Copepod *Heliodiaptomus viduus* (Gurney, 1916)
Major Advisor: Dr. Sunil Kumar Nayak

36. Kishor Gowda B (FGB-MB0-02)
Genetic Analysis of Growth and Reproductive Performance of Selectively Bred *Clarias Magur*
Major Advisor: Dr Shrinivas Jahageerdar

37. M.Porkodi (FGB-MB0-04)
Evaluation of Genotoxicity and Teratogenicity of Indigo Dyes in Zebrafish
Major Advisor: Dr. N.S.Nagpure

38. Raghul R (FGB-MB0-05)
Genetic Analysis of Growth Traits of Juvenile *Cyprinus Carpio* (Linnaeus, 1758) Cultured in Inland Saline Water
Major Advisor: Dr. Mujahidkhan A. Pathan

39. Shreyasi Kar (FGB-MB0-06)
Role of Nanoconjugated Conspecific Kisspeptin in Gonadal Development of *Labeo catla* (Hamilton, 1822)
Major Advisor: Dr. Rupam Sharma

40. Lalremruati (FGB-MB0-07)
In Silico Characterization of FSH and Associated Factors and Identification of the Putative Modulators in Selected Fish Species
Major Advisor: Dr. Shrinivas Jahageerdar

Fish Biotechnology

41. Darshiny M P (FBT-MB0-01)
Sequencing and Characterization of Coding Regions of Selected Genes of the Steroidogenic Pathway of Channa Striata (Bloch, 1793)
Major Advisor: Dr. Aparna Chaudhari

42. Gowhar Iqbal (FBT-MB0-02)
Molecular Characterization of Nematode Parasite Infecting Fish of Barvi Reservoir, Maharashtra
Major Advisor: Dr. A. Pavan Kumar

43. Himansu Shankar Nage (FBT-MB0-03)
Development and Growth Optimization of Muscle Cell Culture from *Pangasianodon Hypophthamus* (Sauvage,1878)
Major Advisor: Dr. Mukunda Goswami

44. Limbola Maharshi Lakhabhai (FBT-MB0-04)
Development of SCAR & PCR RFLP Based Strategies for Identification Of *Clarias magur* and *Clarias gariepinus* Hybrid
Major Advisor: Dr Aparna Chaudhari

45. Pokanti Vinay Kumar (FBT-MB0-05)
Analysis of Muscle Transcriptome of *Labeo rohita* Exposed with Heat Stress
Major Advisor: Dr. Manoj Brahmane

46. Pragati Padhan (FBT-MB0-06)
Construction of RNA-Guided Recombinase (RGR) Platform Components for Targeted Transgenesis in Zebrafish
Major Advisor: Dr. Arvind A. Sonwane

47. S. Sangeetha (FBT-MB0-07)
Characterization of Metazoan and Microbial Diversity from the Ballast Water Using Environmental DNA
Major Advisor: Dr. A. Pavan Kumar

48. Prachi Dattatraya Asgolkar (FBT-MB0-08)
Molecular Characterization of Selected Genes In Hypophyseal Axis of Channa Striata (Bloch, 1793)
Major Advisor: Dr. Kiran D. Rasal

Aquatic Animal Health

49. Amala Jiji (AAH-MB0-01)
Histology and PCR-Based Screening of Freshwater Prawn, *Macrobrachium Rosenbergii* for Pathogens Infecting Hepatopancreas
Major Advisor: Dr. K. V Rajendran

50. Angel Ayana K. J. (AAH-MB0-02)
Screening of Escherichia Coli Isolates for MDR and Molecular Characterization of Integron Associated Resistance
Major Advisor: Dr. Jeena K.

51. Chovatia Ravikumar Mansukhbhai (AAH-MB0-03)
Ontogeny and Tissue Specific Expression Profiles of Recombination Activating Gene (RAG) During Development In Nile Tilapia, *Oreochromis Niloticus*
Major Advisor: Dr. Gayatri Tripathi

52. Jancy Robina (AAAH-MB0-04)
Time-Course Tissue-Level Variation of Tilapia Lake Virus (TiLV) Load In Experimentally-Infected Tilapia
Major Advisor: Dr.K.V.Rajendran

53. Manojkumar C (AAH-MB0-05)
Designing And Standardization of CRISPR-Cas12a Based Detection of White Spot Syndrome Virus
Major Advisor: Dr. Megha Kadam Bedekar

54. Samad Sheikh (AAH-MB0-06)
Study on Antiparasitic Effect of Castor, Ricinus Communis Extracts Against Argulus Infestation in Goldfish (*Carassius auratus*)
Major Advisor: Dr. R.P. Raman

55. S. Surya Teja (AAH-MB0-07)
Synthesis and Characterization of Biogenic Silver Nanoparticles Using Papaya Leaf Extract and its Anti-Bacterial Effect on *Edwarsiella tarda* in Fish
Major Advisor: Dr. K. Pani Prasad

56. Thatikonda Bhargavi (AAH-MB0-08)
Evaluation of Innate Immunity in *Oreochromis mossambicus*
Major Advisor: Dr.K.Pani Prasad

57. Venerability Dhar (AAH-MB0-09)
Evaluation of Dietary Supplementation of Paraprobiotic *Lactobacillus rhamnosus* on Growth and Immune Responses in *Labeo rohita* (Ham.) Against *Edwardsiella tarda*
Major Advisor: Dr. Ram Prakash Raman

Aquatic Environment Management

58. Abhirami N (AEM-MBO-01)
Extraction, Purification and Applications of The Pigments from *Spirulina (Arthrospira) Platensis*
Major Advisor: Dr. S. P. Shukla

59. Ganesh Kumar T (AEM-MBO-02)
A Study on Occurrence and Environmental Risk of Triclosan in Selected Water Bodies of Mumbai
Major Advisor: Dr. Saurav Kumar

60. N.Tachangliu (AEM-MBO-03)
Effect of mixed biochar on soil microbial activity and productivity in *Peneaus vannamei* (Boone, 1931) culture
Major Advisor: Dr. Vidya Shree Bharti

61. Pritam Sarkar (AEM-MBO-04)
Assessment of the Effect of Nanoplastics on Selected Microalgae
Major Advisor: Dr. Rathi Bhuvaneswari G.

62. Shamily. W (AEM-MBO-06)
Study on the Application of Selected Algae for the Remediation of Triclosan
Major Advisor: Dr. Kundan Kumar

63. Shilpa Pradeep (AEM-MBO-07)
Evaluation of Oxidase Enzyme (Laccase)-Mediated Triclosan Degradation in Water and its Effect on Aquatic Organisms
Major Advisor: Dr. Saurav Kumar

64. Bhavana Dhawad (AEM-MBO-08)
Toxicity and Microalgae Assisted Bioremediation of Benzophenone-3
Major Advisor: Dr. Rathi Bhuvaneswari G

Fisheries Extension

65. Deboshmita Dey (FEX-MBO-01)
KVK-Led Fisheries Extension in West Bengal and Bihar: Assessment and Action Plan
Major Advisor: Dr. Ananthan P.S.

66. B. Lalmuansangi (FEX-MBO-02)
Gender Analysis of Aquaculture Based Livelihoods in Mizoram
Major Advisor: Dr. Arpita Sharma

67. Beemalla Samatha (FEX-MBO-03)
Evaluation of CIFE's Skill Development Trainings on Aquaculture in Telangana and Andhra Pradesh
Major Advisor: Dr. Shivaji D Argade

68. Geetha (MFEX-MBO-04)
KVK Led Fisheries Extension in Andhra Pradesh and Tamil Nadu: Assessment and Action
Major Advisor: Dr. Ananthan P.S.

69. Priyanka Mushkam (FEX-MBO-05)
Gender Analysis of Fisheries Sector in Telangana
Major Advisor: Dr Arpita Sharma

70. B.Bhavana (FEX-MBO-06)
Evaluation of Post-Graduation Diploma in Inland Fisheries and Aquaculture Management
Major Advisor: Dr. Shivaji D Argade

71. U. Sangeetha (FEX-MBO-07)
Attitude of Professional Fisheries Students towards Entrepreneurship in Tamil Nadu
Major Advisor: Dr. S.N. Ojha

Fisheries Economics

72. Ahila M.S (FEC-MBO-01)
Value Chain Analysis of Wild Harvested Seaweed in the Gulf of Mannar and Palk Bay, Tamil Nadu
Major Advisor: Dr. Neha W. Qureshi

73. Aparna Anil (FEC-MBO-02)
Macroeconomic Assessment of Carbon Footprints in Marine Capture Fisheries of India
Major Advisor: Dr Neha W Qureshi

74. K Suresh Kumar Patro (FEC-MBO-03)
Prediction of Water Quality Parameters and Estimating its Relation with Abnormality in Freshwater Fish Aquarium: IOT and Machine Learning Approach
Major Advisor: Dr. Vinod Kumar Yadav

75. Mani Selvam J (FEC-MBO-04)
Assessing the Performance, Economics and Energy Efficiency of Various Fishing Systems in Pulicat Region of Tamil Nadu
Major Advisor: Dr. Swadesh Prakash

76. Sagar Sitaram Rathod (FEC-MBO-05)
Farm Ponds for Aquaculture: Assessing Economic Feasibility in Ahmednagar District of Maharashtra
Major Advisor: Dr. Ankush L. Kamble

77. Palsam Karthik Kumar Goud (FEC-MBO-06)
Supply Chain Analysis of Mud Crab (*Scylla* spp.) In Krishna District of Andhra Pradesh
Dr. Swadesh Prakash

78. Waghmare Sneha Dadarao (FEC-MBO-07)
Ecosystem Valuation and Trophic Structure Dynamics for Sustainable Fisheries Management in Dimbhe Reservoir, Maharashtra
Dr. Vinod Kumar Yadav

Fish Nutrition and Feed Technology

79. Halpati Reena Prakashbhai (FNT MB0 03)
Optimization of co-feeding strategy for *Anabas testudineus* (Bloch, 1792) larvae
Major Advisor: Dr. S. Munilkumar

80. Omkar Patra (FNT-MB0-02)
Evaluation of Pomegranate Peel Extract in The Diet of *Labeo rohita* (Ham. 1822) Fingerlings Reared under Different Stocking Densities
Major Advisor: Dr. Shamna N.

81. Patekar Prakash Goraksha (FNT-MB0-04)
Optimization of Weaning Strategy in *Anabas testudineus* (Bloch, 1792) Larvae
Major Advisor: Dr. Sikendra Kumar

82. Potluri Sai Kishore (FNT-MB0-05)
Evaluation of Jal Bramhi (*Centella asiatica*) Leaf Extract in The Diet of GIFT Fingerlings Reared under Different Stocking Densities in Inland Saline Aquaculture
Major Advisor: Dr. Pankaj Kumar

83. Satheesh M (FNT-MB0-06)
Effect of Graded Levels of Dietary Protein on Gonadal Development of *Anabas testudineus* (Bloch, 1792)
Dr. G.H.Pailan

84. Soumyodeep Bhattacharya (FNT-MB0-07)
Evaluation of Pineapple Peel Extract in the Diet of *Labeo rohita* (Ham. 1822) Fingerlings Reared under Different Stocking Densities
Major Advisor: Dr. Parimal Sardar

85. Veeramani Maruthi K N (FNT-MB0-08)
Effect of Graded Levels of L-carnitine on Feed Intake and Growth of *Labeo rohita* (Hamilton, 1822) Fingerlings Reared at Low Temperature
Major Advisor: Dr. Ashutosh D. Deo

86. Atshaya S. (FNT-MB0-01)
Evaluation of papaya peel extract in the diet of *Labeo rohita* (Ham.1822) fingerlings reared under different stocking densities.
Major Advisor: Dr.N.P.Sahu

Fish Physiology and Biochemistry

87. Madhulika (FPB-MB-003)
Biochemical and Hematological Profiling of *Pangasianodon hypothalamus* in different culture systems
Major Advisor: Dr. Sujata Sahoo

88. Jebarson Solomon J (FPB-MB0-01)
Effect of dietary green tea (*Camellia sinensis*) waste extract on fat deposition of striped catfish, *Pangasianodon hypophthalmus* (Sauvage, 1878)
Major Advisor: Dr. Subodh Gupta

89. Komuhi N B (FPB-MB0-02)
Evaluating Effects of Feeding Time on Intestinal Molecular Clock and Digestive Enzyme Secretion in *Labeo rohita*
Major Advisor: Dr. Subrata Dasgupta

90. Naveen S K (FPB-MB0-04)
Effect of Ashwagandha (*Withania somnifera*) root powder and extract on feed intake and growth of *Labeo rohita* (Hamilton, 1822) fingerlings reared at low water temperature
Major Advisor: Dr. Manish Jayant

91. Mule Satyam Rajkumar (FPB-MB0-05)
Effect of Dietary Anabaena on Physio-Metabolic Responses of *Catla catla* (Hamilton,1822)
Major Advisor: Dr. Dilip Kumar Singh

92. Subham Bakli (FPB-MB0-06)
Effect of Different Algal Meal Supplemented Diets on Growth and Physiological Parameters of Indian Major Carps reared in 3 Species Polyculture System
Major Advisor: Dr. Md. Aklakur

93. Vasanthakumaran K (FPB-MB0-07)
Combinatorial effect of dietary Genistein and Diadzein on gonadal development of male *Cyprinus carpio* (Linnaeus, 1758)
Major Advisor: Dr. Tincy Varghese

2.4. List of students awarded Ph.D. degree during 2022

1. Ms. Sahna Don (PHT-PA6-01) 2016-2019
   Contamination dynamics and survival of *Salmonella enterica* in sea food and the environment
   Supervisor: Dr. Sanath Kumar H.
   Viva Voce : 12-01-2022
2. Mr. Vignesh D. (PHT-PA6-03) 2016-2019
   Valorization of *Acetes* spp. for the Bioactive Peptides and Biopolymers
   Supervisor: Dr. K.A. Martin Xavier
   Viva Voce : 15-01-2022
3. Ms. Shameena S.S (AAH-PA6-06) 2016-2019
   Study of concomitant exposure of *Carassius auratus* to *Argulus* and *Aeromonas hydrophila* with reference to temperature
   Supervisor: Dr. R.P.Raman
   Viva Voce : 17-01-2022
4. Ms. Kouberi Nath (AQC-PA7-11) 2017-2020
   Evaluation of an integrated multi-trophic aquaculture (IMTA) system for freshwater species in Tripura
   Supervisor: Dr. Sukham Munilkumar
   Viva Voce : 20-01-2022
5. Mr. Ranjit Kumar N. (AAH-PA6-05) 2016-2019
   Studies on Integron and Transposon Mediated Transfer of Antibiotic Resistance Genes in Bacteria from Shrimp Culture system and their mitigation
   Supervisor: Dr. R.P.Raman
   Viva Voce : 21-01-2022
6. Ms. Pragyan Dash (AQC-PA6-12) 2016-2019
   Growth and reproductive performance of *Neolissochilus hexagonolepis* (MeClelland, 1839) in captivity in mid Himalayan altitude
   Supervisor: Dr. N.K.Chadha
   Viva Voce : 28-01-2022
7. Ms. Sanitha Saseendran (AQC-PA6-05) 2016-2019
   Comparative study on two biofloc based aquaponics for fish and crop production
   Supervisor: Dr. Kiran Dube Rawat
   Viva Voce : 28-01-2022
8. Mr. Sandeep B. Gore (PHT-PA6-05) 2016-2019
   Development and Quality Improvement of Fish Sausage from Indian Major Carps
   Supervisor: Dr. A.K. Balange
   Viva Voce : 05-02-2022
9. Mr. Brahma Nand Shukla (AQC-PA4-13) 2014-2017
   Hypothalamo-Hypophysial Regulation of Reproduction n Labeo rohita (Hamilton, 1822)
   Supervisor:Dr. N.K.Chadha
   Viva Voce : 09-02-2022
10. Mr. Mukesh Kumar (FBT-PA5-03) 2015-2018
    Studies on GnRH-Receptor Interaction in *Clarias magur*
    Supervisor: Dr. Mukunda Goswami
    Viva Voce : 10-02-2022
11. Ms. Lidiya Wilwet (PHT-PA7-03) 2017-2020
    Development of DNA based methods for rapid species identification of raw and processed shrimps
    Supervisor: Dr. B.B. Nayak
    Viva Voce : 17-03-2022
12. Mr. Srijit Chakravarty (AQC-PA-11) 2014-2017
    Study on Hormonal Intervention of testicular maturation and spermiation of Clarias magur (Hamilton, 1822)
    Supervisor: Dr. N.K.Chadha
    Viva Voce : 17-03-2022
13. Mr. Udai Ram Gurjar (FRM-PA7-07) 2017-2020
    Study on Occurrence of Microplastics in water, sediments and selected fishes off Mumbai Coast
    Supervisor: Dr. Martin Xavier K.A.
    Viva Voce : 23-03-2022
14. Mr. Rajan Kumar (FRM-PA4-01) 2014-2017
    Assessment of bottom trawl fisheries along Veraval coast, Gujarat
    Supervisor: Dr. A.P. Dineshbabu
    Viva Voce : 01-04-2022
15. Ms. Harsha Haridas (AQC-PA5-06) 2015-2018
    Optimization of stocking density and carbon source for rearing of *Mugil cephalus* (Linnaeus, 1758) in biofloc based system
    Supervisor: Dr. N.K.Chadha
    Viva Voce : 08-04-2022
16. Ms. Vandita (PHT-PA5-04) 2015-2018
    Emerging pathogenic *Vibrio* species in seafood and the environment : Distribution of virulence markers and antibiotic resistance
    Supervisor: Dr. Sanath Kumar H.
    Viva Voce : 12-04-2022

17. Ms. Shweta Kumari (FEX-PA5-03) 2015-2018
Impact of Cage Culture on Fishers livelihood in Chandil Reservoir, Jharkhand
Supervisor: Dr. Arpita Sharma
Viva Voce : 25-04-2022

18. Mr. Rohitash Yadav (AQC-PA7-07) 2017-2020
Effect of Khejri Prosopis cineraria on growth and immunity of rohu, *Labeo rohita* (Hamilton, 1822)
Supervisor: Dr. N.K.Chadha
Viva Voce : 27-04-2022

19. Mr. Adinath T. Markad (FRM-PA6-08) 2016-2019
Trophic State Monitoring of selected reservoir using Remote Sensing and GIS
Supervisor: Dr. Asha T. Landge
Viva Voce : 06-05-2022

20. Ms. Nageswari P. (AQC-PA6-03) 2016-2019
Evaluation of growth, immune response and carcass quality of *Pangasianodon hypophthalmus* (Sauvage, 1878) fingerlings reared in biofloc based system
Supervisor: Dr. A.K.Verma
Viva Voce : 07-05-2022

21. Mr. Chandra Bhushan Kumar (AAHM-PA7-05) 2017-2020
Assessment of antimicrobial resistance in motile aeromonads isolated from freshwater farmed fish and evaluation of phytocompounds for Anti-Aeromonas activity
Supervisor: Dr. Gaurav Rathore
Viva Voce : 13-05-2022

22. Mr. Ubaid Qayoom (FBT-PA6-02) 2016-2019
Large scale production and pre-clinical toxicity trials on WSS DNA vaccine
Supervisor: Dr. Aparna Chaudhari
Viva Voce : 08-06-2022

23. Mr. Ranjan Singh (FNFT-PA4-04) 2014-2017
Studying protein sparing effect of lipid by supplementation of Ractopamine and L-Carnitine in the diet of *Labeo calbasu* (Hamilton, 1822)
Supervisor: Dr. K.K.Jain
Viva Voce : 09-06-2022

24. Ms. Chitra Soman (FRM-PA6-07) 2016-2019
Effects of biotic and abiotic factors on the responses of selected bivalves to ocean acidification
Supervisor: Dr. B.B.Nayak
Viva Voce : 10-06-2022

25. Mr. Gulshan Kumar (FBT-PA5-01) 2015-2018
Studies on white spot virus entry mechanism in *Penaeus monodon* (Fabricius 1798)
Supervisor: Dr. Aparna Chaudhari
Viva Voce : 13-06-2022

26. Mr. K.S.Wisdom (FGB-PA6-03) 2016-2019
Effects of chitosan-carbon nanotube conjugated nonapeptides on reproduction in *Clarias magur* (Hamilton, 1822)
Supervisor: Dr. Rupam Sharma
Viva Voce : 18-06-2022

27. Ms. Bahni Dhar (PHT-PA6-06) 2016-2019
Accelerated salt-fermentation of pangas (*Pangasianodon hypophthalmus*) and improvement of its quality
Supervisor: Dr. B.B.Nayak
Viva Voce : 21-06-2022

28. Ms. Hoilenting (FEC-PA5-04) 2015-2018
Flood and Fisheries in Assam : An Economic Evaluation of Losses, Current Coping Strategies and Way Forward
Supervisor: Dr. Rama Sharma
Viva Voce : 25-06-2022

29. Mr. Sudhanshu Raman (FNFT-PA5-03) 2015-2018
Utilization of Dhaicha *(Sesbania)* leaf meal in the diet of *Labeo rohita* (Hamilton, 1822)
Supervisor: Dr. Ashutosh D. Deo
Viva Voce : 05-07-2022

30. Mr. Shyam Prasad Mamidala (AQC-PA8-14) 2018-2021
Effect of dietary protein levels on growth, physiological responses and gene expression of stunted Milkfish, *Chanos chanos* (Forsskal, 1775)
Supervisor: Dr. Muralidhar P.Ande
Viva Voce : 13-07-2022

31. Ms. Sajina K.A. (FNFT-PA-6-01) 2016-2019
Utilization of *Chromolaena ordata* leaf meal and its protein concentrate fortified with nutraceuticals in the diet of *Labeo rohita* fingerlings
Supervisor: Dr. N.P. Sahu
Viva Voce : 14-07-2022

32. Ms. Sangeetha M. Nair (FRM-PA5-03) 2015-2018
Taxonomic study of selected fishes of the genus *Mystus Scopoli,* 1777 from India with special reference to Kerala
Supervisor: Dr. A.K.Jaiswar
Viva Voce : 24-08-2022

33. Mr. Mritunjoy Paul (FNFT-PA7-04) 2017-2020
Dietary Intervention of Improving Growth and Immunophysiological Responses in GIFT Tilapia Fingerlings in Inland Saline Water
Supervisor: Dr. Parimal Sardar
Viva Voce : 25-08-2022

34. Mr. Prasanta Jana (FNFT-PA7-03) 2017-2020
Dietary Intervention for Improving growth and Immunophysiological responses in *Penaeus vannamei* (Boone, 1931) juveniles in inland saline water
Supervisor: Dr. N.P. Sahu
Viva Voce : 26-08-2022

35. Mr. Stanzin Gawa (FEC-PA5-01) 2015-2018
An Economic Evaluation of Cage Culture in Reservoirs of Jharkhand
Supervisor: Dr. Nalini Ranjan Kumar
Viva Voce : 30-08-2022

36. Mr. Katira Nareshbhai Nathabhai (FRM-PA6-05) 2016-2019
Status of coral reef in outer Gulf of Kachchh region, Gujarat
Supervisor: Dr. Geetanjali Deshmukhe
Viva Voce : 02-09-2022

37. Mr. Balakrishna ChintadaAQC-PA8-122018-2021Developing intensive culture techniques of Calanoid copepod, *Acartia* sp. as a live feed for marine fin fish larval rearing
Supervisor: Dr. Ritesh Ranjan
Viva Voce : 12-09-2022

38. Mr. Om Pravesh Kumar Rai (AEM-PA5-03) 2015-2018
A Study on Biodiversity of Kanke Reservoir of Ranchi (Jharkhand, India) for the Assessment of its ecological status
Supervisor: Dr. S.P.Shukla
Viva Voce : 28-09-2022

39. Mr. Tarachand Kumawat (FRM-PA4-02) 2014-2017
Swarming dynamics of scyphozoan jellyfishes along the Gujarat Coast, India
Supervisor: Dr. K.Vinod
Viva Voce : 12-10-2022

40. Mr. Hafeef Roshan K.T. (FPB-PA6-03) 2016-2019
Evaluation of mucuna leaf meal-based diet on the growth and reproductive performance of *Cyprinus carpio* (Linnaeus, 1758)
Supervisor: Dr. Ashutosh D.Deo
Viva Voce : 15-11-2022

41. Mr. Aurobinda Upadhyay (AQC-PA7-03) 2017-2020
Effect of substrate based periphyton on growth, survival and health status of Olive bard, *Puntius sarana* (Ham. 1822) reared in cages
Supervisor: Dr. B.K.Das
Viva Voce : 12-12-2022

42. Mr. Prem Singh Prajapat (FRM-PA5-04) 2015-2018
Stock structure analysis of white sardine, *Escualosa thoracata* (Valenciennes, 1847) from Indian waters
Supervisor: Dr. Zeba Jaffer Abidi
Viva Voce : 13-12-2022

43. Mr. Kishor Kunal (AEM-PA4-03) 2014-2017
Study on habitat ecology, species diversity and biology of snow trouts in Kameng drainage of Arunachal Pradesh, Eastern Himalaya
Supervisor: Dr. Debajit Sarma
Viva Voce : 14-12-2022

44. Mr. Sandeep K.P. (AQC-PA7-10) 2017-2020
Evaluation of nutraceutical properties of selected microalgae and their putative role on growth and health of penaeid shrimp
Supervisor: Dr. K. Ambasankar
15-12-2022

45. Mr. Rajesh N. (AQC-PA6-11) 2016-2019 Life History traits of *Abudefduf sp* from the Southeast coast of India
Supervisor: Dr. N.K.Chadha
Viva Voce : 19-12-2022

46. Mr. Chandan Haldar (FBT-PA6-01) 2016-2019
Identification of Growth Associated SNPs in *Clarias magur* (Hamilon, 1822) using RNA-Sequencing
Supervisor: Dr. Aparna Chaudhari
Viva Voce : 20-12-2022

47. Mr. Lakan Lal Meena (AQC-PA8-07) 2018-2021 Management of Nutrient supplementation for Okra (*Abelmoschus esculentus*) in Recirculating Aquaponics system with *Pangasianodon hypophthalmus* (Sauvage, 1878)
Supervisor: Dr. A.K.Verma
Viva Voce : 21-12-2022

2.5. Guest Lectures

1. **Dr. A Vennila**, Principal Scientist, ICAR-Sugarcane Breeding Institute, Coimbatore
   Importance of Maintaining a Healthy Ecosystem and Human Well-being by Addressing Issues Related Soil Fertility, Soil Health, Nutrient Imbalance
   5 December 2022
2. **Dr. Sherly Tomy** Principal Scientist, ICAR-CIBA
   Reproductive Physiology of Crustaceans
   7 October 2022
3. **Dr. C.P. Balasubramanium**, Principal Scientist, ICAR-CIBA
   Molting Physiology of Crusatceans
   13 October 2022
4. **Dr. Shivendra Kumar**, Associate Professor, RPCAU, BiharNutrigenomics and Nutritional Programming in Fish16 October 2022
5. **Dr. J.K Sundaray,** Principal Scientist, ICAR-CIFA
   General Aquaculture Practices
   17 August 2022
6. **Dr. Vivekanadan,** P. S. (Retd), ICAR-CMFRI
   Climate Change: Effect on Fish & Fisheries
   16 August 2022
7. **Dr. Unmesh Katwate,** Bombay Natural History Society
   Participatory Approach for Mahseer Conservation
   4 August 2022
8. **Dr. Kaladharan E. P.**, Principal Scientist (Retd.), CMFRI
   Phycopreneurship in India: Status and Prospects of Seaweed Culture
   27 July 2022
9. **Dr. P. Koteswara Rao,** Principal Scientist, SIFT, Kakinada
   Usage of Chemicals in Aquaculture
   10 July 2022
10. **Mr. S. Balaji,** State Coordinator, NaCSA, Kakinada
    AMR and Chemical Residues in Fish and Fishery Products10 July 2022
11. **Dr. N.K. Sanil ,** Principal Scientist, ICAR-CMFRI, Kochi
    Electronmicroscopy: Principles and Applications
    25 March 2022

2.6. Students Placement

Name of student	Designation	Organization	Date
Mr. Tanmoy Kumar Manna	Fisheries Extension Officer Govt. of West Bengal	Fisheries Department,	September 2022
Mr. Omkar Patra	AFO	Odisha State Department	December 2022
Ms. Amruta Gopan	AFO	Kerala	November 2022
Mr. Munish Gangwar	Assistant Professor	NDUAT, Ayodhya	December 2022
Mr. Gyandeep Gupta	SMS	NDUAT, Ayodhya	December 2022
Mr. Sarvendra Kumar	Assistant Professor	College of Fisheries, Kishanganj, BASU, Bihar	March 2022
Dr. Showkar Dar	Assistant Professor	College of Fisheries, Kishanganj, BASU, Bihar	March 2022
Mr. Chinmay Nanda	AFO	Odisha State Department	December 2022
Ms. Shraddhnajali Sahoo	AFO	Odisha State Department	December 2022
Mr. Soumyadeep Bhattacharya	Fisheries Extension Officer	Fisheries Department, Govt. of West Bengal	September 2022
Mr. Manas Maiti	Fisheries Extension Officer	Fisheries Department, Govt. of West Bengal	September 2022
Ms. Tenji Pem Bhutia	Asst. Professor	College of Fisheries, Kishanganj, Patna, Bihar	March 2022
Mr. Suresh Kumar Patra	FDO	Orissa	December 2022
Mr. Sandeep Pal	FEO	West Bengal	August 2022
Mr. Suman Dey	FEO	West Bengal	September 2022
Mr. Sambit Priyadarshi	Asst. Manager, NABARD	Kolkata	August 2022
Mr. Rajpal Yadav	Assistant Professor	Gopal Narayan Singh University, Sasaram, Bihar	November 2022
Mr. Pritam Tripathy	Assistant Professer	School of Fisheries, Centurion University of Technology and Management Odisha	December 2022
Mr. T. Velumani	Sr. Programme Associate	Dakshin Foundation Karnataka	December 2022
Ms. Suchismita Pursty	Assistant Fisheries Officer	Ministry of Fisheries and Animal Husbandry Development department Odisha	December 2022
Mr. Abhinandan Kashyap	FDO, DoF	Assam	June 2022
Mr. Subhash Banjare	Chattisgarh	June 2022j	
Mr. Pown Kumar	Marketing Manager	Growel Andhra Pradesh	July 2022
Mr. Kakumanu Vivek	Fisheries Dev. Officer	DoF, Andhra Pradesh	February 2022
Mr. V Lukas	Probationary Officer	State Bank of India Mizoram	January 2022
Mr. Sanjay Stephen	Fisheries Dev. Officer	DoF, Andhra Pradesh	February 2022

Mr. Mondeep Saikia	Fisheries Dev.Officer	DOF, Assam	January 2022
Mr. Kaviin	Agri. Field Officer	Union Bank of India Chennai	July 2022
Mr. Shravan Kumar	Fisheries Inspector	Chattisgarh	June 2022
Ms. Deepa Chhetri	Block Officer, DoF, Sikkim	Sikkim	August 2022
Mr. Dhiraj Devakate	Technical Officer	Avanti Feeds Gujarat	June 2022
Mr. Makamguang Kamei	Asst Professor	Centurian University, Bhubaneshwar, Odisha	December 2022
Ms. Ritty M. Thomas	Senior Field Officer	Rajiv Gandhi Centre for Aquaculture	June 2022
Ms. Sonali Panda	Assistant Fisheries Officer	Odisha Public Service Commission (OPSC)	December 2022
Ms. Sanchita Naskar	Fishery Extension Officer	Govt. of West Bengal	August 2022
Ms. Rozirani Behera	Assistant Fisheries Officer	State govt	December 2022
Ms. Sushree Sangeeta Dey	Assistant Fisheries Officer	State govt	December 2022
Ms. Riya Kumari	Fisheries Extension Officer	Government of Bihar	June 2022
Ms. Aishwarya Sharma	Assistant Professor	College of Fisheries, Kishanganj, Patna, Bihar	February 2022
Ms. Dani Rupa	--	Private Sector	March 2022
Mr. Pokanti Vinay Kumar	YP-II	CIFE	October 2022
Dr. Ubaid Quyoom	Consultant (NSPAAD)	NBFGR	October 2022
Dr. Chandan Haldar	Fisheries Extension Officer	State Government, Kolkata	September 2022
Mr. Raju Ram	Fisheries Dev. Officer	State Government, Sirohi, Rajasthan	July 2022
Mr. Utsa Roy	Fisheries Extension Officer	State Government, Kolkata	September 2022
Ms. Riya Kumari	Fisheries Extension Officer	State Government Sheikhpura, Bihar	May 2022
Ms. Saumya Pandey	SMS	KVK, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, UP	July 2022
Mr. Yashwanth B.S.	Project Scientist	Centre for Marine Living Resources and Ecology, Kochi	November 2022
Ms. Triparna Pahari	Fisheries Extension Officer	State Government, Kolkata	Septemebr 2022
Ms. Aishwarya Sharma	Assistant Professor-cum-Jr. Scientist	Bihar Animal Sciences University, College of Fisheries, Kishanganj, Bihar	March 2022
Mr. Tapas Paul	Assistant Professor	BAU-COF, Kishanganj, Bihar	March 2022
Ms. Kangana Das	Assam State Govt.		April 2022
Ms. Jane Jacob	Assistant Manager	NABARD, Bengaluru	September 2022
Mr. Ganesh Kumar	Assistant Manager	NABARD, Chennai	September 2022
Mr. Siju R.	Assistant Manager	NABARD, Pune	September 2022

2.7. Honours and Awards received by Students

Name of student	Discipline and batch	Name of the Award received	Date
Ms. Venisza Cathy John	Aquaculture; M.F.Sc 2019-21 batch	Hiralal Chaudhuri Gold Medal (Discipline topper)	23rd April, 2022
Ms. Venisza Cathy John	Aquaculture; M.F.Sc 2019-21 batch	Dr. C.V. Kulkarni Gold medal (Overall topper of the batch)	23rd April, 2022
Ms. Venisza Cathy John	Aquaculture; M.F.Sc 2019-21 batch	Overall Best M.F.Sc Dissertation	6th June, 2022
Ms. Venisza Cathy John	Aquaculture; M.F.Sc 2019-21 Batch	Dr. D.R. Jalihal Award Gold Medal (Best MFSc student)	11th Dec 2022
Dr. Vignaesh D	Post-Harvest Technology 2016-19 batch	Prof. K.H. Alikunhi Gold Medal (Best Ph.D Thesis)	27th July 2022
Dr. Udai Ram Gurjar	Fisheries Resource Management 2017-20 batch	Dr.. C.V. Kulkarni Best Ph.D. Student Research Award for the year 2021-22	27th July 2022
Mr. Harshavarthini. M	Fish Genetics and Breeding (MFSc) 2019-21 batch	Dr. Hiralal Chaudhuri Gold Medal Award (Discipline topper)	23rd April 2022
Mr. Shubham Soni	Fisheries Extension 2019-21 batch	Best Post Graduation Thesis in Agricultural Extension	11 June 2022
Ms. Ahila M.S	Fisheries Economics 2020-22 batch	Best Photo Essay on Micro entrepreneurs in unorganised sector (Appreciation Award) by EMRC, Pondicherry University	2022
Mr. Seenivasan P	Fisheries Economics 2019-21 batch	First Prize, Oral Presentation 13th Asian Fisheries and Aquaculture Forum	2 June 2022
Mr. Seenivasan P	Fisheries Economics 2019-21 batch	Third prize: Oral Presentation: International conference on Advances in Agriculture and Food System Towards Sustainable Development	22-24 August 2022
Ms. Suvetha V	Fisheries Extension 2019-21 batch	Third Prize for best Post Graduation Thesis in Agricultural Extension	11 June 2022
Mr. Suman Dey	Fisheries Extension 2016-19 batch	Minderoo Foundation Grant (Rs 30,000) to attend World Fisheries Congress, 2021	2022
Mr. Vikas Kumar Ujjania	Aquaculture 2021-2024 batch	Research Scholar Award For Valuable contribution in Fisheries and Life Science Kalash Research and Welfare Society, Fisheries and Life Science Award Ceremony, Uttar Pradesh	31 July 2022

2.8. Papers presented by Students

Name of the student	Paper/Poster	Title
37th Annual National Research Conference Cooperative Connect, Goa, 9-10 December, 2022		
Ms. Akilandeshwari A.	Paper	Kerala State Cooperative Federation for Fisheries Development Ltd. (MATSYAFED): Paradigm Shifter from Welfare to Wealth
Ms. Akshata Thavai	Paper	Mangrove Eco-tourism - A Case of Swamini Self-Help Group in Sindhudurg District of Maharashtra
Reorienting the strategies towards sustainable Aquaculture and Fisheries, Faculty of Fisheries Science, KUFOS in association with the Department of Fisheries Government of Kerala, 6-7 January 2022		
Ms. Sathya G	Paper	Assessment of Socio-Economic Vulnerability to climate change: A village level study of Andhra Pradesh
12th Indian Fisheries and Aquaculture Forum (IFAF) abstract TNJFU and Asian Fisheries Society, Chennai. 5-7 May 2022		
Ms. Ahila M.S	Paper	Gender Analysis of Wild Seaweed Harvesting in Tamil Nadu.
Mr. Saiprasad Bhusare	Poster	Evaluation of the Low Protein and High Energy Diets Supplemented with Bile Acid on Growth and Physio-metabolic changes in GIFT Juveniles Reared in Inland Saline Water
Mr. Paul Nathaniel T	Poster	Non- Lethal Heat Shock Mitigates Stress in *Penaeus vannamei* exposed to potassium deficient inland saline water
Mr.Shivkumar	Poster	A capture culturing of Vinegar eel: A livefeed for Fish fry
Ms. Sushree Sangeeta Dey	Paper	Impact Of Different Biofloc Media On Growth and Immuno-Physiological Performance of *Anabas Testudineus* (Bloch, 1792) Stocked At Different Densities
Ms. Meenatchi. M	Poster	A Scientometric Assessment of Research on Artemia in India Vis-a-vis the World (1949-2021) - A Meta-analysis
Mr. Zaheer Abbas	Poster	Assessment of reduction in catch sorting time with separator panel of fish by-catch in dol net fisheries
Mr. P. Chellamanimegalai	Poster	Pigments profile of different seaweeds from the Okha coast, Gujarat
Ms. Aiswarya S	Oral	Spatial Prediction of Flower Tail Shrimp Abundance using Geostatistical Methods in the Vembanad Lake
Mr. Komal Nandagawali	Poster	Assessment of Sedimentation and its Impacts on Fisheries in Navegaonbandh Reservoir Using Remote Sensing
Ms. Kamei Lanthaimeilu	Oral	Evaluation of Length-weight Relationship (LWR) *Aluterus Monoceros* (linnaeus, 1758) along the Indian Coast
Mr. Komal Nandagawali	Oral	Assessment of Sedimentation and its Impacts on Fisheries in Navegaonbandh Reservoir Using Remote Sensing
Mr. Ansuman Panda	Oral	Integrative Taxonomy of the Genus AtropusOken, 1817 (Carangiformes: Carangidae) Reveals Misidentification of Species
Ms. Harshavarthini	Poster	Evaluation of Mithi river water for genotoxic potential in zebrafish (*Danio rerio*) embryos

Ms. Akshaya Mayekar	Poster	Combining ability and heritability of body weight in Rohu (*Labeo rohita*)
Ms. Adya Pandey	Poster	Physiometabolic Responses of *Penaeus Vannamei* Reared in Inland Saline Environment reveal the Optimum Stocking Density for Commercial Culture
Ms. Archana Mishra	Poster	Evaluation of Stress Response in *Cyprinus Carpio* (Linnaeus,1758) Cultured at Various Salinities
Mr. Phibi Philip Naduvathu	Paper	Performance Comparison of *Cyprinus Carpio* (Linnaeus, 1758) Populations Reared in Inland Saline Waters at Varying Salinities

8th Global Conference on Gender in Aquaculture and Fisheries, Kochi, November 22, 2022

Ms. Naila M. Bhat	Paper	Analyzing the fishing Community of Kashmir through Gender Lens
Ms. Ahila M.S	Paper	Seaweed Harvesters in the Gulf of Mannar and Palk Bay: A Tale of Woe' Gender perspective in wild seaweed value chain: A case from Gulf of Mannar and Palk Bay, Tamil Nadu
Mr. Shubham Soni	Paper	Assessment of Waste Generated in The Fish Markets of Mumbai
Mr. Santosh N. Kunjir	Paper	Gender Based Information on Patenting Activities in the Indian Fisheries Sector
Mr. Sandesh V. Patil	Paper	Need of Women Specific Interventions for Equitable and Sustainable Brackishwater Shrimp Aquaculture Development in Maharashtra
Ms. Suchismita Prusty	Paper	Postural Analysis of Marine Fish Retailers in the Coastal State Odisha, India
Ms. Nidhi Katre	Paper	Participation of Fisherwomen in Fisheries Cooperative Societies of Bargi Reservoir, Madhya Pradesh
Ms. Priyanka Mushkam	Paper	Using the Gender Analysis Tool for Fisheries and Aquaculture (GATFA©) in the Inland Capture Fisheries of Nagarjunsagar Reservoir, Telangana
Mr. Rajpal Yadav	Paper	Exploring the Role of Fisherwomen in Kota, Ajmer and Udaipur Divisions of Rajasthan
Ms. B. Lalmuansangi	Paper	Gender Analysis of Paddy-Cum Fish Culture in Mizoram State, India

1st Indian Fisheries Outlook (IFO), CIFRI Barackpore, March 22-24, 2022

Mr. Shyam Datta Waghmare	Paper	Pollution, Ecology and Fisheries I Ujjaini Reservoir, Maharashtra,
Mr. Suman Dey	Paper	Fish Marketing Extension Service Model for Supply Chain Actors- A market led extension approach.
Mr. Rajpal Yadav	Paper	Constraints Analysis of Fisheries Extension Service Providers of Rajasthan, India
Mr. Suresh Kumar Patra	Papers	Temporal dynamics of Land Use Land Cover Changes and assessment of environmental and climatic parameter Using Remote Sensing and GIS: A Case Study in Limboti reservoir, Loha taluka, Maharashtra, India
Ms. Sneha Waghmare	Paper	Temporal dynamics of Land Use Land Cover Changes and assessment of environmental and climatic parameter Using Remote Sensing and GIS: A Case Study in Dimbe reservoir, Ambegaon TaluK, Maharashtra India

Mr. P. Prakash Goraksha	Poster	The nutritional evaluative of fish protein hydrolysate prepared from Mackerel fish (Rastrelliger kanagurta)
Ms. H. Reena Prakashbhai	Poster	Microalgae – Starter food for fish and shrimp larvae
Satheesh M	Poster	Evaluation of nutritional composition of shrimp protein hydrolysate (SPH) from non-penaeid shrimp (*Acetes indicus*) using papain enzyme
Mr.Jebarson Solomon J	Poster	Evaluation of antioxidant potential of green tea waste extract: A prospective nutraceutical for aquafeed
Mr. Naveen S K	Poster	Potential of Withania somnifera Root extract as an antioxidant in aquafeed
Mr. Paul Nathaniel T,	Poster	Determination of Non-Lethal Heat Shock for inducing Hsp70 production in *P. vannamei* juveniles reared in inland saline water
Ms. Shivangi Bhatt	Poster	Effect of sulphate on physio-biochemical responses of GIFT reared in potassium-deficient low saline waters
Mr. Shivkumar	Poster	Extraction of Flavanone compound from Orange peel and Evaluation of its Antioxidant properties
Ms. Neerudu Harika	Poster	Study on stocking density optimization of *Pangasianodon hypophthalmus* and *Ocimum basilicum L.* in recirculating aquaponic system.
Ms. Meenatchi.M	Poster	Salinity dependent abundance of opossum shrimp (mysid) along selected salt pans of Mumbai, Maharashtra
Ms. Kamei Lanthaimeilu	Oral	Length-weight relationship of *Aluterusmonoceros* (Linnaeus, 1758) along the Tamil Nadu coast. Barrackpore
Ms. Thangjam Nirupada C.	Oral	Present status of fish and fisheries in a Ramsar wetland, Loktak Lake, Manipur
Mr. Ansuman Panda	Oral	Skeletal abnormalities in the genus *Alepes Swainson*, 1839 (Carangiformes: Carangidae)
Mr. Bhukya Bhaskar	Oral	Ecosystem Services of the Powai Lake Mumbai. Challenges for urban lake conservation planning.
Ms. V. L. Ramya	Paper	Phenomic and molecular marker-based population delineation of Carnatic carp, *Barbodes carnaticus* (Jerdon, 1849)
Ms. Adya Pandey	Poster	Expression studies of Insulin-like Growth Factor Binding Protein (IGFBP) at transcript level in *Penaeus vannamei* reared in inland saline water at varying stocking density
Mr. Angom Lenin Singh	Poster	Stock comparison of performance traits of *Cyprinus carpio* (Linnaeus, 1758) cultured in inland saline water
Mr. Ganesh Kumar T.	Paper	Occurrence of Triclosan, an Emerging Pollutant along the Coastal and Riverine waters of Mumbai, Maharashtra
Mr. Madhusudhana Rao, B	Oral	An Incidence of Tilapia Lake Virus (TiLV) infection in tilapia, *Oreochromis niloticus* during winter season
Mr. Bhukya Bhaskar	Poster	Ecosystem Services of the Powai Lake Mumbai: Challenges for urban lake conservation planning
Mr. Suman Nama	Oral	Morphometrics and meristic analysis of the Yellow striped goatfish, *Upeneus vittatus* (Forsskål, 1775) along the Indian coast

International Conference on Responsible Aquaculture and Sustainable fisheries Interact (RASHI) CoF Lembucherra, 13- 16 December 2022

Mr. Abhilash Thapa	Paper	Rainbow Trout (*Oncorhynchus mykiss*) Farming in Sikkim, India: An Economic Investigation
Mr. Seenivasan P	Paper	Contrasting Fisheries Development in the 'aspirational' Nadubar and 'progressive' Ahemdnagar, Maharashtra, India
Mr. P. Prakash Goraksha	Poster	"Noval feed ingredient derived from fish waste-A boon for fish larval diet".
Ms. Halpati Reena	Poster	Microalgae – derived nutraceutical for aquafeed
Mr. Prakash Patekar	Poster	Novel feed ingredient derived from fish waste- A boon for fish larval diet
Mr. Shivkumar	Poster	Evaluation of Proximate Composition of Captive Cultured Vinegar eel: A livefeed for Fish fry.
Mr. Lakan Lal Meena	Paper	Application of foliar spray of macronutrients (K, P) and micronutrient (Fe) in a recirculating aquaponics system and its effects on the growth of okra (*Abelmoschus esculentus*) with *Pangasianodon hypophthalmus*
Ms. Abinaya P	Poster	Synthesis of bentonite organoclay and its characterization: an immunostimulant (INS P/06)
Ms. Swagatika Sahoo	Oral	Lipid enhancement in *Ulva* spp. through media intervention for biodiesel production
Mr. Vinay Pokanti	Poster	Analysis of muscle transcriptome of Labeo rohita exposed with heat stress
Mr. Ganesh Kumar T.	Paper	Assessment of environmental risk of Triclosan in selected water bodies of Mumbai
Mr. Mohammed Meharoof	Paper	Economic Valuation of Cultural Ecosystem Services: The Case of a Tropical Reservoir Ecosystem
Mr. Mohammed Meharoof	Paper	Change Detection, Mapping and Potential Assessment for Climate Smart Fisheries in Tropical Reservoir
Mr. Mohammed Meharoof		Fish Culture Area Mapping, Efficient Ranching Assessment and Change Detection for Reservoirs (Fish CAMERA-CDR) Framework (Student Innovation)
Mr. Liton Paul & Mr. Suresh Kr Patra		Ornamental Fish Detection and Behaviour Analysis (OFDABA)-IoT and Artificial Intelligence Approach (Student Innovation)

13th AFAF Taiwan, 31st May to 02 June 2022

Mr. Seenivasan P	Paper	COVID 19 and Fishers Livelihoods: The case of Mumbai Bhaucha Dhaka Market, India
Mr. Omkar Patra	Poster	In Vitro Evaluation of Pomegranate Peel Extract as an Antioxidant Source for Aquafeed
Mr. Mohd Ashraf malik	Poster	Solid- state fermentation can improve the nutrients and anti nutritional profile of Water hyacinth (*Echhornia crassipis*) leaf meal

International conference on Advances in Agriculture and Food System Towards Sustainable Development Goals, Bengaluru, 22 August 2022

Mr. Seenivasan P	Paper	Assessing socio-economic vulnerability for development: A bottom up approach
Mr. Prakash Goraksha P.	Poster	Comparative study on the nutritional evaluative of fish flesh and fish waste protein hydrolysates prepared from Mackerel fish (Rastrelliger kanagurta)

Mr. Jebarson Solomon J	Poster	Dietary Green tea (*Camellia sinensis*) waste lowers excess fat deposition in striped catfish, *Pangasianodon hypophthalmus* (Sauvage, 1878)

19th Biennial International Conference of ANIMAL NUTRITION SOCIETY OF INDIA (ANSI) at Ludhiana, 16th to 18th November, 2022

Mr. Paul Nathaniel T.	Poster	Functional Additives for Alleviating Osmotic Stress in Fish and Shrimps Reared in Inland Saline Water
Ms. Shivangi Bhatt	Poster	Combinatorial effect of sulphate and potassium deficiency on growth and physio-biochemical responses of GIFT fingerlings reared in low saline water
Mr. Saiprasad Bhusare	Paper	Evaluation of Bile Acid containing Low Protein and High Energy on Growth and immunological responses in GIFT Tilapia Juveniles Reared in 10 ppt Inland Saline Water
Mr. Shivkumar	Paper	Orange fruit waste-based natural antioxidants: A novel feed additive in animal nutrition
Mr. Vijayakumar S.	Poster	Lipid nutrition of GIFT juveniles reared in inland saline water
Ms. Akhila S	Poster	Glycerol: A promising ingredient to meet futuristic challenges of aquafeed industry
Mr. Chandan G. M	Poster	Digital Presentation on Utilization of Fermented Mixed Leaf Meal in the Diet of *Labeo rohita* (Hamilton, 1822) Fingerlings

National symposium on Fisheries and Aquaculture for Livelihood and Nutritional Security. Organized by DCFR, Bhimtal, 18-19, 2022

Mr. Chandan G.	Poster	Effect of varying dietary protein levels on growth and gonadal development of Clarius magur broodstock
Ms. Nisha Chuphal	Poster	Effect of dietary lipid levels on growth performance, haemoto-biochemical parameters and osmoregulatory capacity of Penaeus vannamei juveniles in ISW
Mr. Vijayakumar S. Mannur	Poster	Effect of low protein and high lipid diet on nitrogenous waste production and growth performance of GIFT reared in recirculatory aquaculture system
Ms. Akhila S,	Poster	Preferential utilization of energy source in Genetically Improved Farmed Tilapia reared at high temperature and fed with graded levels of dietary protein and lipid
Mr. Mohd Ashraf Malik	Poster	Echhornia crassipis leaf meal with exogenous enzyme supplementation as a replacer of de-oiled rice bran in the diet of Cyprinus carpio fingerlings

ITMU, ICAR – CIFE, 2022

Mr. Selvarani B	Poster	Waking up the sleeping Giant" Innovative technology for sustainable future
Mr.Jebarson Solomon J		Arduino chip based automatic fish feeder system- Innovative technology for sustainable future.

International Conference on AAFS, 2022, Aug. 22 - 24th, 2022

Mr. Saiprasad Bhusare	Poster	Improving survival of fish larvae through better weaning strategies

3rd International River Summit **18-20 Nov 2022**

Ms. Aatira Farooq	Paper	Iron supplementation in aquaculture wastewater and its effect on the growth of spinach and pangasius in nutrient film technique based aquaponics

Ms. Aatira Farooq	Paper	Iron supplementation in aquaculture wastewater and its impact on osmoregulatory, haematological, blood biochemical, and stress responses of pangasius with spinach in nutrient film technique based aquaponics

VIIth International Conference on Global Research initiatives for sustainable agriculture & allied sciences (GRISAAS-2022) at Birsa Agricultural University, Ranchi, Jharkhand, India 23rd November 2022

Mr. Lakan Lal Meena	Paper	Comulative effects of iron with potassium as foliar application on the growth of okra (Abelmoschus esculentus) with Pangasianodon hypophthalmus

International Conference on Emerging Trends in Applied Microbiology and Food Sciences held at Yashvantrao Institute of Sciences, Satara, 02-03 December 2022

Ms. Jerusha S.	Poster	In silico characterization of a multidrug-resistant *Salmonella enterica* serovar Infantis carrying the pESI megaplasmid
Ms. Deeksha Bharti	Poster	Incidence of *Cronobacter* spp. in fresh and dried seafood sold in fish markets of Mumbai

International seminar on wetlands and mangroves, Kochi, Kerala, 24-26 March 2022

Ms. Aiswarya S	Oral	Spatial distribution of Metapenaeus dobsoni(Miers,1878) along Cochin estuary

National Symposium GeoSmart India 2022 ISRS-ISG,HICC, Hyderabad, 15-17 November 2022

Ms. KanchiBhargavi		Touching the Untouched: Implications of geospatial tools in mapping the reservoirs for fisheries development

Sustainable Aquaculture for Atmanirbhar Bharat, 23-24 September 2022

Ms. Pragati Padhan	Poster online	टिकाऊ जलकृषि के लिए जीन एडिटिंग (GE) तकनीक: जेब्राफिश मॉडल में RNA-निर्देशित पुनःसंयोजक (RGR) मंच के माध्यम से GE की सत्यापना हेतु अनुसंधान

XVI Annual Convention of Indian Society of Animal Genetics and Breeding (ISAGBCON2022) and National Conference on Innovations in Animal Genetics and Breeding for Sustainable productivity of livestock and poultry, Hyderabad, 2-3 Dec 2022

Ms. Akshaya Mayaekar	Poster	Estimation of combining ability and genetic parameters for growth traits of Rohu carp (*Labeo rohita*) from diallel cross.

24th Annual Conference of SSCA (online) on Recent Advances in Statistical Theory and Applications (RASTA-2022), ICAR-NAARM, Hyderabad, 23-27 Feb 2022

Mr. Roshan Rameez	Oral	Alternate approaches to estimate the precision of variance components and heritability estimated by REML method under disputable large sample approximation.

2.9. Students Activities

भा.कृ.अनु.प-सीआईएफई द्वारा महिला छत्रवास में स्वच्छता अभियान का आयोजन

भा.कृ.अनु.प-केंद्रीय संस्थान शिक्षा मात्स्यिकी, मुंबई ने 26 दिसंबर, २०२२ के दौरान होने वाले स्वच्छता अभियान के अंतर्गत महिला छत्रवास के छात्राओं और अधिकारियों ने भाग लिया। 26 दिसंबर, २०२२ को गर्ल्स हॉस्टल के परिसर की सफाई में वार्डन के साथ गर्ल्स हॉस्टल के सभी सहपाठियों ने महत्वपूर्ण भूमिका निभाई। डॉ. परमिता बनर्जी ने सूखे और गीले कचरे के पृथक्करण का प्रदर्शन किया। सफाई अभियान सुबह 11:00 से 1.00 बजे तक जारी रहा।

इस स्वच्छता अभियान का संचालन का नेतृत्व, डॉ. पारोमिता बनर्जी सावंत (वार्डन, महिला छत्रवास) और डॉ. शमना एन.(सहायक वार्डन, महिला छत्रवास) ने छात्र प्रतिनिधियों के समर्थन से किया था|

ICAR-CIFE Organizes Cleanliness Drive at Boys & Girls Hostels and awareness on waste management (Dry and Wet waste), New campus on 26 December 2022

ICAR-CIFE, Mumbai organized a Cleanliness Drive and awareness program on dry and wet waste management at Girls Hostel, New campus as a part of Swachhata Campaign on 26 December 2022. All the inmates of Girls hostel along with wardens were instrumental in cleaning the premises of the Girls Hostel and Dr. Paramita Banerjee demonstrated the dry and wet waste segregation. The Cleanliness drive continued from 11:00 to 1.00 PM. This drive was headed by Dr. Paramita Banerjee Sawant (Warden, Girls Hostel), and Dr. Shamna N. (Deputy Warden, Girls Hostel) supported by the student representatives.

ICAR-CIFE, Mumbai organized a Cleanliness Drive at boys hostel as a part the of Cleanliness Campaign during 16-31 December 2022. The hostel inmates were part of the event. The Cleanliness campaign began at 8.30 AM. During the Swachhata Abhiyaan, the hostel premises and adjacent areas were cleaned. Dr. Rupam Sharma, Scientist (Warden) Dr. Shashi Bhushan, Scientist (Deputy-Warden), coordinated the event.


भा.कृ.अनु.प.-केन्द्रीय मात्स्यिकी शिक्षा संस्थान,मुंबई
ICAR-CENTRAL INSTITUTE OF FISHERIES EDUCATION

2.10 Convocation

ICAR-CIFE Celebrated its XV Convocation on 23 April, 2022. Hon'ble Minister of Fisheries, Animal Husbandry and Dairying, Govt of India, Shri Parshottam Rupala was the Chief Guest of the function. Dr. Trilochan Mohapatra, Secretary, Department of Agricultural Research & Education (DARE), Govt. of India and Director-General, Indian Council of Agricultural Research (ICAR) presided over the function. Dr J. K. Jena DDG (Fisheries) ICAR in the august presence of home M.P. Hon'ble Shri Gopala Shetty and local MLA Dr. Bharati Lavekar were present as Guests of Honour. Dr. Ravishankar C. N., Director, and Vice Chancellor, CIFE, in his welcome address, highlighted the salient academic and research achievements of the institute. He also underlined the research and thrust areas and the achievements in the flagship programmes taken up and new academic initiatives taken by the institute. Dr. Mohapatra in his convocation address emphasised on the need of Blue Revolution to increase fish production to meet the future demand. He said that ICAR is in the process of charting out new education policy where students will be ready as per the industry requirements. He also added that the use of digital platforms and artificial intelligence will be given more impetus. Hon'ble Shri Parshottam Rupala ji in his convocation address hoped the fisheries sector to be the mainstream field in the coming days and fisheries has that potential which no other sector has. Govt of India has developed programs to achieve that. The curriculum should have parallel support to this initiative. And fisheries ministry is ready to do whatever necessary to promote entrepreneurship in fisheries. He lauded the efforts of North Eastern states who have performed very good in the fisheries sector. He congratulated CIFE and its faculty for producing world class talent in Fisheries. During the convocation, former Director of CIFE, Dr. Dilip Kumar was awarded honorary degree of D.Sc. A total of 230 M.F.Sc. and 91 Ph.D. Degrees were awarded besides presenting 45 Gold Medals to meritorious students of CIFE. The program ended by the formal vote of thanks by Dr. N.P. Sahu, Jt. Director of ICAR-CIFE

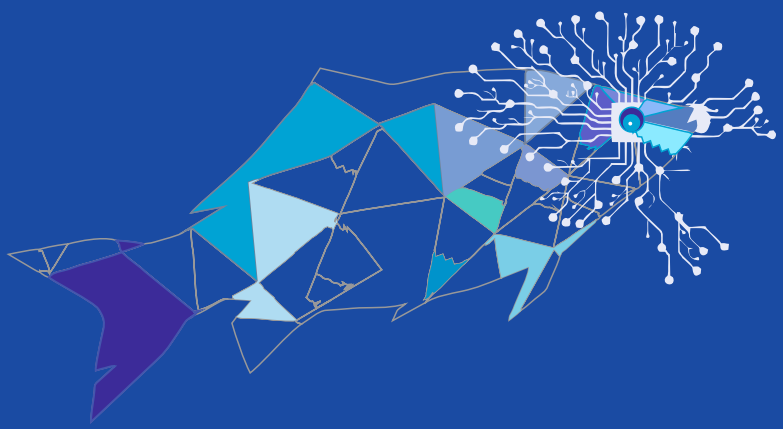
2.11 Swar Sangam

A Cultural Event by students and Koli community was held on 24th April 2022, where talents were displayed and the diverse traditional culture of vast majority of states of India were presented.

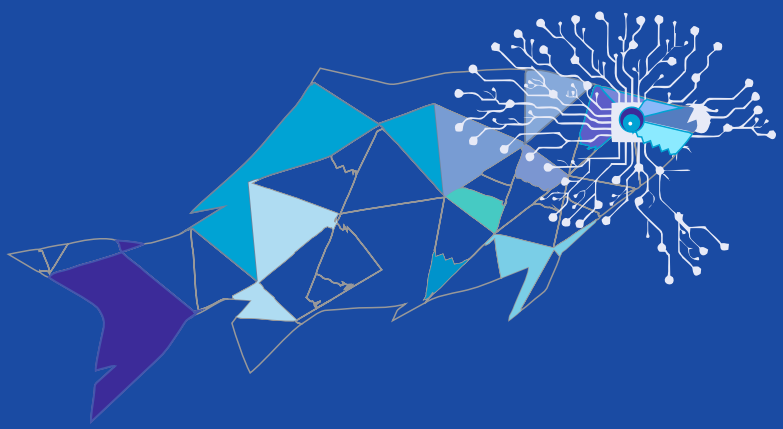
2.12 Alumni Meet

ICAR - Central Institute of Fisheries Education organized 'VARISMRITI-22' the Alumni Meet– 2022 at the Yari Road Campus of ICAR-CIFE on 23rd April 2022. In order to get the maximum coverage and enable the presence of alumni around the world, the program was organized in hybrid mode i.e. online and offline mode. The program was attended by more than 300 alumni across the globe. The Deputy Director General (Fisheries) Dr. J.K. Jena graced the occasion and appreciated the Institute for organizing such interaction which will inspire the young students in choosing their goals. In the introductory remark, Dr. C.N. Ravishankar, Director and Vice-Chancellor of ICAR-CIFE, stressed upon establishing a strong linkage between the students and alumni. He urged alumni to guide the students and handhold them for their career. The Joint Director, Dr N.P. Sahu expressed his happiness for the response received from the alumni in conducting the program. Eminent ex-students of the institute were invited as speakers for the technical session where they shared their journey of excelling in their own specialized field and also shared their past memoir of CIFE. The session was followed by another interesting session 'CIFE-Shark Pool' where the students were given chance to present their innovative entrepreneurship ideas which were appreciated by the Entrepreneurs present during the session and promised to guide our students in achieving their goals. Later, the general body meeting was held and certain important decisions were taken. In the interaction and jamming session, alumni shared their memories of their student life. The program was concluded with DJ night and dinner.

Research Achievements



3.1 Inland Saline Aquaculture



NATIONAL AGRICULTURAL HIGHER EDUCATION PROJECT

Development of Energy Efficient and Envionment Protective - Aquaculture Technologies for Degraded Soils -

Centres for Advanced Agricultural Science and Technology (CAAST)

Funded by: **World Bank & Govt.of India** Supported by: **ICAR-Education Division**

Duration: 2017-2023 **Project Code: CIFE/2017/100/EF**

Principal Investigator : Dr. N. P. Sahu (from 1.6.2022); Dr. Gopal Krishna (till 31.05.2022)
Nodal Officer: Dr. Rupam Sharma (from 1.6.2022); Dr. Gayatri Tripathi (till 31.05.2022)

Component Leaders/Co-PIs
Dr. N. P. Sahu (1d, 2)
Dr. K. V. Rajendran (1f)
Dr. B. B. Nayak (3)
Dr. Geetanjali Deshmukhe (1e)
Dr. S. Jahageerdar (1g)
Dr. P. S. Ananthan (1a, 4)
Dr. A. K. Balange (1h)
Mr. V. Hari Krishna (1e)
Dr. Vidyashree Bharti (1b)
Dr. Babitha Rani (1c)

Co-PIs
Dr. N. K. Chadha
Dr. Aparna Chaudhari
Dr. S. N. Ojha
Dr. Parimal Sardar
Dr. Rupam Sharma
Dr. Gayatri Tripathi
Dr. S. Dasgupta
Dr. Paromita B. Sawant
Dr. Sanath Kumar
Dr. Martin Xavier
Dr. Saurav Kumar
Dr. Shashi Bhushan
Dr. Tincy Varghese
Dr. Mujahidkhan A. Pathan
Dr. Shamna N.
Dr. Neha Wajahat Qureshi
Dr. Pankaj Kumar
Dr. K. Sreedharan
Mr. Abuthagir Iburahim
Dr. Dasari Bhoomaiah

Component 1: Development of Energy Efficient and Eco-friendly Technologies

Aquaculture is accepted as one of the viable options for utilising the otherwise agriculturally unproductive, degraded and unutilised salt-affected areas. Shrimp aquaculture (*L. vannamei*) is a recent entrant in inland salt-affected areas, thanks to CIFE's pioneering technology development and demonstration in Haryana, Punjab and Rajasthan since 2013-14. NAHEP-CAAST Project was taken up in 2017 by ICAR-CIFE to address the emerging challenges and develop eco-friendly and energy efficient technologies to strive towards sustainability. Significant progress has been made under the Project even though Covid-19 pandemic disrupted the field work during 2020 and 2021. The Project was extended for one more year (2022-23) and efforts were made during 2022 to complete the committed work that spanned research, development, training and extension.

Development of the composite site suitability index for sustainable inland saline aquaculture, customised recirculating aquaculture system (RAS) and biofloc technology for intensive inland shrimp aquaculture, biochar technology for effect in-site waste management and water quality maintenance, field validation of nutraceuticals for growth and immunity enhancement in *L. vannamei,* screening of potential common carp stocks for selection, and preparation of value added products from inland saline grown shrimp were the research highlights. Training and capacity building programs, guest lectures, industry linkages and outreach programs organised under the Project are given in respective sections.

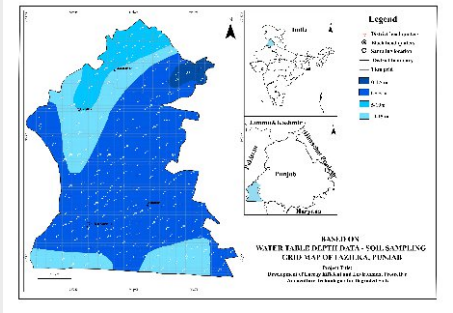
Component 1a.

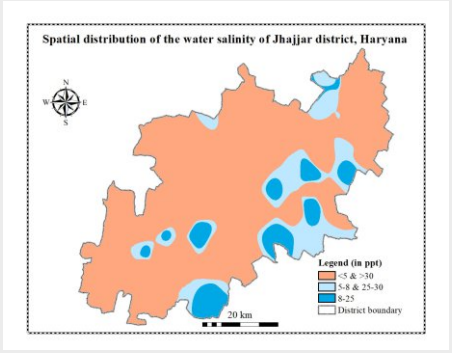
Resource Availability, Characteristics and Potential of Inland Saline Soil and Water

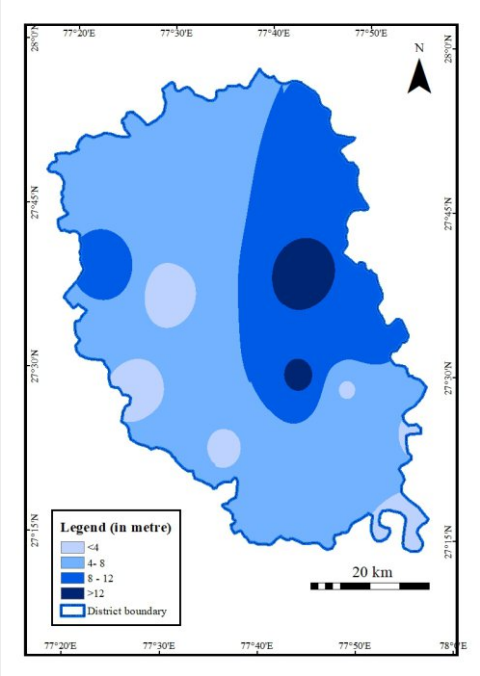
ICAR-CSSRI estimates that India has about 5.5 million ha of salt-affected lands in inland regions, and 1.93 million sq. km area with ground saline water, prevalent mainly in the arid and semi-arid regions of Haryana (2.32 lakh ha), Punjab (1.51 lakh ha), Uttar Pradesh (13.7 lakh ha), and Rajasthan (3.75 lakh ha), affecting the agricultural productivity adversely. However, no credible evidence exists as to the extent to which these areas are suitable for sustainable shrimp aquaculture. This study identifies the suitable areas using an interdisciplinary approach involving geo-spatial data, land use and cover, topography, soil-water chemistry, and the farmers' know-how and behavioural attributes. The study covered four districts - Rohtak and Jhajjar (Haryana), Fazilka (Punjab) and Mathura (Uttar Pradesh).

Till 2021, using remote sensing imageries and GIS tools, rectified village, block and district level vector database, and various thematic layers, namely road network, drainage, slope, rainfall, soil moisture, vegetation, salinity, and ground water depth have been prepared for the four districts. Using waterlogged areas and the surface salinity maps, a stratified and proportionate sampling framework was developed, and nearly 2000 soil and water samples were collected and analysed for physio-chemical parameters (pH, Electrical Conductivity, Soil Texture, Chloride, Carbonate, Bi-carbonate, Sodium, Potassium, Calcium, Magnesium for soil and water Salinity, Electrical Conductivity, pH, Carbonate, Bicarbonate, Sodium, Potassium, Calcium, Magnesium, Total hardness, Chloride, Total Alkalinity for water). Similarly, the farmers' know-how on the prevalence and history of salinity in their villages, its effect on agriculture and their attitude towards aquaculture and shrimp farming were ascertained. Covid-19 pandemic disrupted the Project work and led to delay.

During 2022, site-specific geo-spatial maps for the identified soil-water parameters, topography and land use, and climate variables were prepared and ground truthing was done. Results revealed large and significant variations in most of the variables across the villages within the district, across districts in different states, as well as between pre-monsoon and post-monsoon periods. A comprehensive and unique indicator based methodological framework called Site Suitability Index for Sustainable Inland Saline Aquaculture (SSI-SISA) was developed to integrate the complex set of relevant variables into a single composite index value for each site / village. The methodology is being expert validated and field tested, and is intended to help in planning and decision making.








31 Jan 2022, 2:10 pm

Component 1b.

Enriching Elemental Deficiency, Carbon Storage and Enhancing Soil Productivity

Biochar, produced using agro-waste (sun dried with moisture < 15%) in a biochar kiln at CIFE farm, was field tested in shrimp farms in inland salt-affected areas. There was significant decrease in seepage loss of water from the pond treated with biochar @2 tonne/ha as compared to the control. Application of biochar causes significant reduction in emission of nitrous oxide from the shrimp ponds. Growth of shrimp was better in the biochar treatment as compared to the control. Biochar is applied by mixing slurry of biochar with sediment during land preparation or in the water column after filling the ponds. Biochar is soaked in water overnight to have better results. Pond studies indicated that biochar can be used for improving water quality parameters, particularly removal of the ammonia and other contaminants, improving the fertility status and physico-chemical and biological activity of the sediment in an inland saline and freshwater aquaculture systems, when it is used as an amendment in sediment bed or given through feed (figure 1). Feed application of biochar retains the nitrogen in organisms by improving the nitrogen use efficiency and thus less release of nitrogenous waste in the system, leading to less release of nitrous oxide, a potential greenhouse gas. Feed application requires less amount of biochar, and different agro waste mixture based biochar can be fed to meet the nutrient deficiency in the organism or the system.

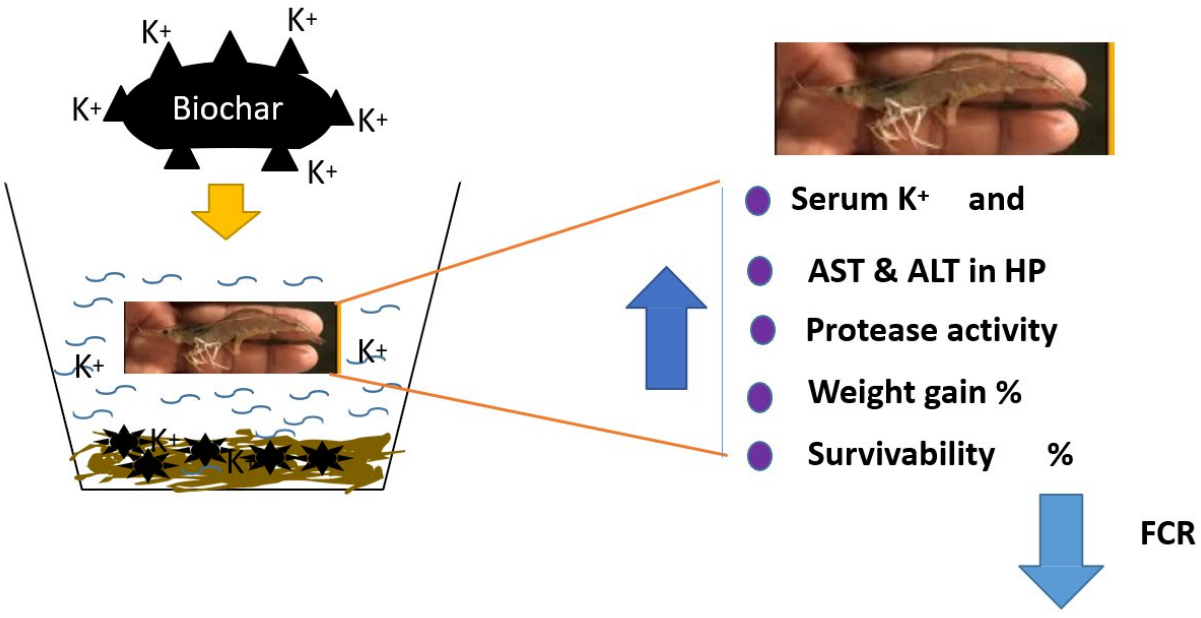
Effect of Mixed Biochar on Soil Microbial Activity and Productivity in *Peneaus vannamei* (Boone, 1931) Culture

CIFE/2020/AEM003/SR

N. Tachangliu

Major Advisor: Dr. Vidya Shree Bharti

The experiment was conducted for 60 days in a 500-litre capacity FRP tank with one control and three treatments. In control (only sediment), T1 (PSB + sediment), T2 (BPB+sediment), and T3 (PSB+ BPB+ sediment), 100 g of biochar was applied to 25 kg of sediment (i.e., the biochar application rate at 9 t/ha). Shrimps were stocked at 60 juveniles per m². At the end, hepatopancreas, gills, and muscle tissues and serum were sampled for enzymes and serum profiles. The water quality parameters showed a significant increase in pH, alkalinity, magnesium, potassium, and a reduction in ammonia and calcium in biochar treatments compared to control. In the case of sediment properties, there was a substantial increase in WHC, SOC, pH, SMBC, and soil enzymes DHA and FDA. Growth parameters revealed a significant increase in final body weight, weight gain percent, SGR, PER, HPSI%, and reduced FCR (within 1- 1.26) in biochar-treated groups. The survivability was high in T3, with 92%, which is mixed biochar amended sediment. It was observed that the mean levels of digestive enzymes (protease, amylase, and lipase) and oxidative stress enzymes (SOD and CAT in the gills) were significantly greater in the biochar amended treatment groups compared to the control. As for the serum, higher hemocyanin was observed in the biochar treated group, with the highest concentration in mixed amended biochar and the least in control. So, among the treatments, T3 showed the best overall performance in terms of water quality, soil characteristics, and growth performance.



Compont 1c.
Biofloc Technology for Sustainable Effluent Management in Aquafarms

A biofloc consortia was developed in controlled condition through optimized process environment in a bioreactor. The process applied and standardized were sludge retention time, intermittent aeration, sludge quantity and biofloculating agents combinations. The floc was produced in the biofloc reactor by enriching the heterotrophic bacteria in the aquaculture sludge through optimized process by following full factorial design and response surface methodology and the desirability ramp was used to optimize the process. The biofloc consortia produced in the reactor within 3-6 days of operating the reactor and then was harvested and dried under moisture free controlled environment to retain the quality of the floc. The product retrieved bioflocculation ability, when provided with condition suitable for multiplication and development, mainly the optimal carbon: nitrogen ratio of 20: 1. The consortia was tested for its ability to develop floc in commercial scale culture units and were found to be developing floc within 3-5 days of inoculation. The shelf life of the consortia developed was estimated to be 90 days in ambient conditions in an airtight package. The technology has been demonstrated through hands-on training to shrimp farmers in inland salt-affected areas.

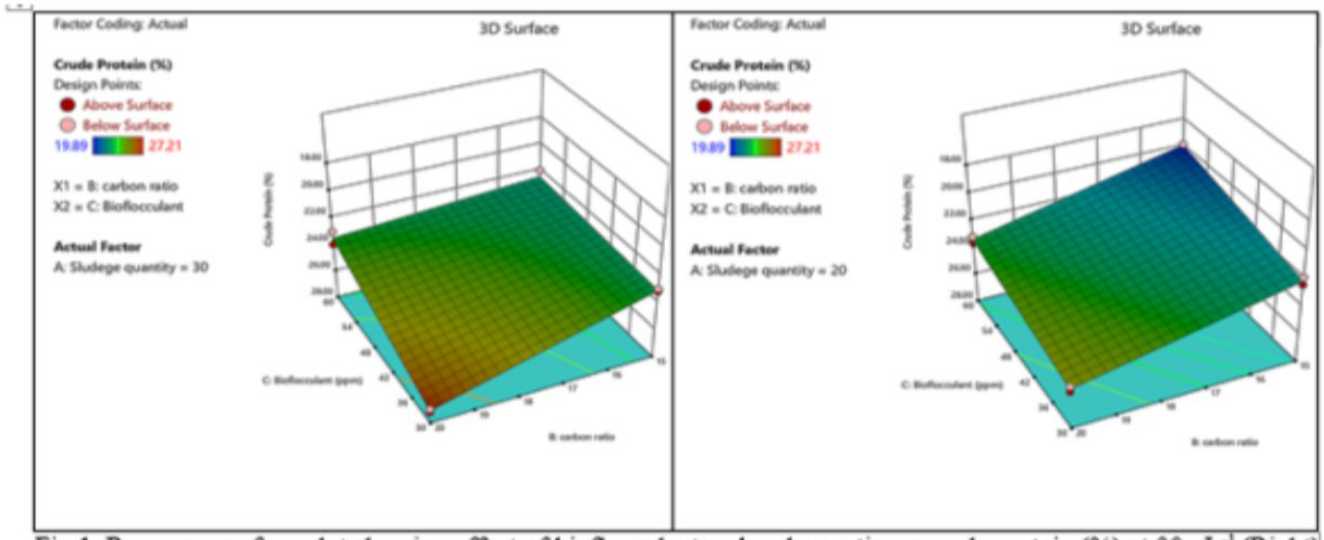


Fig.1. Response surface plot showing effect of biofloccculant and carbon ratio on crude protein (%) at 30 gL^{-1} (Right) and 20 gL^{-1} (left) sludge quantity.

Component 1d:
Nutraceuticals for Stress Mitigation and Growth Enhancement

In all aquaculture systems, feed plays a major role and contributes nearly 60% of total expenditure. Hence, standardization of system specific feed and ensuring effective feed utilization using a right feeding strategy becomes vital. The inland saline aquaculture (ISA) system is an ecologically fragile and sensitive environment, necessitating optimisation of the feed and feeding strategy. The high usage of potassium, a costly nutrient used to fortify the ionic imbalanced inland saline water could be reduced to 50% when *P. vannamei* was fed with 1% potassium chloride in the diet. This result can support the farmer/ entrepreneur to adopt a better strategy for inland saline shrimp farming bringing down the operational cost.

Two specific feeds were standardized for inland saline reared *P. vannamei* and GIFT tilapia. The formula of the feeds has optimum nutrients which is standardized based on the preliminary nutrient requirement studies. The feeds are unique for the ionic imbalanced water due to supplementation of nutraceuticals to mitigate the salinity or osmoregulatory stress in shrimp/fish. This is an eco-friendly feed with low protein and high energy content along with a balanced amino acid profile to meet the requirement of the species. Hence, the release of high phosphorous and nitrogen will be considerably reduced in the system. The feeds and the technology developed under this component has a high commercial value. Two training program were conducted and around 100 participants benefited under this component.

CIFE/2017/FNT004/SR

Dietary Intervention for Improving Growth and Immunophysiological Responses in GIFT Tilapia Fingerlings Reared in Inland Saline Water

Mritunjoy Paul

Major Advisor: Dr. Parimal Sardar

Four experiments were conducted for 60 days each to develop a cost- effective and eco-friendly feed for GIFT tilapia reared in inland saline water (ISW) of 15 ppt salinity. First experiment was carried out with seven purified hetero-nitrogenous (20-50% CP), iso-caloric (400 Kcal DE/100g) and iso-lipidic (6% lipid) experimental diets viz., CP20, CP25, CP30, CP35, CP40, CP45 and CP50 in triplicates. According to polynomial regression analysis, 40.66-41.84% dietary protein is optimum for maximum growth performance and physioimmunological status of GIFT tilapia. Second experiment was conducted with seven iso-nitrogenous (41% CP), hetero-lipidic (4-16% lipid), and hetero-energetic (389.56-449.02 Kcal DE/100g) purified experimental diets viz., L4, L6, L8, L10, L12, L14 and L16 in triplicates. The highest ($p<0.05$) FBW, WG% SGR, PER and transaminase activities with lowest FCR were observed in 10% lipid (L10) fed group.

As per regression analysis, 9.91-10.01% dietary lipid is optimum for maximum growth, physio-metabolic and health status of GIFT tilapia. Third experiment was carried out with twelve practical hetero-nitrogenous (40-30% CP), hetero-lipidic (9-13% lipid), and hetero-caloric (413.14-433.95 Kcal DE/100g) low protein-high energy experimental diets viz., T1 (40% CP and 9% lipid), T1B (T1 + 0.05% bile acid), T1C (T1 + 0.05% L-carnitine), T1BC (T1 + 0.025% bile acid and 0.025% L-carnitine), T2 (35% CP and 11% lipid), T2B (T2 + 0.05% bile acid), T2C (T2 + 0.05% L-carnitine), T2BC (T2 + 0.025% bile acid and 0.025% L-carnitine), T3 (30% CP and 13% lipid), T3B (T3 + 0.05% bile acid), T3C (T3 + 0.05% L-carnitine) and T3BC (T3 + 0.025% bile acid and 0.025% L-carnitine) in triplicates. The highest ($p<0.05$) FBW, WG%, and SGR and the lowest FCR were found in T1B and T2B groups. The highest lipid fed group showed the highest HSI, VSI, IPF, SOD and CAT activities, MDA and serum GLU, T-CHO, TAG and LDL-CHO and bile acid feeding reduced them. Dietary bile acid also improved WBC and NBT in fish. Therefore, it can be concluded that T2B diet (35% CP and 11% lipid supplemented with 0.05% bile acid) could register the best growth performance and health status of GIFT tilapia reared in ISW of 15 ppt. Furthermore, fourth trial under pond conditions revealed that feeding of 35% protein, 11% lipid and 0.05% bile acid containing diet could maximize the growth with better economic return. The outcomes of the present study will help to develop a cost-effective feed for sustainable GIFT tilapia culture in ISW.

CIFE/2018/FNFT003/SR

Dietary Intervention for Improving Growth and Immunophysiological Responses in *Penaeus vannamei* (Boone, 1931) Juveniles Reared in Inland Saline Water

Prasanta Jana

Major Advisor: Dr. N. P. Sahu

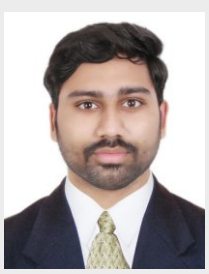
Four experiments were conducted for 60 days each to develop a cost-effective and eco-friendly feed for white-leg shrimp, *Penaeus vannamei* reared in inland saline water (ISW) of 15 ppt salinity. First experiment was conducted with seven semi-purified hetero-nitrogenous (200 to 500 g CP/kg), iso-caloric (396 Kcal DE/100g) and iso-lipidic (60 g/kg) experimental diets viz., CP20, CP25, CP30, CP35, CP40, CP45 and CP50 in triplicates. Growth and immuno-physiological paramerters also exhibited optimum conditions with 392.60-397.90 g CP/kg diet. Second experiment was conducted with six iso-nitrogenous (400 g CP/kg), hetero-lipidic (40 to 140 g lipid/kg), and hetero-energetic (376 to 426 Kcal DE/100g) semi-purified experimental diets viz., CL4, CL6, CL8, CL10, CL12 and CL14 in triplicates. Growth and physio-metabolic parameters and health status of white-leg shrimp, *P. vannamei* showed better performance with feeding 55.80-58.80 g lipid/kg.

Third experiment was carried out with twelve LPHE practical hetero-nitrogenous (400 to 320 g CP/kg), hetero-lipidic (60 to 100 g lipid/kg), and hetero-caloric (384 to 406 Kcal DE/100g) experimental diets viz., T1 (400 g CP/kg and 60 g lipid/kg), T1C (T1 + 0.5 g/kg L-carnitine), T1T (T1 + 5 g/kg taurine), T1ct (T1 + 0.25 g/kg L-carnitine and 2.5 g/kg taurine), T2 (360 g CP/kg and 80 g lipid/kg), T2C (T2 + 0.5 g/kg L-carnitine), T2T (T2 + 5 g/kg taurine), T2ct (T2 + 0.25 g/kg L-carnitine and 2.5 g/kg taurine), T3 (320 g CP/kg and 100 g lipid/kg), T3C (T3 + 0.5 g/kg L-carnitine), T3T (T3 + 5 g/kg taurine), and T3ct (T3 + 0.25 g/kg L-carnitine and 2.5 g/kg taurine) in triplicates. T2ct diet (360 g CP/kg and 80 g lipid/kg supplemented with 0.25 g/kg L-carnitine and 2.5 g/kg taurine) showed the best performance in terms of growth and health status of *P. vannamei* reared in ISW of 15 ppt. Furthermore, in pond condition, T2ct diet exhibited additional 10% growth benefit and an additional profit margin of Rs. 3,27,100 (1 ha, 10,000 m2) in comparison to commercial diet (C). The outcomes of the study will help to develop a cost-effective feed for ISW shrimp culture and can generate extra income for the shrimp farmers of salt-affected regions.

Component 1e.
Sustainable Fish and Shellfish Production Systems through Stocking, Harvesting and Bioremediation Strategies

CIFE/2020/FNT005/SR

Evaluation of *Jal Bramhi* (*Centella asiatica*) Leaf Extract in the Diet of GIFT Fingerlings reared under different Stocking Densities in Inland Saline Aquaculture



Potluri Sai Kishore

Major Advisor: Dr. Pankaj Kumar

A 60-day feeding trial was conducted to evaluate the effect of dietary *Centella asiatica* ethanolic extract on the growth, nutrient utilization and immuno-physiological responses in the GIFT fingerlings reared at different stocking densities in 10 ppt inland saline water. *Centella asiatica* leaf meal crude extract was made using 85% ethanol, methanol and 50% acetone. Qualitative and quantitative studies were conducted to determine the presence of certain bioactive compounds in the different extracts. *Centella asiatica* ethanolic extract showed better dry matter recovery, higher bioactive compounds and highest antioxidant activity. Three iso-nitrogenous (35% CP) and iso-lipidic (11%) practical diets were prepared with the inclusion of three different levels of *Centella asiatica* ethanolic extract (0, 0.5 and 1%). Four hundred and five acclimated GIFT fingerlings (Initial body weight, 2.04 to 2.12 g) with different stocking densities (10, 15, 20 nos./75L) were randomly distributed in nine treatment groups viz. S10CA0, S10CA0.5, S10CA1, S15CA0, S15CA0.5, S15CA1, S20CA0, S20CA0.5, S20CA1 in triplicates.

Results indicated that the fishes fed with 1% *Centella asiatica* ethanolic extract improved ($p>0.05$) the weight gain (g), specific growth rate (SGR), protease, amylase, aspartate aminotransferase (AST) and malate dehydrogenase (MDH) activities and FCR values in all stocking density groups. The body indices, lipase activity and survival % showed no significant ($p>0.05$) difference among the treatments. The superoxide dismutase (SOD) and catalase activity, serum glucose, malondialdehyde (MDA) content increased ($p<0.05$) with high stocking density and decreased with higher (1%) level of *Centella asiatica* ethanolic extract. Whereas, hepatic G6PDH activity, reduced glutathione, glycogen and serum total immunoglobulin content, myeloperoxidase (MPO) and nitroblue tetrazolium (NBT) values increased significantly ($p>0.05$) with the levels of *Centella asiatica* ethanolic extract in all stocking densities. Similarly, an increasing trend was observed in all the hemato-immunological parameters with the increasing levels of *Centella asiatica* ethanolic extract in all stocking densities. It can be concluded that the dietary inclusion of 1% *Centella asiatica* ethanolic extract can improve the growth, nutrient utilization and immuno-physiological responses of GIFT fingerlings reared in low to high stocking density in inland saline aquaculture.

Component 1g.

Genetic Evaluation of Common Carp in Multi-stocks, Multi-inland Saline Environments

Ten stocks of common carp belonging to various geographical locations of India were assembled at ICAR-CIFE, Rohtak Regional centre. Seventy-eight full sib families including seven half sib families were produced in F0 generation. A total of 2200 fish belonging to 62 families were PIT tagged and released in two grow-out ponds of two different salinities (< 4ppt and >8ppt) and growth performance at 200 days pond age was evaluated. In another experiment 1800 fish belonging to six stocks were reared at two different salinities (< 4ppt and >8ppt). About 1500 fish were further PIT tagged at 225 days pond age and growth was evaluated at 365 days pond age. Further (for reporting year 2022), a single pair mating design was used to generate 86 full sib families (F1 Generation, First Batch) belonging to five stocks from Andhra Pradesh, Maharashtra, Manipur, Madhya Pradesh and Haryana. The families were reared in nursery hapas for one month followed by culture at >8ppt salinity in rearing hapas in two ponds of size pond A (1200m2) and pond B (1000m2) respectively. Pond A and pond B had 59 families and 27 families, respectively. The stocking density in rearing hapas was 4.5 fish/m3 and 5160 fish belonging to 86 families were cultured. At forty-five days of culture age, the growth traits and survival traits were recorded.

The animal model heritability estimates of BW0, BW1,SL1, BD1 and survBW1 was found to be high in the range of 0.47-0.67 respectively. The effect of pond was significant on early juvenile performance. Further, tagging of 1780 fish belonging to 85 families using PIT tag was done. The tagged fish were then released for grow out in two ponds (pond A and B) of size 1200 m2and 1000 m2 size approximately. The pond A and pond B are stocked with 964 and 816 fish respectively. The common carp is reared at salinity >8 ppt and winter performance is evaluated.

CIFE/2020/FGB005/SR

Genetic Analysis of Growth Traits of Juvenile *Cyprinus Carpio* (Linnaeus, 1758) Cultured in Inland Saline Water

Raghul R

Major Advisor: Dr. Mujahidkhan A. Pathan

Earlier studies have shown that common carp can withstand > 8ppt salinity without any adverse effect on its growth performance. However, limited literature exists on early performance traits of common carp cultured at >8ppt salinity. This study estimated the genetic parameters for early growth traits viz., body weight (BW), standard length (SL) and body depth (BD) and also evaluate the effect of non-genetic factors on early growth performance. A single pair mating design was used to generate 86 full sib families belonging to five stocks. The families were reared in nursery hapas for one month followed by forty five days' culture at >8ppt salinity in rearing hapas in two ponds of size pond A (1400 m^2) and pond B (1000 m^2) respectively. Pond A and pond B had 59 families and 27 families, respectively. The stocking density in rearing hapas was 4.5 fish/m3 and 5135 fish belonging to 87 families were cultured.

At forty-five days of culture age, the growth traits were recorded on 3137 fish belonging to 85 families. The survival was 61 percent. At forty-five days culture age, the mean BW, SL and BD were 5.7 ± 0.07g, 5.26 ± 0.02cm and 1.93 ± 0.01cm respectively. A general linear model was adopted to identify the effect of stock, pond, stock interaction with pond, sire body weight and dam body weight on the growth traits. The families belonging to HR and MH stock had significantly higher BW compared to others. The families belonging to HR stock had significantly higher SL compared to others. The families belonging to pond B had significantly higher SL compared to pond A. Stock wise and pond wise there was no significant difference for BD. The growth traits recorded exhibit high heritability. The rg for BW & SL, BW & BD and SL & BD is 0.88, 0.89, 0.88 respectively. The study highlights the presence of significant genetic variation in both between and within families and may be exploited for genetic selection.

Development of Nursery based System for *Penaeus vannamei* using ISGW, and Assessment of Physiological and Immunological Parameters in Single Phase and Two Phase Farming Systems

CIFE/2019/101/EF

Project duration:2019- 2023

Principal Investigator
Dr. Sreedharan K
Mr. Hari Krishna (till 30.05.22)

Co-Principal Investigator
Dr. Pankaj Kumar
Dr. Satyaprakash

Funding Agency: DBT
Budget: Rs. 57 lakhs

Post larvae of *Penaeus vannamei* were stocked in nursery rearing ponds in 3 different densities (30,45 and 60 no./m²) in duplicates. After the rearing for 30 days, sampling was done to determine different growth parameters. Besides, 3 animals from each rearing unit was collected, different organs including gill and hepatopancreas were dissected and preserved in RNA for assessing the expression of different immune genes by real time PCR. Growth parameters were found to be better in animals stocked in 30 no./m². The expression of various genes including superoxide dismutase, heat shock protein 70 and sodium-potassium ATPase indicated that it's expression levels were modulated in animals stocked 30 no./m²

Technology Demonstration of Emerging Fish Species in Biofloc Culture System

CIFE/2022/102/EF

Project duration:2022- 2025

Principal Investigator
Dr. Babitha Rani A.M

Co-Principal Investigator
Dr. Sreedharan K
Dr. Shamna N
Dr. Upasana Sahoo

Funding Agency: NFDB
Budget: Rs. 26 lakhs

Biofloc technology is an eco- friendly aquaculture technique based on in situ microorganism production and a source of income generation for landless farmers. The suspended biofloc can assimilate ammonia and other nitrogenous compounds to develop microbial protein which in turn will serve as natural protein rich feed to fishes under culture. Hence, there can be a better performance of fish compared to clear water intensive culture systems. However, the growth of microorganisms in biofloc varies with the salinity and accordingly, the performance of fish will also vary. This project proposes to develop biofloc systems specific to freshwater and inland saline environment with the following objectives to develop demonstration unit for

intensive fish farming in limited space using BFT; to develop ready to use biofloc inoculum through evaluation of various media for selected cultivable species; to evaluate the carcass quality of biofloc reared fishes in freshwater and inland saline water for assessment of palatability; and to train farmers and unemployed youth into income generation through small scale BFTdevelopment and construction of new biofloc units is ongoing.

Techno-economic Feasibility and Value Addition Prospects of Biofloc Technology in Inland Saline Aquaculture

CIFE/2022/01/IF

Project duration:2022- 2024

Principal Investigator
Dr. Babitha Rani A.M

Co-Principal Investigators
Dr. Pankaj Kumar
Dr. Sreedharan K
Dr. T. I. Chanu
Dr. Shamna N
Dr. Upasana Sahoo

An experiment was conducted with high density (400 no /m3 stocking of white shrimp juveniles in biolfoc system using inland saline water of 15 ppt. The culture could sustain in a zero-water discharge mode upto 47 days and the growth obtained was 6.28 gm from an average intial size of 1.54 gm. Another experiment was conducted to optimize the mineral requirement in biofloc system for inland saline aquaculture was carried out with different dosage of commercial mineral mix in a 2X2 factorial design with bioflocculating agents. The shrimp growth was higher at 2g/L dosage of mineral mix in the inoculum and 30 ppm of bioflocculating agent. The growth was upto 14.73 gm from an initial average body weight of 9.48 gm.

White Faeces Syndrome (WFS) in Farmed *Penaeus vannamei* in Inland Saline Areas and Management Strategy

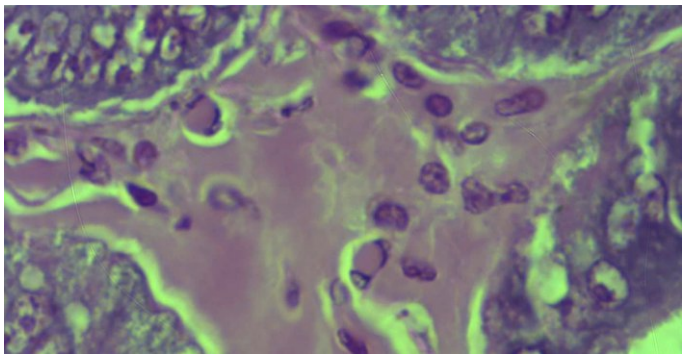
CIFE/2022/16/IF

Project duration:2022- 2025

Principal Investigator
Dr. Sreedharan K

Co-Principal Investigators
Dr. Babitha Rani A.M
Dr. Pankaj Kumar
Dr. K. V. Rajendran
Dr. H. Sanath Kumar

Samples of water and shrimp were collected from the white faeces disease (WFD)-affected *Penaeus vannamei* farms located at Sirsali, Churu district, Rajasthan. Samples were spread plated on TCBS (Thiosulfate-citrate-bile salts-sucrose) agar. The total *Vibrio* count of WFD-affected samples was found to be higher than the normal one. The histopathological analysis of hepatopancreas from the WFS-affected pond revealed certain clinical manifestations such as tubular necrosis and dilated inter-tubular sinus with infiltrated haemocytes.



3.2.

Aquaculture Diversification

Effect of Supplementation of Nutrients on Various Vegetables and Herbs under Aquaponics

(CIFE/2019/7/IF)

Project duration: 2019-2022

Principal Investigator
Dr. A.K. Verma

Co-Principal Investigators
Dr. Vidya Shree Bharati
Dr. Tincy Varghese
Dr. Madhuri Pathak

Technical Associate
Dr. Chandrakant M.H.

Under the project, a NFT recirculating aquaponic system was designed and developed with 30 identical units. Various experiments showed that specific nutrient deficiency in an aquaponic system can be effectively rectified by supplementing such nutrients depending on the requirement in each physiological stage of the plant. Study revealed that excessive levels of potassium and iron could be hazardous to fish if exposed for an extended period. Increased iron supplementation had a significant effect on the growth and yield of spinach; however, higher dose of Fe had an adverse effect and reduced the plant's leaves and roots dry weight contents. Excess Fe interacts with essential macronutrients and micronutrients, and had a negative impact on their uptake, which in turn affects the plant growth and yield of crops. Successive harvesting and revegetation of spinach in an aquaponic system resulted in a higher yield. Increasing iron dosage increased haemoglobin, HCT, WBC count, and RBC count in fish. Based on the growth, proximate composition of fish and plants as well as immuno-haematological, metabolic, plasma biochemical, osmoregulatory, and stress response of fish, it can be concluded that 1.5 mg/l Fe was the best dose for improving overall efficiency of *P. hypophthalmus- Spinacia oleracea* aquaponic system. By Considering the water quality parameters, fish growth, total biomass of fish, fish physiological responses, basil yield, and nutrient content; hence the stocking density of 3.00 kg/m^3 (pangas) with 24 plants/m^2 of basil could be recommended for managing aquaculture wastewater nutrients in basil-pangasius aquaponics. By taking into consideration of the water quality, fish mean body weight, basil yield, plant nutrient content, and fish stress parameters, supplementation of 150 mg/l Potassium with 3.00 kg/m^3 stocking density of pangasius can be suggested as better for better growth performance of pangas (*Pangasianodon hypophthalmus*) with 24 plants/m^2 of basil plants in nutrient film technique-based aquaponics.

Iron Supplementation Effect on Growth of *Pangasianodon hypophthalmus* (Sauvage, 1878) and *Spinacia oleracea* (Linnaeus, 1552) in Aquaponics

(CIFE/2020/AQC001/SR

Aatira Farooq

Major Advisor: Dr. Ajit Kumar Verma

A 105-day experiment was conducted to investigate the effect of iron supplementation on the growth of *Pangasianodon hypophthalmus* (Sauvage, 1878) and *Spinacia oleracea* (Linnaeus, 1552) in aquaponics. The experimental setup consisted of 15 individual and identical aquaponic units. Each unit consisted of 3 components viz., fish tank 174.72 l (0.80 × 0.56 × 0.39 cm) capacity (effective water volume =100l), hydroponic unit (Nutrient Film Technique), and a filtration system. The experiment analysed four different iron supplementation dosage in four treatments i.e. 1.0 mg/l (T1), 1.5 mg/l (T2), 2.0 mg/l (T3), and 2.5 mg/l (T4) which were compared with non-supplemented control (0.0 mg/l). The dosage was given fortnightly. The physico-chemical parameters and nutrient profile of water were within the favourable range for aquaponics with no marked variation between the control and treatment groups except for iron concentration, which was found to vary due to increased level of supplementation in the system. The spinach was harvested six times. The first harvest done before iron supplementation showed no significant difference ($p>0.05$) in spinach yield; however, a significant difference ($p<0.05$) in yield was observed among

the control and treatment groups in the second (45th day), third (60th day), fourth (70th day), fifth (90th day), and sixth (105th day) harvest. The spinach yield increased in five successive harvests and decreased during the sixth harvest. The highest yield was observed during the fifth harvest (90 day) and followed the order: T2> T1 >T3 > T4 > C. The yield showed no significant difference in T2 and T1, and T3 and T4. The mean body weight of fish at harvest was significant ($p<0.05$) and followed the order: T2 > T3 >T4 > T1 > C. The nutrient analysis revealed that iron interacts with essential macronutrients and micronutrients, and had a negative or beneficial impact on their uptake, which in turn affected plant growth and the yield of crops. Haemoglobin, HCT, WBC count, and RBC count were observed to increase in a dose-wise manner. The metabolic enzymes (LDH and MDH activity of liver), and plasma biochemical parameters showed significant difference ($p<0.05$) among the control and treatment groups with higher values found in T4 and T3. Higher plasma glucose and cortisol values were observed in T4 and T3. SOD activity and catalase activity (gill and liver) was decreased or inhibited with an excess of iron dosage, elevating the amount of oxidative stress. Considering the water quality parameters, fish and plant growth, physiological response, spinach yield, and nutrient content, a dose of 1.5 mg/l Fe per 2 weeks (T2) could be recommended as an optimum iron dosage for *Pangasianodon hypophthalmus-Spinacia oleracea* L. aquaponic system.

Management of Nutrient Supplementation for Okra (*Abelmoschus esculentus*) in Recirculating Aquaponics System with *Pangasianodon hypophthalmus* (Sauvage, 1878)

(CIFE/2019/AQC913/SR)

Lakan Lal Meena

Major Advisor: Dr. Ajit Kumar Verma

To elucidate the effect of foliar application of potassium, iron, and phosphorus in single and combined forms on the growth performance of okra with *Pangasianodon hypophthalmus* fingerlings in recirculating aquaponic system, three subsequent experiments of ninety-days each were conducted. In first experiment, the effect of different dosages of potassium viz. 0, 2, 3, 4, and 5 g/l were observed on growth of okra and P. hypophthalmus. Significantly higher growth of okra ($p<0.05$) was observed at higher dosages of potassium. However, the foliar potassium application of 5 g/l showed the highest pod yield compared to control. In second experiment, the combined effect of iron (0.50, 0.75, 1.0, and 1.25 g/l) and potassium (5g/l) were observed on the growth of okra and P. hypophthalmus. The yield of okra was significantly higher in iron doses of 1.0 g/l and 1.25 g/l compared to control.

The third experiment was conducted to evaluate the effects of combined foliar application of

phosphorus dosages of 2.7, 5.4, 8.1 and 10.8 g/l with potassium (5.0 g/l) and iron (1.0 g/l) on the growth of okra and P. hypophthalmus. The okra showed significantly better growth at 8.1 g/l of phosphorus dose than control. In all three experiments, water quality parameters, growth, haematological, biochemical and antioxidant enzyme parameters of fish showed no significant difference among the treatments and control. Overall, the foliar K+, Fe, and P applications considerably improved the overall growth of okra plant in an aquaponics system with Fe (1.0 g/l), K+ (5 g/l) and P (8.1 g/l) without hampering the growth of P. hypopthalmus. As per the study, foliar application of potassium, iron, and phosphorus can be considered as the future prospect for improved nutritional quality and enhanced production of plants in aquaponics.

Development of a Multi-species Brackishwater Fish Culture Model

(CIFE/2019/9/IF)

Project duration: 2019-2022

Principal Investigator
Dr. Muralidhar P. Ande

Co-Principal Investigators
Dr. K.V. Rajendran
Dr. Karthireddy Syamala

Technical Associates
Dr. P. Srinivasa Rao
Mr. R.R.S. Patnaik

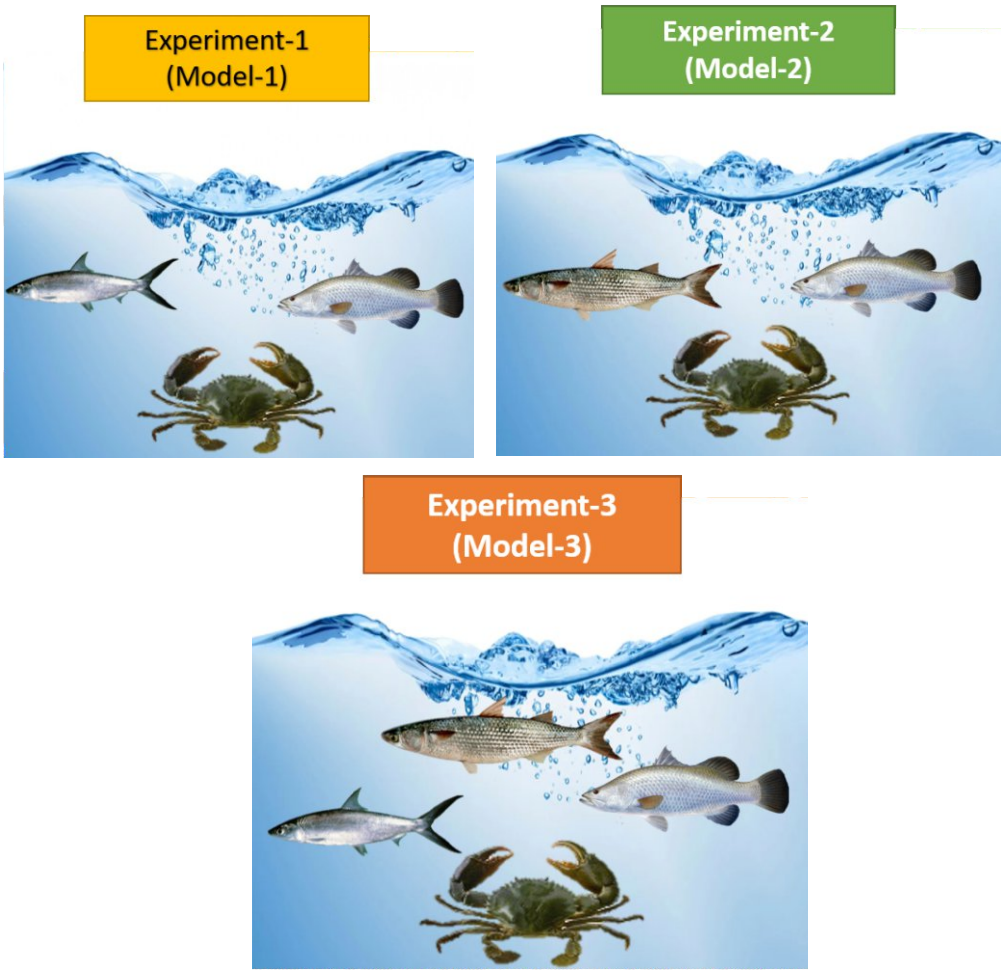
Three different multi species brackishwater fish culture model systems were tested to evaluate the production potential and sustainability of polyculture systems using selected multi-species brackishwater finfish and crab.

Multi species Model-1: Milkfish, *Chanos chanos*, Mud crab, *Scylla serrata*, Seabass, *Lates calcarifer*

Multi species Model-2: Grey mullet, *Mugil cephalus*, Mud crab, *Scylla serrata* and Seabass, *Lates calcarifer*

Multi species Model-3: Milkfish, *Chanos chanos*, Grey mullet, *Mugil cephalus*, Mud crab, *Scylla serrata* and Seabass, *Lates calcarifer*

Economic evaluation of the above three models has shown increased profit margin compared to the monoculture and traditional polyculture systems. A questionnaire was developed to collect data about culture pattern, farmer's status and profit range in Krishna & East Godavari districts. As per the data, about 56% of the farmers in these areas were culturing milkfish in monoculture followed by crab culture (26%). About 73% of brackishwater small and marginal farmers were earning minimum ₹ 20,000-50,000 total profit/year. The surveyed farms had farm area of 1-2 acre or less. All the three models developed as a part of this project are economically viable and hence can be readily adopted by the small and marginal farmers to achieve maximum production and profit per unit area.



Effect of Dietary Protein Levels on Growth, Physiological Responses and Gene Expression of Stunted Milkfish, *Chanos chanos* (Frosskal, 1775)

(CIFE/2018/AQC814/SR)

Shyam Prasad Mamidala

Major Advisor: Dr. Muralidhar P. Ande

A field trial was conducted in stunting (240 days) and post-stunting (180 days) phase of Milk fish to study the effect of dietary protein levels on growth, physiological responses and gene expression. In stunting phase, uniform weight fingerlings (11.71±0.18 g) were stocked @ 20 no/m². The same stunted fish were used in post-stunt rearing with a stocking density of 2 no/m² in triplicate. Experimental fishes were fed with three hetero-nitrogenous diets i.e., C (25% CP), T1 (30% CP), and T2 (35% CP) @ 2% body weight during stunting and @ 4% body weight during post-stunting. The study found that the dietary protein levels significantly affected the growth, physiological responses, and gene expression in both phases. All the stunted groups displayed rapid growth response in post-stunting phase, and fish in T1 group (30% CP) showed complete growth compensation, which resulted in better SGR, %WG, FCR, %VSI, and survival. In stunted fingerlings the physiological activities and haemato-serological parameters were successfully restored among all the fed groups in post-stunting phase. However, during post-stunting, rapid recovery of enzyme assay and improved immunological status in terms of increased Hb%, WBC, serum protein, globulin, and glucose as well as better digestive profile, increased protease, amylase, and lipase activity were recorded in T1 (30% CP) group.

The high protein diet was efficiently utilized to compensate for the loss during stunting by reducing the stress rather than the growth. In contrast to this, at the initial days of post-stunting all the metabolic enzymes were rapidly decreased to adjust with metabolic pathways among all groups. At the end of the stunting and post-stunting, body proximate analysis revealed an increased protein content which indicated the positive effect with a complete restoration of nutrients and better tissue protein was observed in T1 (30% CP) group. Insulin-like growth factors IGF-I and IGF-II upregulated in prolonged starvation and down-regulated in re-feeding. The increased IGFs' gene expression during stunting and post-stunting phase in T1 fed group resulted in minimum stress and better growth performance. Overall, the study suggests that 30% CP dietary protein inclusion level can significantly improve the seed quality, accelerated growth, and is better-suited for milkfish fingerlings in stunting and post-stunting phase. This helps to minimize stress and produce good quality seed for better growth performance and feed utilization.

Dietary Biofloc Supplementation in Grey Mullet, *Mugil cephalus* (Linnaeus, 1758) fingerlings: Effect on Growth and Physio-metabolic Responses

(CIFE/2020/AQC007/SR)

Pooja Chithira

Major Advisor: Dr. Karthireddy Syamala

A growth trial was conducted to evaluate the effect of the inclusion of biofloc at different levels in the diet of *Mugil cephalus* on their growth performance and physio-metabolic responses. The experiment was carried out in two phases; (i) Biofloc production from shrimp culture discharge water and (ii) Feeding trial with Biofloc at different inclusion levels. Biofloc was produced in an indoor ex-situ biofloc set up with shrimp culture discharge water using de-oiled palm kernel meal as the carbon source and urea as the nitrogen source at a C:N ratio of 20:1.

Proximate analysis and floc characteristics were studied to determine the day of floc with high protein (Day 6) for floc harvest. The collected Biofloc was filtered, dried and made into a powder that was used in the second phase feeding trial. Four iso-nitrogenous and iso-lipidic diets were formulated with different levels of biofloc inclusion, including Control (0% biofloc inclusion), T1 (10 % biofloc inclusion), and T2 (20% biofloc inclusion), T3 (30% biofloc inclusion). Following a completely randomized design, a 60-day feeding trial was conducted with 3.56± 0.04g *M.cephalus* fingerlings. The growth performance in terms of final body weight, PWG, SGR, FER, and PER increased with an increase in biofloc inclusion level and a significantly higher growth performance observed in the T3 (30% biofloc inclusion). No significant difference ($p>0.05$) in the survival rates was noticed among the treatment and the lowest FCR (2.25±0.07) was found in the T3. A significantly higher ($p<0.05$) digestive enzyme activity was found in T3. Dietary biofloc inclusion has enhanced the anti-oxidant enzyme activity of *M.cephalus* fingerlings. The metabolic enzyme activity was significantly different in treatment groups compared to the control and a significantly higher ALT and AST activity were noticed in T3. The present study demonstrated that dietary biofloc inclusion has positive effects on growth and physio-metabolic responses of grey mullet fingerlings and 30% biofloc inclusion is recommended.

ICAR-Network Program on Precision Agriculture (NePPA) (Precision Aquaculture/Small-scale Culture Fishery for Fish Production)

(CIFE/2019/200/EF)

Project duration: 2021-2026

Principal Investigator
Dr. Ashutosh D. Deo

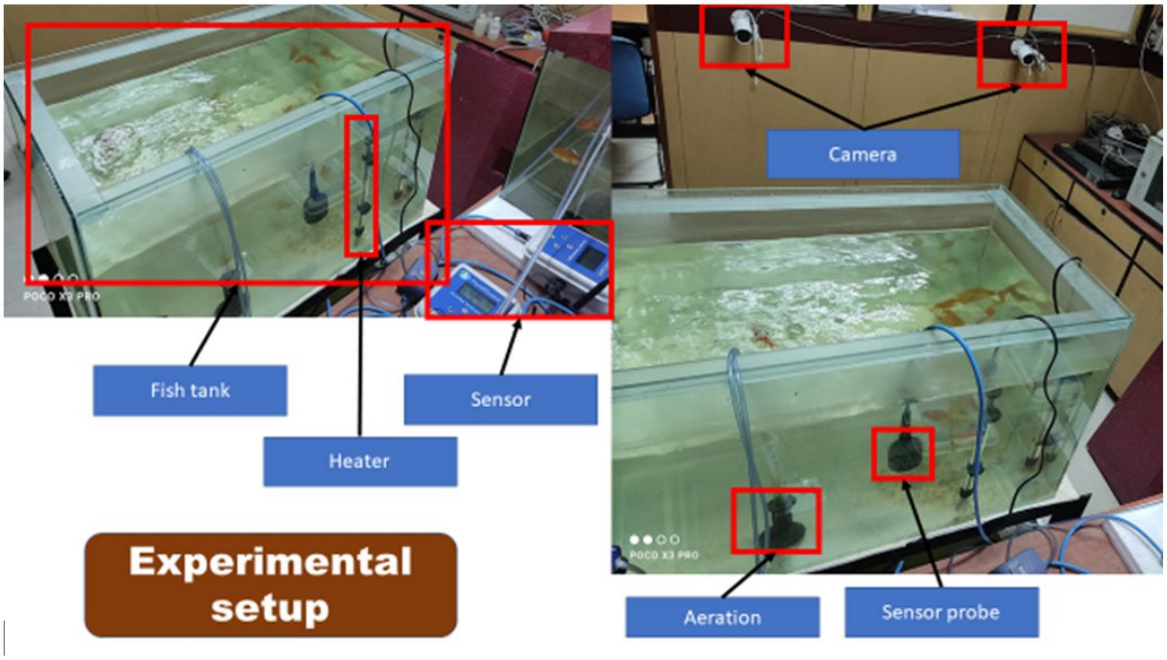
Co-Principal Investigators
Dr. B.B. Nayak, Dr. K. K. Krishnani, Dr. A.K. Verma, Dr. Vinod Kumar Yadav, Dr Vidyashree Bharti, Dr. Karan Kumar K. Ramteke, Dr. Layana P., Dr. Manish Jayant and Dr Arun Sharma

Budget: Rs. 5.26cr

Funding Agency
ICAR, New Delhi

Lead institute
IARI, New Delhi

To setup up, the AI-Assisted Intensive Aquaculture System, out of six proposed, three FRP tanks (10000 L capacity) were fabricated. The place for setting up the AI-IAS has been identified. A prototype for a sensor-based automatic feed dispensing system that dispenses feed based on the behavior of the fish was fabricated. An Indigenous Rotating Power-operated



Drum Filter was also designed. Pilot work for the prediction of water quality parameters and estimating its relation with abnormality in fish tanks using IoT and Machine learning approach was taken up. IoT sensors, which were purchased from Eruvaka technology were used. The sensors show the real-time values of dissolved oxygen and temperature. The obtained sensor data were verified with laboratory data. The three-time stamps (12:05, 20:30, and 22:10) were selected for collecting the observations, and variations in the values of DO and temperature were studied. The data is coming continuously, and we can also download the dataset in excel format. The fish detection in a tank through deep learning methods along with images and videos, and the result is quite acceptable in terms of accuracy for analysis.

Prediction Of Water Quality Parameters and Estimating its Relation with Abnormality in Freshwater Fish Aquarium: IoT and Machine Learning Approach

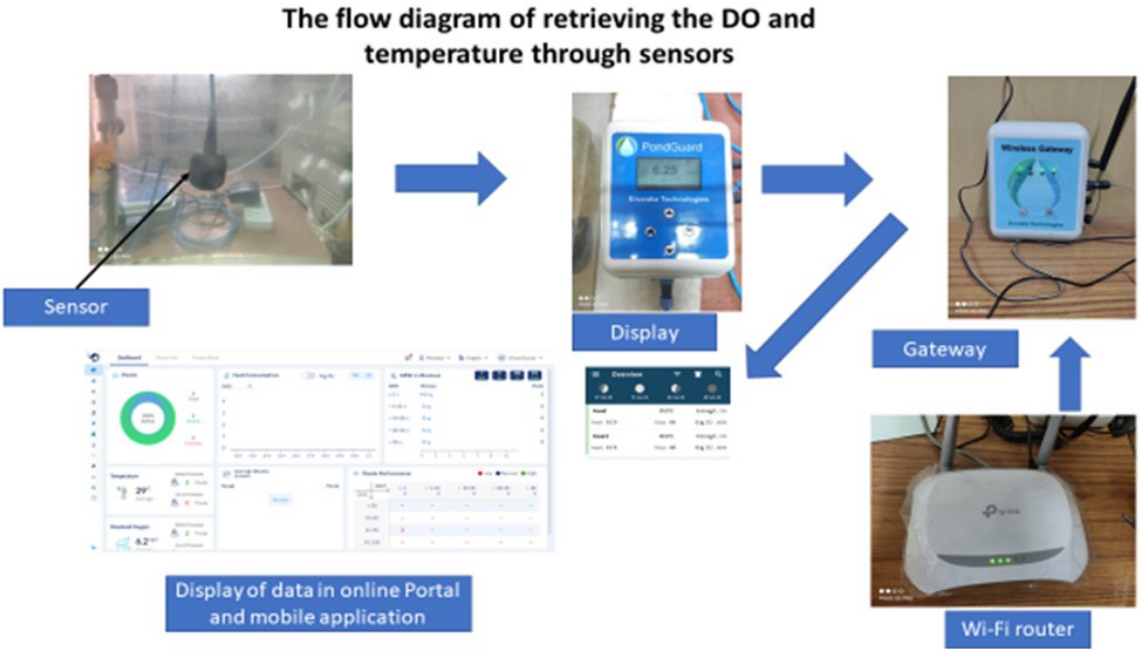
(CIFE/2020/FEC003/SR)

K Suresh Kumar Patro

Major Advisor: Dr. Vinod Kumar Yadav

Controlling the environment in an ornamental fish farm is a considerable challenge because it is affected by variety of parameters. Farmers find it difficult to consistently monitor and maintain water quality indicators since they must be present on the farm. The Internet of Things (IoT) is a nice option to avoid this type of problem or reduce human intervention/effort. The study's main aim is to remote-monitor the ornamental fish aquarium & predict the water quality parameters, analyse behavioural changes in goldfish, and to study the acceptance of IoT technology by ornamental fish farmers. In the fish tanks, we used temperature and dissolved oxygen IoT sensors. After testing the sensor value with laboratory test value, it has been seen that the correlation was more than 99%.

To predict the WQ parameters, an ANN prediction model was used, and its accuracy was judged on the training, validation, and testing data. There was a marginal difference in accurate measurement in all three above mentioned data sets, indicating a good generalization. With the help of object detection algorithms, we can detect fish in underwater environments, in conditions



like turbid water, dark environments, and at night. In this study, the YOLOv5-CNN model was used to classify the fish species in real-time movement. Decision tree, Naïve Bayes classifier, K-Nearest Neighbour (K-NN), and linear discriminant analysis (LDA) were used to analyse the behavioural change data. K (=10) fold validation method used to test the accuracy of all four classifiers. Decision tree was proved to be the most accurate and effective classifier. To study the IoT acceptance among ornamental fish farmers, we used two models, namely Roger's diffusion of innovation model (DOI) and Davis's technology acceptance model (TAM). The result showed the potential factors which will influence the acceptance of IoT technology by ornamental fish farmers.

Studies on Biological Nutrient Recovery from Culturing of Pangasius, *Pangasianodon hypophthalmus* (Sauvage, 1878) by Seasonal Vegetable and Herbs in Aquaponic System

(CIFE/2019/12/IF)

Project duration : 2019-2022

Principal Investigator
Dr. Sunil Kumar Nayak

Co-Principal Investigators
Dr. Dhalong Saih Reang
Dr. A.K. Verma
Dr. Arun Sharma
Dr. Harsha Haridas

Budget: Rs. 25 lakh

Funding Agency
NFDB, Hyderabad

Aquaponics unit with green poly house Area 6mt X 4mt X 3mt, plastic barrel drum (Height-28 cm, Length-90cm) for plants, plastic tub (62cm diameter, height-28 cm) for fish, gravel, PVC pipes for siphoning, timer, submersible motor pump 15-watt, blower -120 watt was set up to study the optimization of Pangas fish to okra plant component ratio in aquaponics system. The experiment was conducted in triplicates and a control for all the objectives. In the first experiment fish were stocked @ 30, 40,50 and 60 plants with 3 Okra plants. Parameters like water quality, fish biomass, different growth parameters, plant height, number of leaves and number of fruits were compared. It was found that in treatment 2 (40 no. of fish) yielded better FCR and survivability. In another experiment plant @ 2, 4, 6 and 8 plants to fish ratio were optimized. All parameters like water quality, fish biomass, different growth parameters, plant height, number of leaves and number of fruits were compared, treatment 3 with 40 numbers of pangasius fish with 6

okra plant yielded better number of fruits and fruit weight per unit. Hydraulic loading rate of 1.5, 2.25, 3 and 3.75 m/day as treatment were done in triplicates. Treatment 2 with hydraulic loading rate of 2.25 m/day showed better number of fruits and fruit weight per unit with 40 number of pangasius fish and 6 okras. In the third experiment it was found that no significant differences were observed in the case of proximate as well as mineral composition of okra pods obtained from different treatment groups. However, slightly higher ash content as well as mineral contents were higher in lower hydraulic loading rate treatments compared to higher hydraulic loading rate.

Development of Package of Practice for *Anabas testudineus* in the Eastern Region of India

(CIFE/2019/10/IF)

Project duration: 2019-22

Principal Investigator
Dr. G. H. Pailan

Co-Principal Investigators
Dr. B.K. Mahapatra, Dr. S. Munilkumar, Dr. S. Dasgupta, Dr. S. Sahoo, Dr. Md. Aklakur and Mr. D.K. Singh

An experiment was conducted to study the effect of graded levels of protein on gonadal maturation of *Anabas testudineus.* The observations on growth parameters showed that the average daily weight gain, percentage weight gain and specific growth rate were significantly ($p<0.05$) varied among the treatments. Highest values of WG% with lowest FCR were observed in the T35 group. Gonado-somatic index and gonad histology of ovary and testes of females and males in different experimental groups revealed that female and male gonads were completely matured in T30 and T35 groups, respectively. Histological analysis showed immature stages in the gonads of T25 group, indicating that inclusion of low protein levels had an adverse effect on gonado- somatic index and other reproductive function. Reproductive performance of *A. testudineus* fed with graded levels of dietary protein indicated that fecundity, fertilization rate, hatchability, larval survival, egg diameter and oil globule diameter were significantly ($p<0.05$) affected. Significantly higher fecundity, fertilization rate, hatchability, larval survival, egg diameter and oil globule diameter ($p<0.05$) were observed in T40 groups. Moreover, steroid hormones like 11-ketotestosterone, 17-β estradiol (E2), 17α, 20β Di-Hydroxy progesterone and cortisol levels in plasma were varied significantly ($p<0.05$) due to feeding of different dietary protein levels. In case of 17-β estradiol (E2), the lowest value was observed in females ofT35 group. The levels of 17α, 20β Di-Hydroxy progesterone were higher in

T30 and T35 male and female fishes, respectively. The results suggested that sudden decline in estradiol and sudden rise in 17α, 20β Di-Hydroxy progesterone indicated that completion of vitellogenesis and ongoing maturation and ovulation in T30 and T35 treatments in comparison to other treatments. The total serum cholesterol level, found to be significantly different ($P<0.05$) among different treatments. Lowest cholesterol was found in the T35 and T30 group of male and female fishes, respectively. Hence, decrease in lipid mobilization indicates that those are utilized for steroidogenesis leads to synthesis of sex steroid hormones and early gonadal maturation. Therefore, from the present study, it can be concluded that, the optimum protein level for the *A. testudineus* broodstock for best reproductive performance was 39.07% to 39.21% based on fertilization rate and larval survival (3DPH).

(CIFE/2020/FNT006/SR)

Effect of Graded Levels of Dietary Protein on Gonadal Development in *Anabas testudineus*

Satheesh

Major Advisor: Dr. G.H. Pailan

Anabas testudineus (average weight 18g) were randomly distributed in 6 treatments (T25-T50) with triplicates and maintained in 18 nos. of cement tanks of 1000L capacity containing 20 fish in each tank. The treatment groups were fed with graded levels of dietary protein. The groups were T25, 25% dietary CP; T30, 30% dietary CP; T35, 35% dietary CP; T40, 40% dietary CP; T45, 45% dietary CP; and T50, 50% dietary CP. Feeding was done twice daily at satiation level. The water quality parameters were monitored and maintained in an optimum level to provide optimum conditions for maturation, growth and survival of the fishes. Final sampling was done after 90 days of feeding trial and parameters like reproductive indices, plasma sex steroid hormones, gonad histology, reproductive performance, serum parameters, and growth parameters were analyzed. The peak point analysis with growth and reproductive responses showed that the optimum protein requirement for *Anabas testudineus* was 39.07% to 39.21%.

Optimization of Weaning Strategy in *Anabas testudineus* (Bloch, 1792) Larvae

(CIFE/2020/FNT004/SR)

Patekar Prakash Goraksha

Major Advisor: Dr. Sikendra Kumar

A-30 day feeding trial was conducted to analyze the effect of different feeding regimens on *Anabas testudineus* larvae, thereby optimizing the weaning strategy. The different feeding regimens were as follows; C1 (Live food for 30 days), C2 (Microparticulate diet for 30 days), T1 (Live food 5 days, microparticulate diet for 25 days), T2 (Live food 10 days, microparticulate diet for 20 days), T3 (Live food 15 days, microparticulate diet for 15 days), T4(Live food 20 days, microparticulate diet for 10 days), T5 (Live food 25 days, microparticulate diet for 5 days), T6 (Live food 5 days, 75% live food and 25% microparticulate diet for next 5 days, 50% live food & 50% microparticulate diet for next 5 days, 25% live food and 75% microparticulate diet for next 5 days, 0% live food & 100% microparticulate diet for next 10 days) and T7 (Live food 10 days, 75% live food and 25% microparticulate diet for next 5 days, 50% live food & 50% microparticulate diet for next 5 days, 25% live food and 75% microparticulate diet for next 5 days, 0% live food & 100% microparticulate diet for next 5 days).

A total of 10,800 *Anabas testudineus* larvae (average weight 0.00016g or 0.16mg) were randomly distributed in nine treatments, including two control groups in triplicates with 400 larvae per aquarium tank (20 larvae per liter water). Significantly ($p<0.05$) higher weight gain and specific growth rate (SGR) were recorded in the T2 group, followed by T6 and T7, whereas the lowest values were found in the C2 group. A significantly ($p<0.05$) highest survival percentage of larvae was reported in the T7 group, which was comparable to T6, and a significantly ($p<0.05$) lowest survival percentage was obtained in the C2 group. The digestive enzymes acid, alkaline protease and lipase activities varied non-significantly ($p>0.05$) among the different treatment groups, whereas amylase activity was found to be significantly ($p<0.05$) higher in the T1 group and lowest in C1, which was comparable with T7. Aspartate transaminase (AST) and alanine transaminase (ALT) reported significantly higher in T1 followed by T2; however, their lowest values were observed in C1 & C2, respectively. Lactate dehydrogenase (LDH) and malate dehydrogenase (MDH) were significantly higher in the T1 group, followed by T2, while their lowest values were reported in T5. The superoxide dismutase (SOD) and catalase activities were significantly($P<0.05$) higher in C2 and their lower value were reported in C1 and T6, respectively. Overall, it can be concluded that the appropriate weaning time for Anabas testudineus larvae is 14 days post hatch onwards and the best weaning strategy can be adopted as in T7 group for higher survival percentage of the larvae.

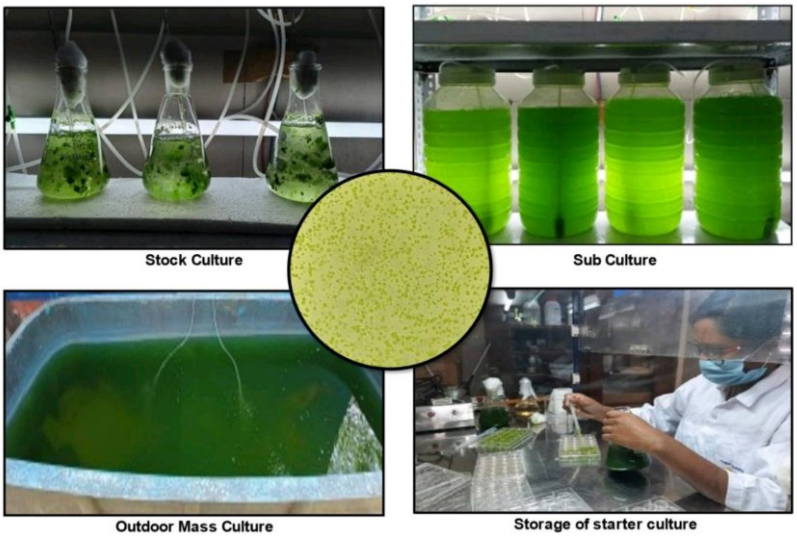
Optimization of Co-feeding Strategy for *Anabas testudineus* (Bloch, 1792) Larvae

(CIFE/2020/FNT003/SR)

Halpati Reena Prakashbhai

Major Advisor: Dr. S. Munilkumar

In the present study, *A. testudineus* larvae were reared under different co-feeding regimens using *Moina micrura*, vitamin E enriched *Moina micrura* and egg custard-based inert diet for a period of 30 days to understand the larval behaviour towards different co-feeding regimens. *Moina micrura* was cultured in cement tanks as a source of live food, and egg custard-based inert diet with crude protein of 40.98% and ether extract of 6.69% was formulated with whole egg, corn flour, milk powder, cod liver oil, vitamin-mineral mixture and fresh squid as protein sources. Different co-feeding regimes were followed to understand the effects of each on *A. testudineus* larvae. Final body weight, weight gain percent and specific growth rate were achieved highest in T9 group fed with 75% vitamin E enriched Moina + 25% egg custard-based inert diet for the first 15 days, 50% vitamin E enriched Moina + 50% egg custard for next 5 days, 25% vitamin E enriched Moina + 75% egg custard for next 5 days, 0% vitamin E enriched Moina + 100% egg custard-based inert diet for next 5 days followed by T8 group with the feeding regimen of 75% vitamin E enriched Moina + 25% egg custard-based inert diet for first 10 days, 50% vitamin E enriched Moina + 50% egg custard for next 5 days, 25% vitamin E enriched Moina + 75% egg custard for next 5 days, 0% vitamin E enriched Moina + 100% egg custard-based inert diet for next 10 days.



The highest survival was obtained in the C2 group (25.33%) followed by T9 and T7 groups. The appropriate co-feeding strategy based on survival, growth and digestive enzyme activity was in T9, T8 and T7 groups. Co-feeding of *A.testudineus* larvae with vitamin E enriched *Moina micrura* and egg custard diet improved growth and survival compared to unenriched *Moina micrura* and egg custard diet alone. The activity of digestive enzymes like Amylase, protease, lipase and metabolic enzymes like ALT, LDH, MDH were also improved with the co-feeding of vitamin E enriched Moina micrura and egg custard diet. Also, vitamin E enriched *Moina micrura* helps in ameliorating stress during the larval rearing. However, the growth and survival of the larvae fed with egg custard alone have shown some drawbacks due to poor utilization, deterioration of water quality and bacterial growth. The present study establishes a co-feeding strategy that can be followed to obtain the highest specific growth rate in *A. testudineus* larvae i.e., 24.77%. using egg custard-based inert diet and vitamin E enriched *Moina micrura*.

Evaluating Environmental Effects on Pearl Formation in *Lamellidens marginalis* Reared in Indoor Conditions

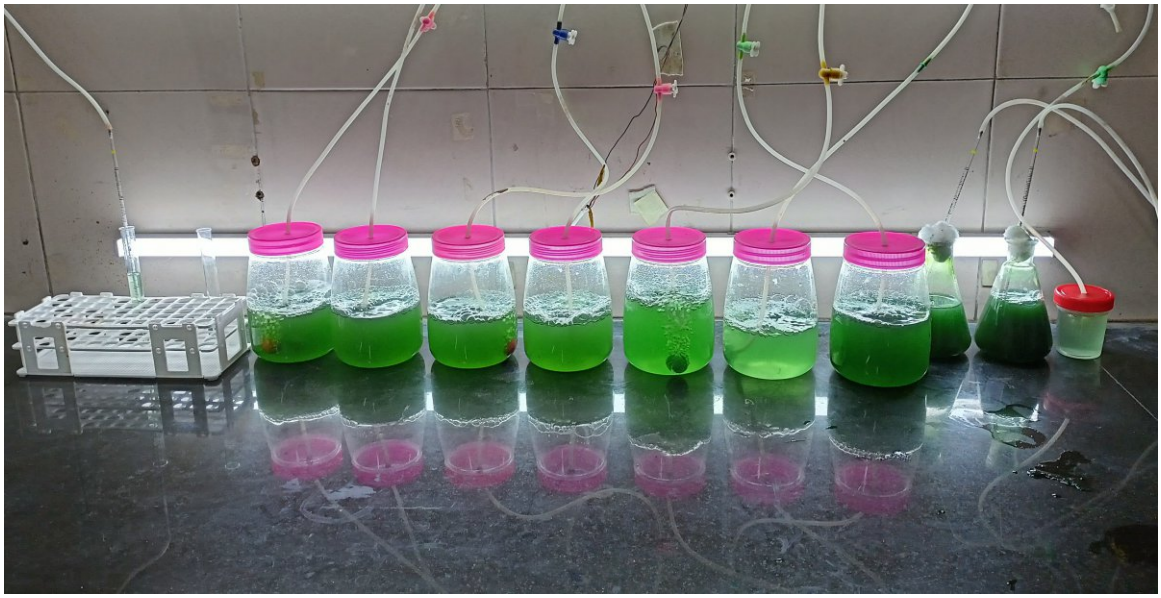
(CIFE/2021/10/IF)

Project duration: 2021-2024

Principal Investigator
Ms. Sweta Pradhan

Co-Principal Investigators
Dr. Suman Manna
Dr. S. Dasgupta
Dr. S. Munilkumar
Dr. G.H. Pailan

An experiment was conducted to study the effect of different algal diets such as *Chlorella sp, Spirulina sp* and mixed algae on pearl culture. The mixed algae fed group was considered as a control group. The pure culture of algae was brought from ICAR-CIFE, AEM division. The culture was maintained in laboratory condition and multiplied in outdoor condition. The implanted mussels were fed with different concentrations of the diet and kept for observation. The experiment was conducted in triplicate. The trial is ongoing.



Strategies for Quality Fish Production Through Species Combination, Environmental Manipulation and Nutritional Interventions

(CIFE/2022/01/IF)

Project duration: 2022-2025

Principal Investigator
Dr. Gouranga Biswas

Co-Principal Investigators
Dr. G.H. Pailan
Dr. Parimal Sardar
Dr. Sujata Sahoo
Dr. H. Mandakini Devi
Dr. Dilip. K. Singh
Dr. Suman Manna

An experiment was conducted to evaluate the quality of Indian major carps from sewage-fed aquaculture system. Indian major carp samples (catla, rohu and mrigal) of size ranges (233-736 g) were collected from two semi-intensive farms (Farm 1 and 2) of sewage-fed aquaculture system. In terms of processing parameters, mrigal gave highest dressed yield of above 60% compared to catla (52-54%) and rohu (53-58%). Catla generated the highest by-products of about 45%. Among the fishes, cooking loss was the highest in rohu (27-28%) followed by mrigal (23-27%) and catla (21-24%). On sensory evaluation, the samples from the Farm 2 were liked moderately, while those from Farm 1 were liked very much. Fish samples from Farm 1 had lower level of crude protein (16.31-16.41%) and lipid (1.01-1.13%) contents compared to that of Farm 2 samples (crude protein: 18.33-19.14%; lipid: 1.70-1.80%).

Captive Breeding of Hilsa, *Tenualosa ilisha*: Phase II

(CIFE/2021/201/EF)

Project duration: 2021-2024

Principal Investigators
Dr. Subrata Dasgupta

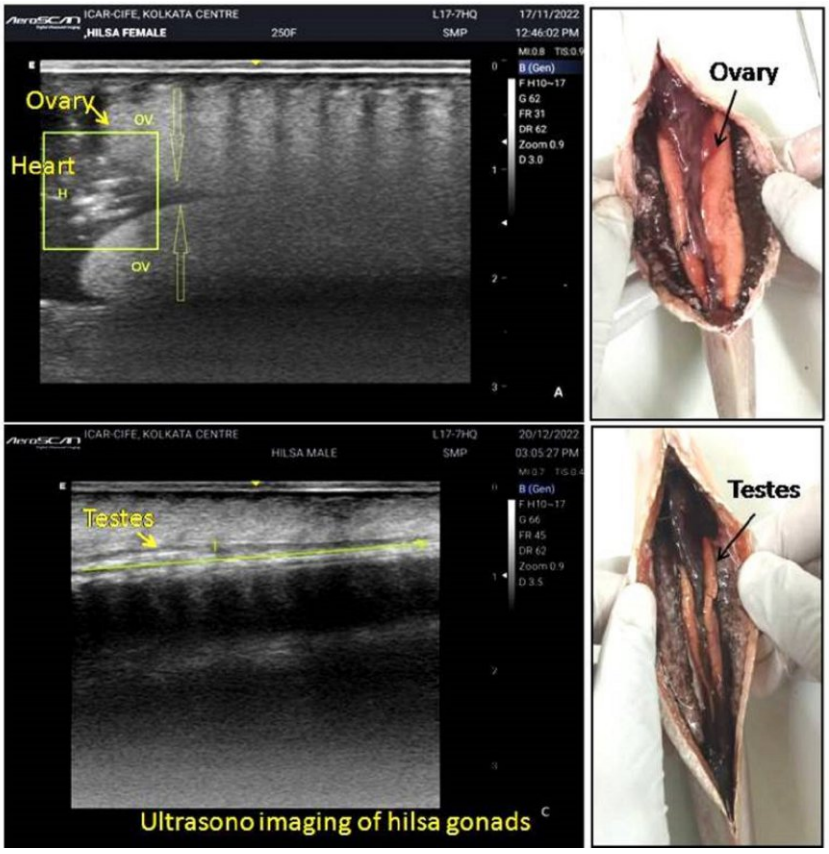
Co-Principal Investigators
Dr. Gayatri Tripathi
Dr. Mujahid Khan Pathan

Budget
69.91 lakh

Funding Agency
NASF, ICAR, New Delhi

An automated anaesthesia device developed for hilsa was found very efficient for anaesthetising riverine and pond-reared hilsa. The anaesthetic solution comprising tricaine methanesulphonate and other stress-alleviating chemicals were found most suitable for achieving operational anaesthesia in hilsa of different habitats. Hilsa fingerlings and juveniles were anaesthetized using the same anaesthetic solution before tagging the hilsa with PIT tag. Post tagged fish did not show any mortality compared to non-anaesthetized pond hilsa.

The method of ultrasound imaging of the ovary and testes was standardized in live broods of hilsa for the first time. The ultrasound scanning of hilsa and carp gonads was performed at B mode with 7-15 MHz frequency following the various parameters, such as mechanical index, thermal index, frequency, gain, frame ratio, dynamic range, zoom and depth. Ultrasound images of different portions of the ovary and testes ensured sex and maturity in hilsa and common carp. The linear correlation analysis showed a highly positive correlation between the live and ultrasound image dimension of the gonads in carp. Isolation and short-term culture of pituitary cells has been standardized in carp. Beta-actin mRNA expression in the isolated pituitary cells after four hours post-incubation (Fig. 3A) indicated the possibility of in-vitro evaluation of GnRH efficacy for gonadotropin synthesis in fish like hilsa. Cloning and sequencing of cDNA encoding partial luteinizing hormone in hilsa, Tenualosa ilisha was done and submitted to NCBI Genbank. Validation of the real-time primers designed based on the partial cDNA sequence was done through real-time expression of luteinizing hormone in the pituitary of hilsa females and males .



Network Project on Ornamental Fish Breeding and culture

(Technology development on captive breeding and seed production of selected indigenous ornamental fishes native to North Eastern Hill region and Western Ghats)

CIFE/2021/202/EF

Project duration: 2021-2024

Principal Investigator
Dr. Paramita Banerjee Sawant

Co-Principal Investigators
Dr. N.K. Chadha
Dr. B.K. Mahapatra
Dr. Gayatri Tripathi
Dr. Gouranga Biswas

Funding Agency:
ICAR, New Delhi

Budget: 160.2 Lakhs

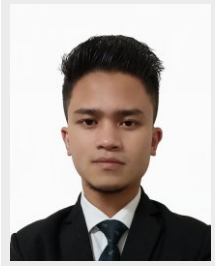
The project is operational at Mumbai headquarters of ICAR-CIFE and its Kolkata Centre. Seven species of indigenous ornamental fishes (three at Mumbai headquarters and four at Kolkata Centre) selected for developing a package of practices for their captive maturation and breeding along with closing of their life cycles. Three species native to the Western Ghats [zebra loach (*Botia striata*), striped Panchax/yellow panchax/malabar killi or golden wonder killifish (*Aplocheilus lineatus*) and Jerdon's carp (*Puntius/Hypselobarbus jerdoni*)] and four species native to the north eastern hill regions (NEH) [green rocket shrimp (*Caridina hodgarti*), glassy perchlet (*Parambassis lala*), scarlet/red badis (*Dario dario/Badis bengalensis*) and highfin/ drape fin barb (*Oreichthys crenucoides*)] are being maintained at Mumbai and Kolkata, respectively.

Out of the seven species, conditions were optimized for natural inducement of maturation in zebra loach using substrates followed by diet matrix analysis and standardisation of protein: lipid ratio for developing a broodstock diet formula for jerdon's carp at Mumbai. According to the International Union for Conservation of Nature (IUCN), the zebra loach (*Botia striata*) is currently endangered in the wild due to habitat alteration combined with a small native range. Loaches are bottom dwellers and therefore, habitat in general and substrate in particular, play a major role in their well-being and maturation. Evaluation of artificial habitats for optimizing captive maturation of the zebra loach using different substrates proved superiority of sand (0.5-1mm) substrate over gravel or stony substrate (5-7 mm) for somatic growth and gonadal maturation. *Dario dario*, commonly known as scarlet badis, red badis or gem badis is a tiny percoid species of the family Badidae which dwells in the Brahmaputra basin starting from Assam and available

throughout the stretch till Northern Bengal in rivers. Trials on natural inducement of maturation using various feed combinations yielded promising results with live (*Tubifex* sp.). Studies on simultaneous habitat manipulation also revealed sandy bottom (10% sand) with gravel and aquatic ornamental plants was the ideal habitat for maturation, reproductive performance and colouration in case of scarlet badis at Kolkata. *H. jerdoni*, locally known as Cha-meen, is a freshwater, benthopelagic and potamodromous cyprinid, endemic to the Western Ghats. Habitat studies during the period under report confirmed its presence in larger streams of southern Karnataka, Tamil Nadu, Kerala and Maharashtra. The alimentary canal of this species was found to be comparatively long with the relative gut length (RGL) varying between 1.08 to 2.95. RGL values increased with the increase in length of the fish. This species appears to be a voracious feeder as the gut was completely gorged and full in majority of the samples with major food items such as worms (round and flat worms) (60%), semi digested plant matter (20%), green algae, diatoms (10%), mud, semi digested animal matter and seeds (10%). Additional studies for nutrient requirement revealed that a dietary protein: lipid ratio standardized for formulating an on-farm maturation diet of *H. jerdoni (in synergistic combination with a copepod based live feed formula)* is 31.6:7. This baseline database developed till date for the above selected native /indigenous ornamental fishes are the first reports.

Study on Captive Broodstock Development and Evaluation of Habitat Manipulation on Reproductive Biology of Scarlet badis, *Dario dario* (Hamilton, 1822)

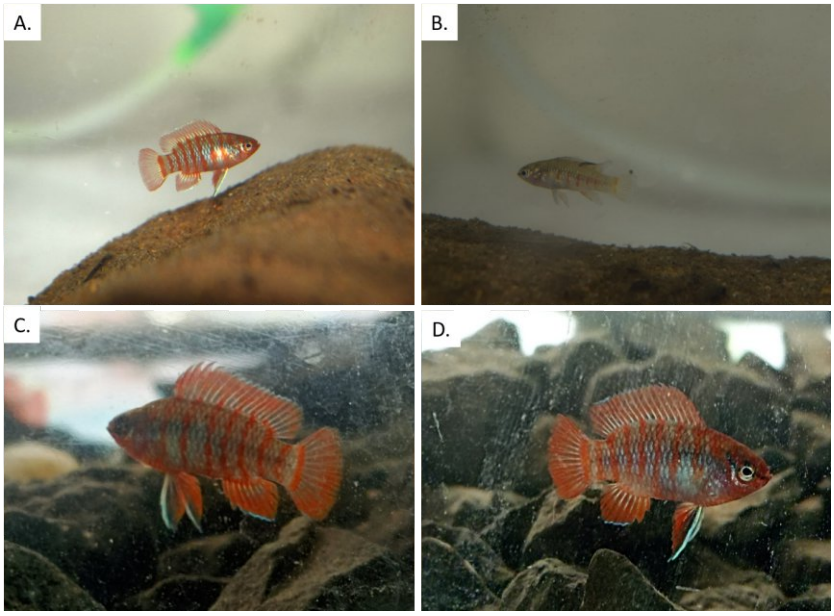
(CIFE/2020/AQC002/SR)



Banlam Jingshai Marbaniang

Major Advisor: Dr. Gouranga Biswas

A 60-day feeding and 30-day habitat manipulation trials were set up and conducted in succession to assess the best feed type for gonadal maturation and most suitable habitat for successful reproductive performance, respectively, for Scarlet badis, *Dario dario*. In the first experiment, fish were randomly distributed into four treatments in triplicate and provided with different feeds to assess and evaluate the impact of each diet on gonadal maturation and ultimately confirm the best performing diet. Three diets having isonitrogenous and isolipidic properties were formulated and prepared using three different protein sources namely, fish meal, squid meal and chicken liver meal for supplementing to fish (average weight: 106.13 ± 3.33 mg) under treatment 1, 2 and 3, respectively and *Tubifex* was given to the control twice daily. In terms of growth parameters, Tubifex fed group performed the best after 60 days of feeding with the highest values of weight gain, PWG, SGR, FCR, FER, PER and survival rate which are significantly higher ($p < 0.05$) than other treatment groups.



Activities of digestive enzymes and antioxidant enzymes were analyzed and results indicated a significant difference ($p < 0.05$) among different treatments, with the highest protease and lipase activity recorded in control

group and highest amylase activity in T1 group, whereas SOD and catalase activities were recorded the highest in T3 groups. Maturity indices such as GSI, tissue hormonal assay and histoarchitecture of gonads revealed that Tubifex fed group performed optimally and results showed a significant difference ($p < 0.05$) among different treatments. In the second experiment, four treatments in triplicates with different habitat manipulations such as addition of plants, sand, and gravel (T1), sand and gravel (T2), black gravels (T3) and a control group with no habitat manipulation, were arranged and stocked with 5 fish per tank to assess the impact of habitat manipulation on sexual dimorphism, reproductive performance and colouration of D. dario. Results revealed that T1 group performed the best in terms of sexual activity, distinct dimorphism, and colouration due to the ambient environment created by the plants and sandy substratum. No significant difference ($p > 0.05$) in terms of growth parameters was observed in all treatments due to the supplementation of a common diet i.e., *tubifex.* The water quality parameters were maintained optimally in both the experiments throughout the experimental duration.

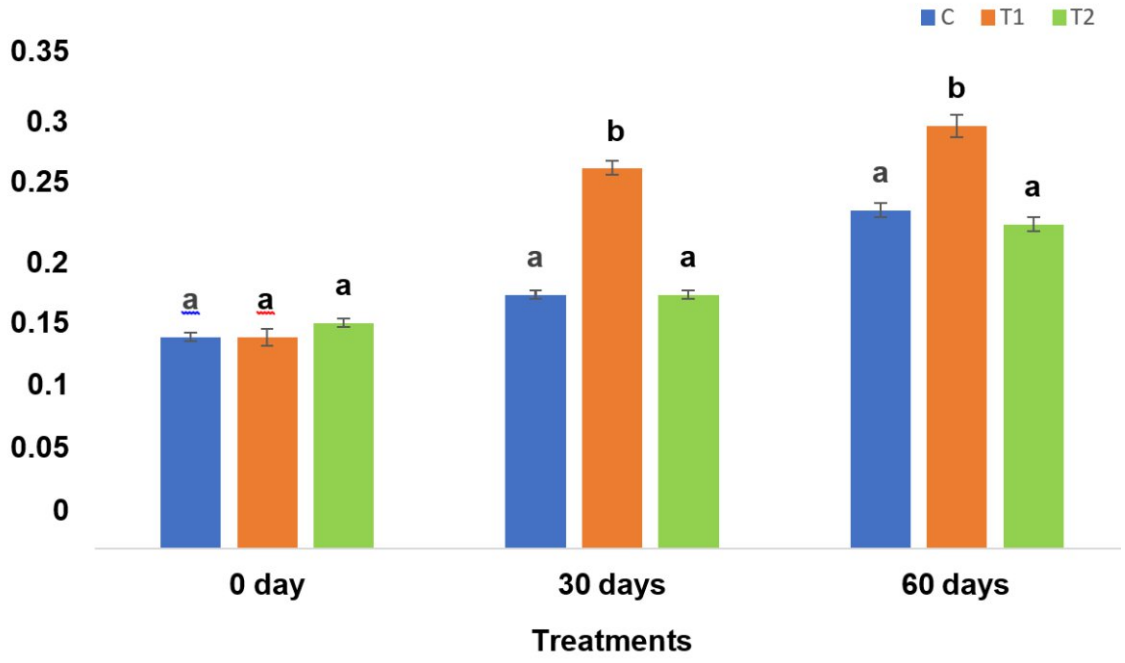
(CIFE/2020/AQC003/SR)

Evaluation of Artificial habitats for optimizing captive maturation of the indigenous ornamental Zebra Loach, *Botia striata* (Rao, 1920)

Christina Khundrakpam

Major Advisor: Dr. Paramita Banerjee Sawant

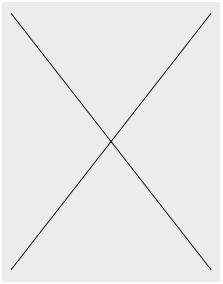
Botia striata (Rao, 1920) is a highly demanded ornamental fish endemic to the Western Ghats of India. They are known for their attractive patterns and stripes present on the body. In this context, a 60-day experiment was conducted to evaluate the effect of artificial habitat for captive maturation of Botia striata. The experiment was conducted with three experimental groups in triplicates viz., control (without substrate), T1 (sand substrate) and T2 (stone substrate). At the end of the trial, growth parameters like weight gain (cm), percentage weight gain (PWG) (%), Specific growth rate (SGR), Feed Conversion ratio (FCR) and Feed Efficiency ratio (FER) were recorded to be higher in T1 as compared to T2 and control but there were no significant differences between the treatment groups ($p>0.05$). Gonad Histoarchitecture and sex steroid profile at 0, 30 and 60 days of sampling reported better gonadal development in T1 compared to T2 and control.



At 60 days, T1 was found with progressively highest gonadal development corresponding to the highest GSI values, lowest HSI and presence of vitellogenic oocytes in the ovary. T1 was also found to have elevated hormone levels of 17α-20β dihydroxy progesterone, 17-β Estradiol and Testosterone at 30 and 60 days. In contrast, T1 was shown to have the lowest value of cholesterol level as compared to other treatment groups supporting appearance of vitellogenic oocytes in experimental groups, especially in T1 and elevation in levels of steroid hormones. Hence, this study provides an insight into the fact that zebra loach (*Botia striata)* can be matured better in the sand substrate. Based on the results of this study, it can therefore, be concluded that utilisation of sand as substrate enhances growth as well as maturation in zebra loach (*Botia striata)*. This study will help optimize conditions for captive maturation and subsequent breeding of this highly demanded indigenous ornamental fish, which is yet to be developed commercially.

CIFE/2014/AQC413/SR

Hypothalamo-hypophysial Regulation of Reproduction in *Labeo rohita* (Hamilton, 1822)



Brahmanand Shukla

Major Advisor: Dr. N.K. Chadha

Reproduction in carp fishes is controlled by the endocrine regulation of hypothalamo-hypophysial-gonadal axis. Attempt has been made to correlate the changes occurring in the hypothalamus (NPO and NLT) and pituitary gonadotrophs with ovarian maturation in female Indian major carp, *Labeo rohita* (Hamilton, 1822). The annual reproductive cycle of the Indian major carp has been divided into six phases (i) Immature phase (December-January), (ii) Early maturing phase (February-March), (ii) Advanced maturing phase (April), (iv) Pre-spawning phase (May-June), (v) Spawning phase (July-August) (vi) Spent phase (September- November). Gonadosomatic index (GSI) and average oocyte diameter depicted maximum values of 21.44±0.50 and 785.18±7.61 µm, respectively, in the spawning phase.

Using specific stains, gonadotrophs have been identified in proximal pars distalis (PPD) of the hypophysis. These cells showed accumulation of secretory material during maturing and pre-spawning phases which is released during the spawning phase of the reproductive cycle. In resting, preparatory and immature phases, the gonadotrophs exhibited inactivity or low profile of activity with scanty accumulation of secretory granules. Hypothalamo-neurosecretory system mainly comprised nucleus preopticus (NPO) and nucleus lateralis tuberis (NLT). The neurosecretory cells of NPO were laden with the neurosecretory material (NSM) in maturing and matured phases whereas they are partially vacuolated during spawning phase. The neurosecretory cells of NLT exhibited heightened activity during mature phase of the reproductive cycle. Furthermore, effects of HCG and GnRH-ovatide administration on the ovarian maturation and breeding response were recorded to understand their role in reproductive endocrinology of the carp. Though the two hormonal drugs did enhance gonadosomatic index (GSI) and ovarian maturity in the carp, the response of GnRH-based ovatide was more pronounced and exhibited germinal vesicle migration (GVM) towards periphery of the oocytes in most of the cases.

CIFE/2020/AQC013/SR

Dietary Supplementation of Fermented Palm Kernel Cake for Growth and Nutrient Utilization of *Penaeus vannamei* (Boone, 1931)

Sourav Roy

Major Advisor: Dr. Muralidhar P. Ande

A 45- day feeding trial was conducted to study the effect of dietary inclusion of fermented palm kernel cake (FPKC) on growth rates, nutrient utilization and physio-metabolic responses of *Penaeus vannamei*. Solid-state fermentation (SSF) of palm kernel meal (PKC) with commercial Baker's Yeast, *Saccharomyces cerevisiae* for 48 h at 30°C enhanced the crude protein content from 14.24 to 22.02% and lowered the crude fibre content from 12.86 to 8.59%. Anti-nutritional factors viz. phytate, oxalate, and tannin were decreased by 88.26%, 33.9%, and 41.51%, respectively after SSF. Five iso-nitrogenous and iso-caloric diets were prepared with different FPKC inclusion viz. 0, 7.5, 15.0, 22.50 and 30.0% and designated as control, T1, T2, T3 and T4, respectively. 15 shrimps (average initial weight, 6.22 g) per tank were stocked in 15 tanks consisting of 5 treatments with three replicates following completely randomized design. Shrimp were fed for 45 days four times daily.

Result of feeding trial exhibited that dietary inclusion of FPKC enhanced the growth rates (weight gain percentage and specific growth rates), feed conversion (feed conversion ratio, feed efficiency ratio and protein efficiency ratio) and protein retention (apprant net protein utilization) in *P. vannamei* ($p<0.05$) and highest growth performance was observed at 30% inclusion level. Survival rate (%) and feed intake were insignificant ($p>0.05$). Digestive enzymes viz. protease and lipase activity were also found significantly ($p<0.05$) highest in the T4 experimental group. Amylase activity was not found to be significant when compared to the control group. Metabolic enzymes like aspartate aminotransferase (AST) and alanine aminotransferase (ALT) activities in hepatopancreas and gills were significantly higher in T4 fed groups. Oxidative stress enzymes like superoxide dismutase (SOD) and catalase (CAT) activities were significantly ($p<0.05$) decreased with FPKC inclusion. Analysis of whole-body carcass composition exhibited an increase in crude protein content while crude lipid was decreased. Based on the results, it can be concluded that 30% yeast-fermented palm kernel cake could be incorporated in the diet of *Penaeus vannamei* without having any adverse effects on growth, nutrient utilization and physio-metabolic responses.

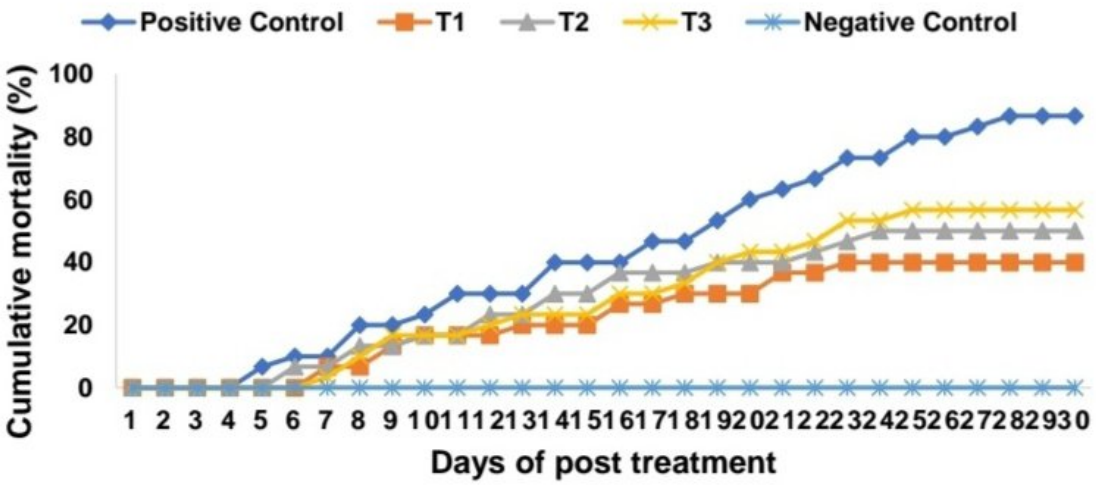
CIFE/2020/AQC011/SR

Modulation of Non-specific Immune Response, Growth, and Disease Control through Dietary Supplementation of Herbal Therapeutic Agents, *Curcuma longa* and *Allium sativum* in Biofloc Based Culture System of Tilapia

Sourav Bhadra

Major Advisor: Dr. Babitha Rani A.M.

Through dietary supplementation of turmeric (*Curcuma longa)* and garlic (*Allium sativum*) extract, a 45-day feeding trial was carried out in biofloc based culture system to modulate the immune response and disease control against Aeromonas hydrophila infection in GIFT tilapia (*Oreochromis niloticus*) fingerlings. For the first experiment, four experimental diets were developed by coating commercially available feed with four different doses of herbs, i.e., T1, T2, T3, and T4, with 0.05% turmeric extract, 0.1% turmeric extract, 0.05% garlic extract, and 0.1% garlic



extract, respectively, using a binder gel. The basal diet fed to the control group had no (0%) herbal extract. These diets were fed to the fish until the challenge study. Compared to control, a notable improvement in growth, weight gain, protein efficiency, and feed conversion were also observed in the botanicals fed groups. TEC, TLC, PCV, Hb content, oxidative burst activity, myeloperoxidase activity, and total immunoglobulin were improved after feeding with turmeric and garlic extract. There was a reduction in serum glucose in herbal extract treated groups compared to control during the post-challenge period.

Compared to a lower dosage or no herbal extract supplemented groups, T1 and T4 groups fed with a higher dose (0.1%) of herbal extract had better RPS (45% and 35%, respectively). Based on findings of the 1st experiment, a 30-day feeding study was carried out to see if a combination of turmeric and garlic extracts was effective in treating an experimentally induced aeromonasis ailment in GIFT tilapia (O. niloticus) fingerlings. To test, three experimental diets were made viz. T1, T2, and T3, by covering commercial feed with a mixture of turmeric and garlic extract at 75:25, 50:50, and 25:75 ratios, respectively. The dosage was determined by taking 0.1% herbal inclusion as the maximum based on the result of 1st experiment. Higher RPS was recorded in the T1 group (54%), followed by T2 (42%) and T3 (35%). Our findings suggest that 0.1 % dietary inclusion of turmeric and garlic extract separately as prophylactic measure and 0.1 % mixed herbal dietary supplementation as therapeutic measure against *A. hydrophila* infection under the BFT-based culture system of GIFT tilapia (O. niloticus).

CIFE/2020/AQC011/SR

Optimization of Stocking Density and Carbon Source for Rearing of *Mugil cephalus* (Linnaeus, 1758) in Biofloc Based System

Harsha Haridas

Major Advisor: Dr. N.K. Chadha

Two experiments were conducted to find the suitable carbon source and optimum stocking density for the nursery rearing of grey mullet in biofloc-based systems. The first experiment was conducted for 60 days to evaluate the growth performance of *Mugil cephalus* in a biofloc-based system using different carbon sources such as T1- sucrose, T2- cassava (Manihot esculenta), T3- sugarcane jaggery and T4-barley (*Hordeum vulgare*) and clear water as control. The in-situ biofloc was prepared using different carbon sources to maintain a C/N ratio of 15:1 in 150 L working volume in 300 L FRP tanks. After acclimatization, 15 healthy fish of average weight 0.91±0.041 g were randomly stocked into different biofloc treatment tanks. Biofloc-based units obtained significantly better ($p<0.05$) growth performances in terms of weight gain, feed conversion ratio (FCR), specific growth rate

(SGR), the protein efficiency ratio (PER) as well as digestive enzyme activity (amylase, protease, lipase), immune response (respiratory burst activity, myeloperoxidase activity, lysozyme activity) and lower stress compared to clear water control. Significantly higher ($P<0.05$) growth performance in terms of SGR with lower FCR were found in the barley-based biofloc group. Similarly, enhanced digestive enzyme activity in terms of amylase, lipase and protease were found in the barley-based biofloc group.

The non-specific immune parameters such as lysozyme respiratory burst activity and Myeloperoxidase activity ere significantly higher in the barley-based treatment group followed by jaggery and cassava-based treatment groups. Likewise, stress indicators in serum (Cortisol and Glucose) and antioxidant status in the liver (Superoxide dismutase and Catalase) were lower in barley-based treatment compared to sucrose, cassava and jaggery based treatment groups. The second experiment was carried out for 60 days with five different stocking densities in barley biofloc to optimize the stocking density. The grey mullet fry with an average body weight of 5.20±0.1 g was stocked in biofloc tanks at the rate of 100 nos m-3 (SD1), 150 no.s m-3 (SD2), 200 nos m-3 (SD3), 250 nos m-3 (SD4), and 300 nos m-3 (SD5). The highest growth in terms of average body weight, PWG, SGR, PER, and survival with lower FCR was found in lower stocking densities such as SD1 and SD2 at the end of 60 days experiment. Hence, the study concludes that the grey mullet can grow well in a biofloc-based culture system and efficiently utilize biofloc as feed. Barley had proved to be a potential carbon source for the rearing of grey mullet in a biofloc-based system. Stocking density of 150 nos m-3 is optimum for producing and maintaining the floc in the nursery rearing of grey mullet.

CIFE/2016/AQC603/SR

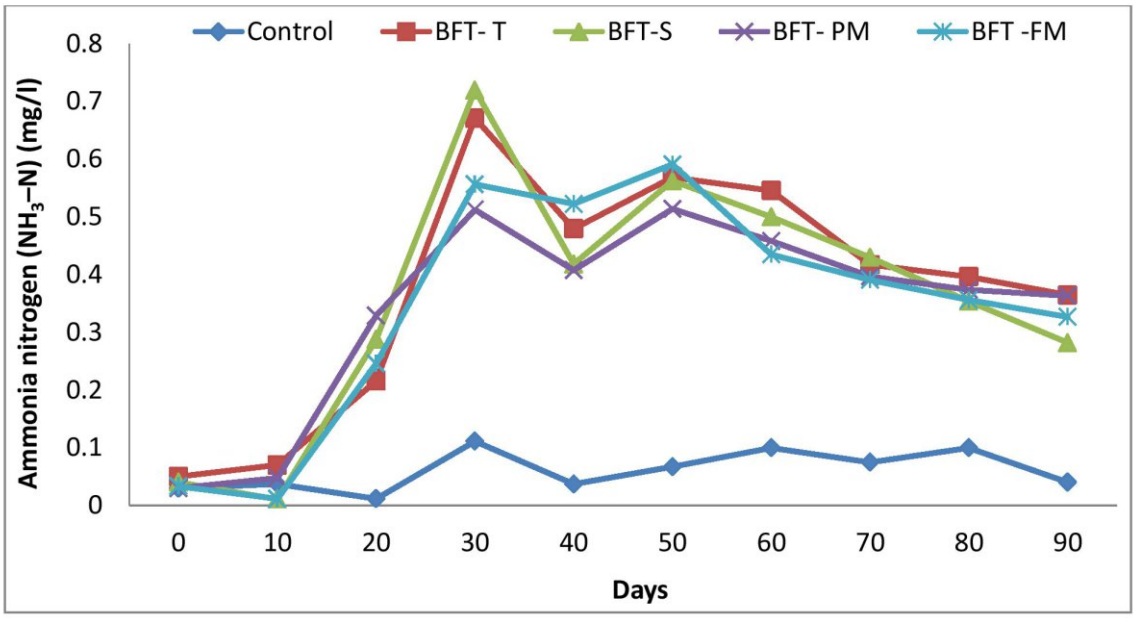
Evaluation of Growth, Immune Response and Carcass Quality of *Pangasianodon Hypophthalmus* (Sauvage, 1878) Fingerlings Reared in Biofloc Based System

P. Nageswari

Major Advisor: Dr. A.K. Verma

Two experiments of 90 days each were conducted to identify the potential carbon source and to optimize the stocking density for *Pangasianodon hypophthalmus* fingerlings in biofloc technology. In the first experiment, four different carbon source viz., BFT-T (Tapioca), BFT-S (Sorghum), BFT-PM (Pearl millet), BFT-FM (Finger millet) at C/N ratio 15:1 and one control (clear water) were taken. All the treatments and control were stocked @20 pangas fingerlings (6.4±0.05) per 100 l water (200 no/ m^3) in triplicate with complete randomized design. In terms of feed conversion ratio (FCR), feed efficiency ratio (FER), specific growth rate (SGR) and protein efficiency ratio (PER), significantly improved growth performance was observed in BFT-FM group. The significantly higher weight gain was recorded in BFT-FM followed by BFT-PM, BFT-S, BFT-T and lowest in control. Digestive enzymes activity significantly improved in all BFT groups compared to the control. Metabolic enzyme activities of liver tissue were significantly lower in BFT group than the control.

Challenge study was performed with virulent strain Aeromonas hydrophila. Haemato-immunological parameters (NBT, Hb, TEC, TLC, and PCV) were significantly improved in BFT-FM groups before and after challenge condition; whereas, MCV, MCH, and MCHC did not show any significant difference under both conditions. Anti-oxidant stress enzymes (SOD, CAT) and serum biochemical parameters (Total protein, albumin globulin, myeloperoxidase, lysozyme and phagocytic assays) also exhibited the same trend in pre and post-challenge condition. Stress parameters (serum glucose, cortisol) were significantly lower in BFT-FM group than the control under both the conditions. RPS was significantly higher in BFT-FM followed by BFT-PM group. Proximate composition of fish carcass and biofloc improved significantly in BFT-FM group compared to other treatment groups. Texture and colour profile of fish carcass did not show any



significant difference among the treatment groups. Furthermore, in the second experiment, fingerlings were stocked at the rate of 150, 180, 210, 240, and 270 per m3 and 150 per m3 in control (clear water) in triplicate to assess the growth and immune response. Stocking density at BFT-150/m^3 showed the best growth performance though stocking density up to BFT- 240/m^3 was still higher than the control. Digestive enzyme and metabolic enzyme activity was found to be decreased with respect to increasing stocking density in biofloc units. Haematological, immune, anti-oxidant stress enzymes also showed the same trend. The same effect of immune enhancement was proved with higher relative survival percentage when challenged with Aeromonas hydrophila. Overall, the study suggests that the biofloc system at C/N ratio 15:1 with carbon source finger millet flour can sustain *P.hypophthalmus* fingerlings at higher stocking density up to 210-240/m^3 without compromising the growth, immune health status, and survival would be an alternative option to boost the pangas production in future.

CIFE/2020/AQC703/SR

Effect of Substrate Based Periphyton on Growth, Survival and Health Status of Olive bard, *Puntius sarana* (Ham. 1822) Reared in Cages

Aurobinda Upadhyay

Major Advisor: Dr. B.K.Das

The present study was aimed to evaluate the growth, survival and health status of *Puntius sarana* reared with a different substrate based periphyton like bamboo, sugarcane bagasse and mosquito net. At first, three stocking densities i.e. 10 m^{-3} (SD10), 20 m^{-3} (SD20) and 30 m^{-3} (SD30) of P. sarana were evaluated for 90 days in inland open water cages of 6x4x4 m^3. All the experiment was carried out at Salia Dam, Ganjam district, Odisha. The study revealed that a significantly higher final body weight (FBW) (110.28±1.80 g) was achieved in SD10, compared to other treatments. However, SD20 fetched a higher yield in comparison to SD10 and SD30. The feed conversion ratio (FCR) was significantly lower and better in SD10, in comparison to SD30, which was an increase in production margin by about 28%. Moreover, multiple biomarkers like haemato-immunological indices (WBC, RBC, haemoglobin, haematocrit, platelets, serum protein, triiodothyronine, thyroxine), metabolic (liver enzymes, protease, amylase, lipase) and stress responses (superoxide dismutase, catalase, cortisol, serum glucose, heat shock protein) indicated that SD20 found suitable stocking density for *P. sarana* in the cage. In

the second experiment, two natural substrates (bamboo-BM; sugarcane bagasse-SB) and one artificial substrate (mosquito net-MN) were evaluated in the cage culture with *P. sarana*. Bamboo was considered the most desirable substrate for periphyton production in terms of plankton density, dry matter, AFDM, chlorophyll, Autotrophic Index, amino acid, fatty acid and mineral composition. The highest yield of *P. sarana* was obtained in BM.

The body composition, nutritional value (amino acid, fatty acid and mineral composition), growth attributes, hemato-biochemical parameters, stress responses and digestive enzyme activities of fish indicated that *P. sarana* reared in bamboo based cage culture in the inland open water reservoir was found most feasible. Considering the outcome of the first and second experiments, *P. sarana* was stocked at 20 m^{-3} with bamboo-based periphyton at a graded level of commercial feed (CF) reduction. Five stages of feed reduction i.e. 100% (CF100), 75% (BM+CF75), 50% (BM+CF50), 25% (BM+CF25) and 0% (BM+CF0) were selected in comparison to the satiation level feeding. Growth performance in terms of weight gain, SGR, AGR and yield was higher in 75% commercial feed supply with BM periphyton. Better feed utilization in terms of FCR, FCE and PER was achieved in BM+CF75, in comparison to CF100, which was an increase in production margin by about 45%. This study suggested that periphyton produced by bamboo can support 25% feed reduction in the inland open water cage culture of *P. sarana* stocked at 20 m^{-3}.

CIFE/2020/FRM006/SR

Impact of Culture Conditions on Growth and Biochemical Composition of Selected Brown Algae

Sudipta Barman

Major Advisor: Dr. Geetanjali Deshmukhe

Coastal ecosystems are vulnerable to climate change. Seaweeds are the primary producers and foundation species in these areas. Salinity is a potential environmental factor that influences brown algal growth and biochemical composition. The effects of different salinity (25, 30, 35, and 40 ppt) levels on the growth and biochemical composition of Padina tetrastromatica were studied in an indoor culture experiment maintained for 21 days. The daily growth rate of *P. tetrastromatica* exposed to different salinity levels varied significantly. The maximum daily growth rate of 3.20% was observed at 35 ppt for the Shrivardhan-collected specimens, whereas the Ratnagiri-collected samples showed a maximum daily growth rate of 3.02% at 35 ppt. In 25 ppt treatment salinity, the daily growth rate was recorded as the minimum for the specimens collected from both sampling sites. For *P. tetrastromatica,* 35 ppt of salinity was found to be optimal. Significant differences in biochemical composition were also observed in the experimental period that encompassed extreme salinity. The protein content was found to be a maximum at 30 and 35 ppt for Shrivardhan and Ratnagiri samples, respectively. The lipid content was increased under salinity stress. The cultured species showed higher total carbohydrate content than the wild collected sample for both sites. In the case of the Shrivardhan sample, the total phenol content was highest at 40 ppt, while the Ratnagiri sample showed the highest total phenol content at 35 ppt. The result showed that the optimum condition for growth and biochemical composition varies with the geographical location's ecology and the harvesting time. Based on this study, a two-stage culture process can be utilized to obtain a higher amount of bioactive compounds. Firstly, optimal growth conditions are to be provided to achieve high biomass, followed by exposure of thallus to stress conditions for accumulation of target desired metabolites (bioactive compounds) in the second step.

CIFE/2020/FRM005/SR

An Appraisal on the Larval Morphogenesis and Allometric Variations in Hatchery Reared Larvae of Silver Pompano, *Trachinotus Blochii* (Lacépède, 1801)

Silpa R.

Major Advisor: Dr. Asha .T. Landge

The silver pompano, *Trachinotus blochii*, of the order perciformes and the family carangidae, is one of the most widely cultured coastal fish along the Indian coast. To assist larval identification, to surpass critical periods in culture practices, larval morphology and allometric studies were carried out in the present study. A total of 230 larval specimens of hatchery reared silver pompano were collected for morphological, morphometric and allometric studies. The observed morphological characteristics identified five post-embryonic stages: yolk-sac, preflexion, flexion, postflexion, and juvenile. A total of 6 (yolksac to preflexion) and 12 (postflexion and juvenile) morphometric variables were extracted. In this research, it was evident that the structures of the body (i.e., the pigmentation of the eye, the development of the head and the body) had slower growth than the fish growth in length. Principal component analysis of morphometric traits was efficient in differentiating each larval stage due to differences in stage-specific phenotypic plasticity.

All the morphometric variables contributed to the separation of yolksac, preflexion and flexion stages. The head-based variables (pre anal fin length, pre dorsal fin length, pre pectoral length), caudal peduncle depth and eye diameter were the contributing measurements for separating postflexion and juvenile stages. Hence morphometric, morphological and allometric studies on the larvae will be baseline data to strengthen the easy identification of larval stages and supplement future studies on the species.

CIFE/2020/AQC005/SR

Filtration Rate Optimization in RAS with Trickling Biofilter using FRP Rings for Rearing of GIFT Tilapia

P. Bharathi Raja

Major Advisor: Dr. Chandrakant M H

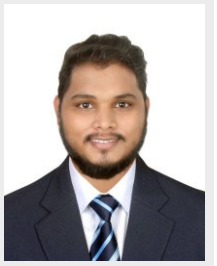
A trickling biofilter with fiber reinforced plastic (FRP) rings as substrate was designed and fabricated, and a recirculating aquaculture system (RAS) was developed to optimize the rate of filtration and evaluate the water quality and growth performance parameters of GIFT Tilapia reared for 75days. The RAS consisted a FRP tank for rearing fry of GIFT Tilapia, submersible pump fitted with PVC pipe and fittings, and trickling biofilter unit. A trickling biofilter was designed and fabricated using 3-4 mm thick PVC pipe (0.20 m dia. and 0.64 m ht.) to contain 0.018 m^3 biofilter media (FRP rings). A perforated mild steel (MS) plate was attached at the bottom of the biofilter chamber to hold the biofilter media and allow filtered water return to the culture tank. A shower was fitted above the biofilter chamber for spraying culture water on biofilter media. The FRP rings were filled inside the biofilter chamber for growth of biofilm for housing the bacterial (nitrifier) colonies on their surfaces. The foot valve of the suction pipe was covered with nylon mesh / screen to prevent the entry of fry of GIFT Tilapia.

The experiment consisted three treatments and a control with each treatment having triplicates following a completely randomized design. Three different flow rates as 200, 300, and 400L/hr were assigned as treatments T1, T2, and T3 respectively. The control did not have any recirculation

of water; however, water exchange @ 20-30% was done twice a week. The fry of GIFT Tilapia (0.3 to 0.8 g) were stocked in FRP tanks (water volume 300 L) @ 60 per tank. Fish were fed with floating feed fed @ 15, 10,8, 6, 5, and 3% for each 15 days sampling interval. While the physico-chemical parameters of water quality; antioxidant stress parameters, biochemical parameters, and growth parameters of GIFT Tilapia were found to be significantly better in the Treatment T3 (400 L/hr), the digestive activity showed better results in T2 (300 L/hr). Based on the overall results of the present study, it may be concluded that the trickling biofilter with FRP rings as substrate can be an efficient biofilter for RAS. Since the best growth of GIFT Tilapia and critical water quality parameters in optimum range were recorded in the Treatment T3, a filtration rate of 400 L/hr can be suggested as optimum for intensive culture of GIFT Tilapia in trickling biofilter based RAS using FRP rings as biofilter media.

CIFE/2020/AQC010/SR

Assessment of Production Performance of Genetically Improved Farmed Tilapia in Freshwater Integrated Multi-Trophic Aquaculture System



Sagar Vitthal Shinde

Major Advisor: Dr. Kapil Sukhdhane

The present investigation was carried out to evaluate the production performance of GIFT tilapia in Freshwater Integrated Multi-Trophic Aquaculture system. The experiment was performed for 60 days by incorporating floating weed *Lemna minor* as inorganic extractive and bivalve *Lamellidens marginalis* as organic extractive to assess the growth, survival, water quality and physiological response on GIFT fed fishes in 1000l outdoor tanks. The treatments were assigned as control (C) only GIFT, T1; GIFT and *Lemna minor*, T2; GIFT and *L. marginalis* and T3; GIFT, *Lemna minor* and *Lamellidens marginalis*. The stocking densities for GIFT and *L. marginalis* were 40,000 fingerlings/ha and 750 kg/ha while lemna was transplanted to cover 25% of the tank surface area. The fish were fed with a sinking pelleted feed (30% Crude Protein) at the rate of 4% body weight. Among different water quality parameters pH, electrical conductivity, dissolved oxygen, total hardness and TDS varied significantly ($p<0.05$) among different treatments. Transparency was found very high in the FIMTA system.

The nitrogenous waste like NH3-N, NO2-N, and NO3-N content in the control group was the highest and the lowest in T3; phosphate (PO4-P) was documented as highest in control and was lowest in T3 and T1. The presence of *L. marginalis* in T2 and T3 reduced calcium and hardness levels of water. Potassium was impacted by Lemna minor and found to be decreased in T3 and T1 treatments. The growth, biomass, survival, daily weight gain (DWI), and daily growth index (DGI) were highest in the FIMTA system than in other treatments. Serum superoxide dismutase enzyme activity levels were increased in control, and the lowest was reported in FIMTA. The catalase activity was significantly inhibited in T3, T1, and T2 compared to the control. Antioxidant enzymes activity like SOD and catalase were the lowest in T3 due to better environmental conditions. Acute stress parameters like cortisol and glucose were significantly lower in the treatment group compared to the control. Myeloperoxidase activity in control was reported lower than in other treatment systems where T3 had the highest value for MPO. Total protein and albumin levels in serum were reported higher in T3 than in control. The results indicate that FIMTA of GIFT with *L. Minor* and *L. marginalis* can ameliorate water quality and physiological responses, enhancing fish survival and productivity.

CIFE/2017/AQC711/SR

Evaluation of an Integrated Multi-Trophic Aquaculture (IMTA) System for Freshwater Species in Tripura

Kouberi Nath

Major Advisor: Dr.Sukham Munil Kumar

Two sequential in-door experimental trials were conducted to assess the relative suitability of *Wolffia globosa, Lemna minor, Spirodela polyrhiza* as inorganic extractive (Trial 1) and that of Lamellidens marginalis and Pila globosa as organic extractives (Trial 2). In trial 1, the duckweeds were randomly inoculated in triplicates in glass aquaria (60x30x30cm; 30 L) filled with groundwater with initial inorganic nutrient concentrations of 2 mg/L NH_4-N and 0.5 mg/L PO_4-P and time series of removal rates and biomass production were evaluated by monitoring the time series of dissolved inorganic nutrient concentrations. In trial 2, the molluscs were introduced in aquaria filled with water, abundant in phytoplankton and time series of phytoplankton density, turbidity and dissolved oxygen were monitored to assess their filtration rates and oxygen consumption rates.

While Wolffia exhibited markedly high ($p < 0.05$) removal rates of dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP) especially during initial 5 day, as well as high net biomass production over the rest of other duckweeds, *L. marginalis* exhibited significantly higher filtration rates ($p < 0.05$) as compared to P. globosa. Subsequently, Trial 3 was conducted in outdoor tanks (5m x 4m x 1m; 90 d) provided with soil base (5-7 cm) to evaluate relative survival, growth and health performance of fed rohu *(Labeo rohita)* when cultured in combination, partition with *Wolffia*-canopy (T1), *L. marginalis* (T2), and in combination with *W. globosa* canopy and *L. marginalis* (T3) while exclusive fed rohu served as control (C). The survival, daily growth index (DGI), net fish yield (NFY) was found highest in T3 than those in other treatments. The DIN including NH4-N, NO3-N and NO2-N were highest in the control and lowest in T3. Notable, DIP was undetected in T1 and T3. Further, *L. rohita* exhibited superior health parameters in T3 in comparison to rest of other treatments as evidenced by low ($p < 0.05$) SGPT, SGOT, catalase activity, and high values of superoxide anion production ($p < 0.05$) superoxide dismutase enzyme activities in serum. The gross and net returns were highest in T3. The results indicate that the co-culture of *L. rohita* with *W. globosa* and *L. marginalis* can improve water quality, welfare parameters, and enhance fish survival, productivity, and return.

Bioaugmentation of Aquaculture Waste in *Pangasianodon hypophthalamus* (Sauvage,1878) Rearing Medium Using Combination of Selected Microbes and Enzymes

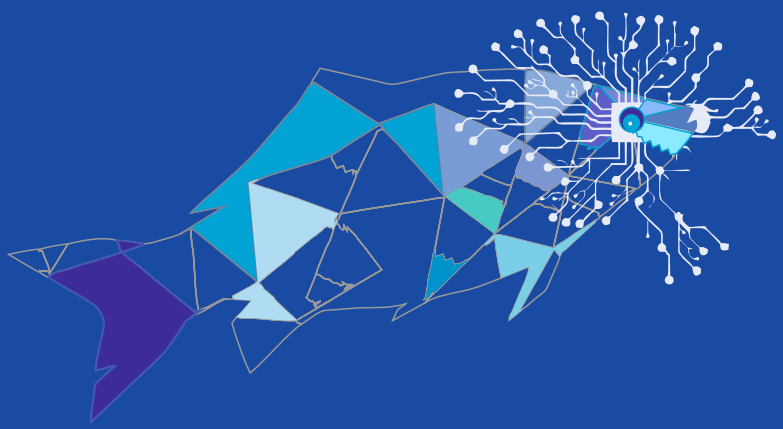
CIFE/2020/AQC009/SR

Rozirani Behera

Major Advisor: Dr. Upasana Sahoo

There was no significant difference ($p \geq 0.05$) in the survival percentage between the different treatments. Significantly higher erythrocyte count, haemoglobin content, haematocrit value, leucocyte count, and respiratory burst activity were observed in T4 which has a higher concentration of *Bacillus subtilis* and *Lactobacillus sporogenes* with lipase as compared to other treatment groups and control. The number of adherent neutrophils was significantly higher in all the treatment groups than in the control. Significantly, higher digestive enzyme activity was found in the T4. The present study revealed that T4 i.e the combination of *Bacillus subtilis* and *Lactobacillus sporogenes* (1:2 ratio) in the higher dose (3g/100l) in combination with a lipase of (0.1gm/ 100l) gave the best result in the water quality, growth as well as immune response of *Pangasianodon hypopthalamus* fingerlings. The highest growth rate was seen in T4 i.e as a high dose of microbes combines with enzymes improves the digestive activity which further improves the feed utilization of fish in the culture system.

3.3 Nutrition and Feed Technology



Strategies to Enhance Feed Intake and Growth in Carps During Winter

CIFE/2019/05 /IF

Project duration:2019- 2022

Principal Investigator
Dr. Ashutosh D. Deo

Co-Principal Investigator
Dr. Md. Aklakur
Dr. Shamna N
Dr. Manish Jayant
Dr. Subodh Gupta
Dr. N.P. Sahu

Cold-water RAS system was fabricated at the beginning of the project using 18 nos. of 60L capacity bucket type tubs and low temperature was maintained below 20oc using an online chiller. In the first experiment, a feeding trial was conducted with *Cyprinus carpio* with varying levels of Quinone in the diet. The best result was obtained in a 0.8mg/kg Quinone supplemented diet with increased feed intake, growth, and metabolic activities at low temperatures. In the second experiment, varying levels of ethanoic lemon peel extract were used as a metabolic modifier and the best result was recorded with 0.5-1.0% level incorporated diet in *Labeo rohita.*

Another experiment was conducted with different levels of onion peel extract and 0.5 % crude onion peel extract incorporated diet showed improved feed intake and growth in *L. rohita* at low temperature. The effect of L- carnitine on growth and metabolism of low temperature exposed carps showed that inclusion of 1-1.25% of L-carnitine stimulated growth, feed intake and lipid metabolism in *Labeo rohita* reared in in a low temperature (18 ± 1ºC) recirculatory aquaculture system (RAS) with a flow rate of 1.8 L/min. The project was severely affected by the outbreak of the COVID 19 pandemic and the lockdown. Hence, a proposal for Phase II has been submitted to IRC for conclusive works.

Effect of Graded Levels of L-carnitine on Feed Intake and Growth of *Labeo rohita* (Hamilton, 1822) Fingerlings Reared at Low Temperature

CIFE/2020/FNT008/SR

Veeramani Maruthi K N

Major Advisor: Dr. Ashutosh D Deo

A 60-day feeding trial was conducted with an aim to delineate the effect of dietary L-carnitine supplementation on feed intake and growth of rohu, *Labeo rohita* fingerlings reared at low temperature. Six isonitrogenous (30% crude protein) and isocaloric (386.89 kcal/100g digestible energy) practical diets with varying levels of L-carnitine supplementation *viz.*, control (C) (0% L-carnitine), T 0.25 (0.25% L-carnitine), T 0.50 (0.5% L-carnitine), T 0.75 (0.75% L-carnitine), T 1.00 (1% L- carnitine) and T 1.25 (1.25% L-carnitine) were prepared. The experiment was conducted in a low temperature (18 ± 1ºC) RAS with a flow rate of 1.8 L/min.

The results from indicated that dietary supplementation of L-carnitine significantly improved ($p<0.05$) the feed intake, final weight, weight gain, weight gain %, specific growth rate (SGR), thermal growth coefficient (TGC), feed efficiency ratio (FER) and nutrient utilization. Survival rate was significantly higher in L-carnitine fed groups ($p<0.05$) and T 1.00 and T 1.25 groups showed higher growth and nutrient utilization among. The lipase activity followed a similar trend, whereas the protease activity was significantly higher in T 0.25 and T 0.50 groups ($p<0.05$). The muscle aspartate aminotransferase (AST) and alanine aminotransferase (ALT) activities were significantly

lower in T 1.00 and T 1.25 groups ($p<0.05$). The lactate dehydrogenase (LDH), malate dehydrogenase (MDH) and oxidative stress enzymes like superoxide dismutase (SOD) and catalase (CAT) showed a decreasing trend with the increasing level of L-carnitine inclusion in the diet.

The whole-body lipid content was significantly lower ($p<0.05$) in the T 0.25 and T 0.50 groups and the activities of hepatic glucose-6-phosphate dehydrogenase (G6PDH) and malic enzyme were found to be significantly higher in T 1.00 & T 1.25 groups. Similar trend was observed in HSI values. The serum glucose levels and haemoglobin content in the blood increased with the dietary inclusion of L-carnitine. From these results, it can be concluded that dietary supplementation of L-carnitine at 1.0 to 1.25% could be suggested to increase the feed intake, growth, and metabolic activities of rohu fingerlings reared at low temperature.

CIFE/2020/FPB004/SR

Effect of Ashwagandha (*Withania somnifera*) Root Powder and Extract on Feed Intake and Growth of *Labeo rohita* (Hamilton, 1822) Fingerlings Reared at Low Water Temperature

Naveen S. K.

Major Advisor: Dr. Manish Jayant

Present study was carried out to evaluate the effect of Ashwagandha (*Withania somnifera*) root powder (ARP) and extract (ARE) on feed intake, growth performance and physio-metabolic responses of *Labeo rohita* fingerlings reared at low temperature. Four extracts *viz.* ethanolic, methanolic, acetone and aqueous were prepared from Ashwagandha root powder with a dry matter recovery of 7.98, 4.54, 3.50 and 5.80 %, respectively.

Methanolic ARE exhibited highest antioxidant activities followed by ethanolic & acetone extract and lowest in aqueous extract ($p<0.05$). The antioxidant activities were directly proportional to the total phenolic and total flavonoid contents of the different AREs ($p<0.05$). Seven iso-nitrogenous (30.09 % crude protein) and iso-caloric (376.98 kcal digestible energy/ 100g diet) practical diets were formulated and prepared by supplementing ashwagandha root powder (0.5, 1.0 & 2% inclusion) and extract at (0.5, 1.0 & 2% inclusion). Feed intake was significantly higher in ARP and ARE supplemented fed groups ($p<0.05$) than non-supplemented group (C). Fish fed with ARP and ARE- based diets (2.0%) exhibited higher growth rates than control ($p<0.05$). Protease activity was increased with ARP and ARE levels and were in correlation with growth rates ($p<0.05$). Amylase activity was decreased with ARP and ARE levels whereas lipase exhibited an increasing trend with dietary ARP and ARE levels ($p<0.05$).

Aminotransferase (aspartate aminotransferase and alanine aminotransferase), and malate dehydrogenase (MDH) and isocitrate dehydrogenase (IDH) activities exhibited a linear trend in rohu fingerlings fed with ARP and ARE levels ($p<0.05$). Glucose-6-phosphate dehydrogenase (G6PDH) activity was significantly decreased in ARP and ARE fed groups ($p<0.05$). Lactate dehydrogenase (LDH), and superoxide dismutase (SOD) and glutathione S-transferase (GST) activities were enhanced maximum in ARP and ARE fed groups ($P<0.05$). Serum glucose content, total protein, and globulin were significantly affected by dietary ARP and ARE supplementation ($p<0.05$). Based on the results, 2.0 % ARP and 2.0% ARE in the diet of *L. rohita* fingerlings reared at low temperature could be suggested for enhancing the feed intake and growth performance.

Nutritional Intervention for Reducing Solid Waste & Enhancing Phosphorus and Nitrogen Retention of Aquafeed in Recirculatory Aquaculture System (RAS)

CIFE/2020/07/IF

Project duration:2020- 2023

Principal Investigator
Dr. Sikendra Kumar

Co-Principal Investigator
Dr. Ashutosh D. Deo
Dr. A.K. Verma
Dr. Md. Aklakur
Dr. Tincy Varghese

The optimum growth performance of GIFT tilapia fingerlings was found at stocking density 3833g/m (250 fishes /m³) in recirculating aquaculture system (RAS) with the lower release of dietary phosphorus, total ammonia, nitrate and nitrite. Significantly ($p<0.05$) higher WG%, SGR & lower FCR of GIFT tilapia fingerlings found at 34% crude protein and 10% lipid-based diet in the RAS. Significantly ($p<0.05$) lower total ammonia, nitrite and nitrate were found in the RAS of GIFT tilapia fingerlings fed at 30% crude protein and 12% lipid diet. The experiment on nutritional strategy to reduce the faecal solid release in the RAS of GIFT tilapia fingerlings is in progress.

Evaluation of the Toxico-physiological Effect of Dietary Mycotoxin and Cyanotoxin in Selected Carps

CIFE/2019/11/IF

Project duration:2019- 2022

Principal Investigator
Dr. Md. Aklakur

Co-Principal Investigator
Dr. Ashutosh D. Deo
Dr. G.H. Pailan
Dr. Dilip Kumar Singh

Total 11 farms associated with mortality of Catla and other carps, especially grass carp in winter months, were monitored. There was no marked difference in appearance or physical damage. In all the fishes after mortality, the scales were found to be loose, especially in grass carp. The water color of such farms was yellowish or reddish-green with bloom on the surface or turbidity due to bloom.

Three experimental trials were completed and three more trials are underway. Two genera *Microcystis* and *Anabaena* have been tested for their toxicity in dietary formulation with 0.5 % and 15 % inclusion. The dietary inclusion of *Microcystin* with 5 % showed reduced growth without any significant impact on survival. The powder mix of *Anabaena, Nostoc,* etc. did not show any negative impact on the growth of fish. The *Microcystis* has been found to reduce the growth in *Catla catla* above 5 % inclusion. The feed performance was best reported at 2 % inclusion of microcystin in feed-in *Catla catla.*

The experiment conducted for 100 days revealed that the growth performance showed a decrease after 2 % inclusion. FCR was found to increase significantly from the 2 % group while PER decreased significantly from the 2 % and above inclusion group. But body composition of the experimental fish was not

affected by the inclusion of graded levels of MBGA and 100% survivals were observed in all treatment ponds. Protease activity was found to decrease significantly from the 1 % inclusion group, whereas lipase activity was found to decrease significantly ($p<0.05$) from the 2 % and above inclusion group. Amylase activity was reduced significantly in 4 % and above treatments compared to control. Stress enzyme activity was found to increase significantly in high dosage MBGA. The SOD and catalase activities were found to increase significantly from 2 % inclusion. Hematological parameters, such as RBC, Hb and Hct were decreased significantly after 2 % inclusion of microcystin groups while WBC count was enhanced in these groups.

CIFE/2020/FNT006/SR

Effect of Different Algal Meal Supplemented Diets on Growth and Physiological parameters of IMC Reared in Three Species Polyculture Syatem

Subham Bakli

Major Advisor: Dr. Md. Aklakur

A study was conducted to evaluate the effect of different algal meal supplemented diets on Indian Major Carps reared in 3 species polyculture system. The crude protein (%) content of different algal powders ranged from 43 to 58 percent, which was found to be adequate for inclusion in IMC fingerlings feed. A feeding trial with same experimental design and with two samplings (60 days and 120 days) were carried out to evaluate the growth, production, feed performance, physiological and hematological parameters of Indian major carps. The different IMC species were *Catla catla* (Surface and zooplankton feeder), *Labeo rohita* (Column and periphyton feeder), and *Cirrhinus mrigala* (Bottom and detritus feeder).

Fishes were fed five iso-nitrogenous (30% CP) and iso-caloric (363.87 ± 1.43 Kcal/100g) diets for 120 days. The diets were C (0% dietary algae), T1 (5% dietary *Chlorella* sp.), T2 (5% dietary *Microcystis* sp.), T3 (5% dietary *Anabaena* sp.), T4 (5% dietary mix Blue-green algae). The study revealed that the best growth performance was by *C. mrigala*, followed by *Catla catla*, and least in *L. rohita* during 60 &120 days observations. The growth indices such as WG (%), SGR, ADG up to 60 days did not show significant difference ($p>0.05$) among the treatments; however, they varied significantly ($p<0.05$) after 120 days feeding trial, among the treatments.

The higher ($p<0.05$) growth performance, observed in the control group and showed decrease ($p<0.05$) in *Microcystis* and *Anabaena* supplemented groups. FCR was found to increase significantly ($p<0.05$) in the algal-fed group, while PER decreased significantly in those group. But body composition of the experimental fishes was not affected by the inclusion of algal diets, and about 87.88% survivability was observed in all treatment ponds. Stress enzyme activity was found to increase significantly in the algae-fed group. Hematological parameters, such as RBC, Hb, and Hct, decreased significantly ($p<0.05$) in algal fed groups. WBC count was enhanced. Thus, it is concluded that the *Microcystis* and *Anabaena*-rich blue-green algae supplemented diets are least suitable for IMC fingerlings with long exposure.

CIFE/2020/FPB005/SR

Effect of Dietary *Anabaena* on Physio-Metabolic Responses of *Catla Catla* (Hamilton,1822)

Mule Satyam Rajkumar

Major Advisor: Dr. Dilip Kumar Singh

A 60-day feeding trial was conducted to investigate the effect of dietary *Anabaena* blue-green algae (ABGA) inclusion on the growth and physio-metabolic responses of *Catla catla* (Hamilton,1822) fingerlings. Fish were fed six iso-nitrogenous (30% Crude Protein) and iso-caloric (378.09 kcal/100g) diets for 60 days. The diets were C (0% ABGA), T1 (3% ABGA), T2 (6% ABGA), T3 (9% ABGA), T4 (12% ABGA) and T5 (15% ABGA). Growth parameters viz. percent weight gain (PWG), specific growth rate (SGR), protein efficiency ratio (PER), and feed conversion ratio (FCR) were calculated at the end of the experimental period of 60 days.

The study revealed that growth parameters were not significant (P>0.05) among the treatments. Body composition of the experimental fish was significantly not affected by the inclusion of a graded level of ABGA. Digestive enzyme activity varied significantly among the treatment groups. Amylase activity was found to be decreased significantly (P<0.05) in T4 and T5 treatments compared to other treatments. In contrast, lipase and protease activity were insignificant (P>0.05) among all experimental treatments. Stress enzyme activities exhibited linear relationship with dietary ABGA inclusion and highest activities was observed in T5 fed group. Serum parameters, such as serum glucose content was increased significantly (P<0.05) from the control group to T5, whereas serum albumin content decreased significantly (P<0.05) in ABGA fed groups.

In contrast, total serum protein and A/G ratio did not differ significantly (P>0.05). Metabolic enzymes, such as aspartate aminotransferase (AST) and alanine aminotransferase (ALT) activity were found as non-significant (P>0.05) among the experimental treatment groups. Carbohydrate metabolic enzymes, LDH (Lactate Dehydrogenase) and MDH (Malate Dehydrogenase) activity were linearly increased significantly (P<0.05). Haematological parameters, such as RBC (red blood corpuscles), Hb (haemoglobin) and PCV (packed cell volume), were decreased significantly from control to T5 groups, while WBC count was enhanced in these groups. Thus, it is concluded that upto 15% inclusion of dietary *Anabaena* did not affect the growth parameters but somewhat changes in physio-metabolic parameters. However, there is scope for further addition as the higher level must be accessed.

CIFE/2022/07/IF

Project duration: 2022-2025

Principal Investigator
Dr. Manish Jayant

Co-Principal Investigators
Dr. Parimal Sardar
Dr. Subodh Gupta
Dr. Ashutosh D. Deo
Dr. Kiran D. Rasal
Dr. Arun Sharma
Dr. Shamna N

Utilization of Jojoba (*Simmondsia chinensis*) and Mahua (*Madhua indica*) Cake / Meal-based Products in Aquafeed

The jojoba cake was procured from Rishabh oils Pvt. Ltd, Kolkata, India and ground in pulverizer and then sieved. The meal produced from the cake (Jojoba meal) was processed to extract the proteins using alkali solubilization of proteins followed by precipitation at isoelectric pH (Fawole et al., 2016; Jayant et al., 2021). Sixteen different combinations of pH in triplicates viz. 11.0/4.0, 11.0/4.5, 11.0/5.0, 11.0/5.5, 11.5/4.0, 11.5/4.5, 11.5/5.0, 11.5/5.5,

12.0/4.0, 12.0/4.5, 12.0/5.0, 12.0/5.5, 12.5/4.0, 12.5/4.5, 12.5/5.0 and 12.5/5.5 were used to standardize the process. The pH combination of 12.0/5.0 exhibited significantly higher dry matter recovery, protein recovery and crude protein (%) content ($p<0.05$). Dry matter recovery, protein recovery and crude protein (%) of prepared isolates were ranged from 11.71-23.70, 33.56-72.09 and 79.00-88.37 %, respectively.

Valorization of Fruit and Vegetable Waste For Aquafeed

CIFE/2022/09/IF

Project duration: 2022-2025

Principal Investigator
Dr. Shamna N

Co-Principal Investigators
Dr. Parimal Sardar
Dr. Manish Jayant
Dr. Subodh Gupta
Dr. Babitha Rani A.M.
Dr. Manjusha L.
Dr. Jeena K
Dr. Namrata A. Giri (ICAR-NRCP)

Market visits were conducted and fruit waste (Pineapple peel, Papaya peel and Pomegranate peel) and vegetable waste (Cabbage waste, Cauliflower waste and Mixed vegetable waste) were collected. Proximate composition of the procured wastes was conducted in the FNBP laboratory . Extract was prepared from pineapple peel, papaya peel extract and pomegranate peel using four different solvents (Ethanol, Methanol, Aqueous & Acetone). The dry matter recovery and in vitro qualitative and quantitative antioxidant assays were conducted. Ethanolic extracts of pineapple peel meal, papaya peel meal and pomegranate peel meal showed higher dry matter recovery and antioxidant activities.

Evaluation of Pomegranate Peel Extract in the Diet of *Labeo rohita* (Hamilton, 1822) Fingerlings Reared Under Different Stocking Densities

CIFE/2020/FNT002/SR

Omkar Patra

Major Advisor: Dr. Shamna N

A 60-day feeding trial was conducted to evaluate the effect of dietary pomegranate peel extract on growth and physio-metabolic changes in *Labeo rohita* fingerlings reared under different stocking densities. Pomegranate peel extract was prepared using five different solvents and quantitative and qualitative assessment of antioxidant activities were carried out. From the results, it was observed that pomegranate peel ethanolic extract (PPEE) showed highest dry matter recovery and antioxidant activity. Following a 3×3 factorial design, four hundred and five (initial body weight 4.36 to 4.45 g) fingerlings were stocked in three different stocking densities (10,15 and 20 nos/ 75L). Three isonitrogenous (30%) and isocaloric (345 Kcal DE/100g) practical diets were prepared using different PPEE levels (0, 0.5, and 1%), in triplicates.

Results showed that high stocking density reduced the weight gain (WG), weight gain % (WG %), specific growth rate (SGR), feed efficiency ratio (FER), protein efficiency ratio (PER) significantly ($p<0.05$), while feeding of 1% PPEE enhanced these parameters irrespective of stocking density. Digestive enzymes (amylase and protease) activities were decreased ($p <0.05$) significantly, whereas metabolic enzyme activities (aspartate aminotransferase, AST; alanine aminotransferase, ALT; lactate dehydrogenase, LDH and malate dehydrogenase, MDH) were

significantly increased due to high stocking density. However, feeding of 1% PPEE reversed the trend.

Similarly, all the antioxidant parameters (superoxide dismutase, SOD; catalase, CAT; myeloperoxidase, MPO & malondialdehyde, MDA) except reduced glutathione and glucose-6-phosphate dehydrogenase (G6PDH) were significantly ($p<0.05$) increased in high stocking density groups. Blood glucose and hepatic glycogen content followed an inverse trend with high stocking density as well as PPEE supplementation. Various immunological parameters (total protein, total immunoglobulin content, and respiratory burst activity) showed a lower value in SD20E0 group followed by SD15 E0 group, while all the PPEE (0.5 & 1%) fed groups showed increased value compared to their respective control groups. Consequently, it can be concluded that feeding PPEE at 1% in the diet improves the growth and immunity of *Labeo rohita* irrespective of low or higher stocking density.

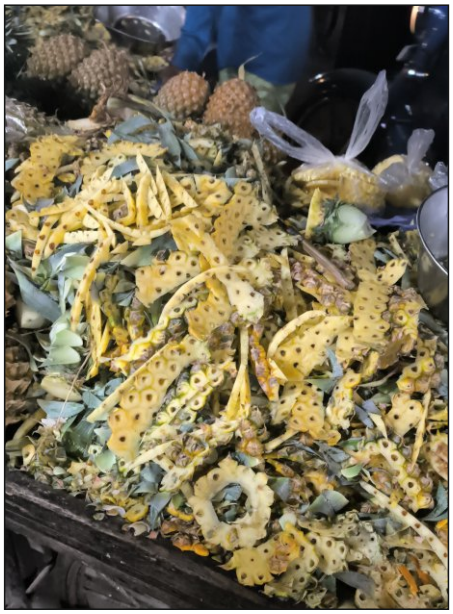
CIFE/2020/FNT007/SR

Evaluation of Pineapple Peel Extract in the Diet of *Labeo rohita* (Hamilton, 1822) Fingerlings Reared under Different Stocking Densities

Soumyodeep Bhattacharya

Major Advisor: Dr. Parimal Sardar

In-vitro anti-oxidant studies were carried out to assess the anti-oxidant potential of ethanolic, methanolic, acetoneic and aqueous extracts of pineapple peel and ethanolic extract was found to be the better one. A 60-day feeding trial was conducted to evaluate the effect of dietary supplemented ethanolic extract of pineapple peel (PPE) on growth, feed conversion, nutrient utilization and physio-metabolic responses of *Labeo rohita* fingerlings reared under different stocking densities. Four hundred and five acclimated fingerlings of *L. rohita* (4.15±0.006) were randomly distributed in nine distinct experimental groups in triplicate following a 3 x 3 factorial design. Three iso-nitrogenous (30% Crude protein) and iso-caloric (376 kcal DE/100g) practical diets were prepared for feeding the respective group on satiation basis twice daily.



High stocking density significantly ($p<0.05$) reduced weight gain percentage, specific growth rate (SGR), protein efficiency ratio (PER), protease and lipase activity, glucose-6-phosphate dehydrogenase, glycogen content, serum total protein, albumin and globulin content, respiratory burst activity and serum total immunoglobulin levels and increased feed conversion ratio (FCR), the activities of tissue AST, ALT, LDH, MDH, SOD, CAT, GST, serum malondialdehyde and myeloperoxidase and serum glucose level, but dietary PPE at 1% level improved these parameters especially in fish of medium stocking density. Hence, it is concluded that dietary supplementation of ethanolic extract of pineapple peel at 1% level could enhance growth performance with improvement of immuno-physiological responses of crowding stress exposed fish.

CIFE/2020/FNT001/SR

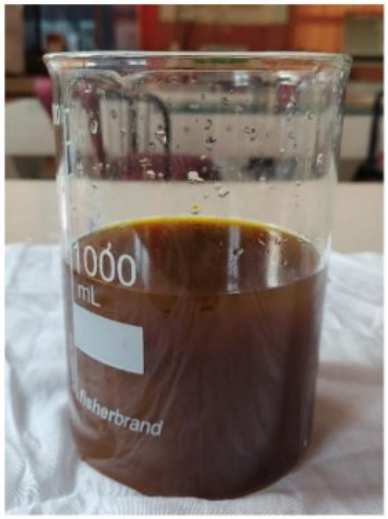
Evaluation of Papaya Peel Extract in the Diet of *Labeo rohita* (Hamilton,1822) Fingerlings Reared under Different Stocking Densities

Atshaya S

Major Advisor: Dr. N.P. Sahu

In-vitro anti-oxidant studies were carried out to assess the anti-oxidant potential of ethanolic, methanolic, acetoneic and aqueous extracts of pineapple peel and ethanolic extract was found to be the better one. A 60-day feeding trial was conducted to evaluate the effect of dietary supplemented ethanolic extract of pineapple peel (PPE) on growth, feed conversion, nutrient utilization and physio-metabolic responses of *Labeo rohita* fingerlings reared under different stocking densities. Four hundred and five acclimated fingerlings of *L. rohita* (4.15±0.006) were randomly distributed in nine distinct experimental groups viz. SD10E0 (10 fish/75L + without dietary extract), SD10E0.5 (10 fish/75L + 0.5% dietary extract), SD10E1 (10 fish/75L + 1% dietary extract), SD15E0 (15 fish/75L + without dietary extract), SD15E0.5 (15 fish/75L + 0.5% dietary extract), SD15E1 (15 fish/75L + 1% dietary extract), SD20E0 (20 fish/75L + without dietary extract), SD20E0.5 (20 fish/75L + 0.5% dietary extract) and SD20E1 (20 fish/75L + 1% dietary extract) in triplicate following a 3 x 3 factorial design.

Three iso-nitrogenous (30% Crude protein) and iso-caloric (376 kcal DE/100g) practical diets were prepared for feeding the respective group on satiation basis twice daily. High stocking density significantly ($p<0.05$) reduced weight gain percentage, specific growth rate (SGR), protein efficiency ratio (PER), protease and lipase activity, glucose-6-phosphate dehydrogenase, glycogen content, serum total protein, albumin and globulin content, respiratory burst activity and serum total immunoglobulin levels and increased feed conversion ratio (FCR), the activities of tissue AST, ALT, LDH, MDH, SOD, CAT, GST, serum malondialdehyde and myeloperoxidase and serum glucose level, but dietary PPE at 1% level improved these parameters especially in fish of medium stocking density. Hence, it is concluded that dietary supplementation of ethanolic extract of pineapple peel at 1% level could enhance growth performance with improvement of immuno-physiological responses of crowding stress exposed fish.



Identifying Physio-biochemical Parameters as Welfare Indicators of IMC under Different Culture Conditions

CIFE/2020/10/IF

Project duration: 2020-2023

Personnel:
Principal Investigator
Dr. Sujata Sahoo

Co-Principal Investigator
Dr. Dilip Kumar Singh
Dr. S. Dasgupta
Dr. Gayatri Tripathi
Dr. G.H. Pailan
Dr. N.P. Sahu

The physiological status of a population can be assessed using biochemical and haematological parameters which in turn can be their welfare indicators. Fish welfare is often neglected in comparison to other animal welfare. For proper health monitoring and better production, standard physiological indices of candidate species are extremely useful. In this work, Pangas and Indian major carps from different culture systems were evaluated with haemato-biochemical parameters, condition factors and serum enzyme profile with respect to their environments. Water sample from extensive, sewage-fed aquaculture and semi-intensive aquaculture were collected and analyzed. Water quality parameters of sewage-fed system were on higher side. The blood samples were collected from *Pangasianodon hypophthalamus* (weight ranges from 70.8-385 g) in different culture systems and different blood parameters like, RBC, WBC, heamatocrit, heamoglobin, thrombocytes, MCV, MCH, MCHC and PCV were estimated. In the present study, haemoglobin, TEC, and PCV were high in the semi-intensive system, followed by the extensive and intensive system. The condition factor of *P. hypophthalamus* from the intensive culture system was highest (0.98±0.18), followed by semi-intensive and extensive fish culture systems. Good condition factor in the intensive and semi-intensive system indicates proper management and good health status of fish.

Serum enzymes SGPT, SGOT, ALP and LDH of *Catla catla* and *Labeo rohita* from sewage-fed, semi-intensive and extensive aquaculture were estimated using standard protocols. In case of *C. catla*, SGOT, SGPT and ALP levels were highest in the fish reared in sewage-fed system followed by those in extensive system and lowest in the fish of semi-intensive system. Fish reared in all the three systems differ significantly ($p<0.05$) in SGOT level. Whereas LDH level was highest in fish of sewage-fed system followed by semi-intensive and lowest in extensive system. In *L. rohita*, the mean concentration of serum SGPT, SGOT and ALP were significantly higher ($p<0.05$) in the fish reared in sewage-fed culture systems. But, the mean concentration of serum LDH was found to be significantly higher ($p<0.05$) in the extensive culture system fish.

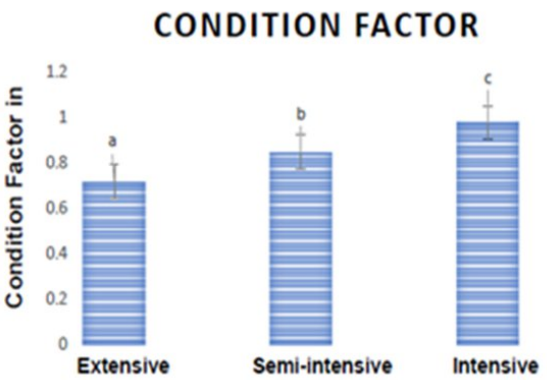
Biochemical and Hematological Profiling of *Pangasiadon hypothalamus* in Different Culture Systems

CIFE/2020/FNT003/SR

Madhulika

Major Guide: Dr. Sujata Sahoo

The present study was directed toward assessing the health status of *Pangasianodon hypophthalamus* (Sauvage, 1878) in different culture systems. A total of 30 fish samples were collected from different culture systems (extensive, semi-intensive, and intensive) for assessing and comparing the condition factor, hematological and biochemical parameters. The results indicated that Fulton's condition factor was significantly higher in the intensive culture system (0.98±0.18), followed by semi-intensive (0.85±0.30) and extensive (0.72±0.16) culture systems.



Hematological parameters such as Hb (7.42±0.03 mg/dl), TEC (2.45±0.56 ×106 /mm³), and PCV (24.24±1.64%) were found to be higher in the semi-intensive culture system. TLC (5.20±3.01×10³ /mm³) and MCH (30.86±0.22 pg) were higher in the intensive culture system, while MCV and MCHC did not vary significantly in all culture systems. Serum biochemical parameters such as glucose, cortisol, metabolic enzymes, protein profile, lipid profile, urea, creatinine, and serum ion levels were found to be higher in the intensive and semi-intensive culture system. However, ALT and potassium concentrations were higher in the extensive culture system, while SOD, catalase, A:G ratio, and bilirubin showed no significant difference in all culture systems. Overall growth and metabolism were recorded to be high in the intensive culture system. In terms of welfare concerns, fish were found to be growing healthy in all the culture systems. The current study suggested that the hemato-biochemical parameters can be good indicators of the health status of fish and can be assessed in a minimum invasive way.

Effect of Phytoestrogen on the Reproductive Performance of Fish and its Mitigation through Nutritional Intervention

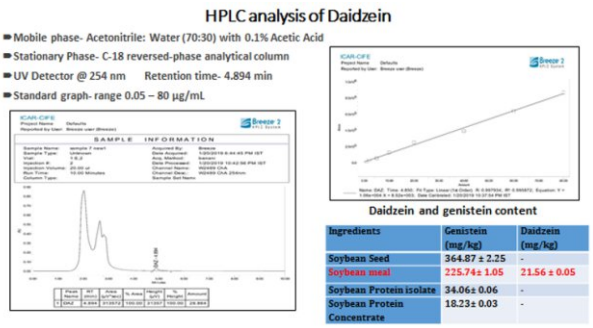
(CIFE/ 2019/06 /IF)

Project duration: 2019-2024

Principal Investigator
Dr. Subodh Gupta

Co-Principal Investigators
Dr. P.P. Srivastava
Dr. Tincy Varghese
Dr. Sunil Kumar Naik

The effect of soybean origin phytoestrogens, daidzein, and genistein on female common carp, *Cyprinus carpio* was studied. Daidzein was quantified by HPLC method and found to be 21.56 ± 0.05 µg/g in soybean meal (Table 1). A 60-day feeding trial was conducted to evaluate the estrogenic activity of pure daidzein alone and/ or soybean meal containing equivalent quantity of daidzein in the broodstock diet of female common carp. Serum testosterone and progesterone level were decreased with the increasing dose of daidzein. The histological study showed that the percentage of vitellogenic oocytes increased due to the feeding of higher doses of daidzein.



Daidzein and genistein content

Ingredients	Genistein (mg/kg)	Daidzein (mg/kg)
Soybean Seed	364.87 ± 2.25	-
Soybean meal	225.74± 1.05	21.56 ± 0.05
Soybean Protein isolate	34.06± 0.06	-
Soybean Protein Concentrate	18.23± 0.03	-

However, feeding a higher level of soybean meal reduced the number of vitellogenic oocytes but size of the vitellogenic oocytes comparatively increased. Gonadosomatic index, fecundity and fertilization rate did not differ significantly among the treatment groups. The feeding of daidzein or soybean meal disrupted the sex steroid profile and vitellogenin level of common carp. Thus, the combinatorial effects of both pure genestien, and daidzein, and soybean meal containing equivalent quantities of daidzein and genestein in reproductive performance broodstock would be concluded. Dietary genistein at 0.9 mg/100g (equivalent to 40% SBM) and daidzein at 754.80 µg/100g (equivalent to 35% SBM) in purified form disrupted reproductive functions in adult *Cyprinus carpio* Soybean meal inclusion of 30% and more in feed adversely affected reproduction in male and female *Cyprinus carpio.*

CIFE/2020/FNT007/SR

Combinatorial Effect of Dietary Genistein and Diadzein on Gonadal Development of Male *Cyprinus carpio* (Linnaeus, 1758)

Vasanthakumaran K

Major Advisor: Dr. Tincy Varghese

A 60-day trial evaluated the combinatorial effect of dietary soy phytoestrogens (isoflavones), genistein, and daidzein on the gonadal development of male Cyprinus carpio (Linnaeus, 1758). Adult male Cyprinus carpio (60 ± 20g) were fed with control diet (C), low (GL, 110 mg%, equivalent to 17.5% soybean meal) and high (GH, 210 mg%, equivalent to 35% soybean meal) doses of genistein containing diets, low (DL, 4 mg% , equivalent to 17.5% soybean meal) and high (DH, 8 mg%, equivalent to 35% soybean meal) doses of daidzein containing diets, and two combination diets of both genistein and daidzein at lower (DGL) and higher doses (DGH) for 60 days. The fishes were spent by injection of the inducing agent before the experiment.

The GSI (gonadosomatic index) and HSI (hepatosomatic index) values showed a dose-dependent increase in the isoflavone-fed groups. There was a decline in superoxide dismutase activity when fed with the combination of G & D, but no differences were observed in the catalase activity. Serum 11-KT (testosterone), E2 (estradiol), and vitellogenin levels rose significantly ($p<0.05$) in the high dose of G, D, and their combination fed groups but Serum cortisol and DHP levels decreased significantly ($p<0.05$). The level of expression of cyp 19a1 and 20-β HSD decreased ($p<0.05$) with an increased dose of G, D, and their combination in the diet of male common carp. All the changes in steroid hormones, vitellogenin, and mRNA expression of enzyme biomarkers were more evident in the high-dose combination of the D and G (DGH) fed group than in the individual isoflavone-fed groups.

The histological study revealed that the proportion of spermatocytes increased with a concomitant decrease in the proportion of spermatozoa in the high-dose fed groups of daidzein. Hence the study concluded that the feeding of diets

with isoflavones equivalent to 35% of soybean meal to broodstock of male *Cyprinus carpio* disrupts the sex steroid profile and induced vitellogenin synthesis of the male common carp, revealing the estrogenic activity of the combination of genistein and daidzein which leads to delayed maturation in the male common carp. Thus, the inclusion of soybean in the broodstock diet should be below 35% to ensure the normal reproductive function of male common carp.

CIFE/2020/FPB001/SR

Effect of Dietary Green Tea (*Camellia sinensis*) waste extract on fat deposition of striped catfish, *Pangasianodon hypophthalmus* (Sauvage, 1878)

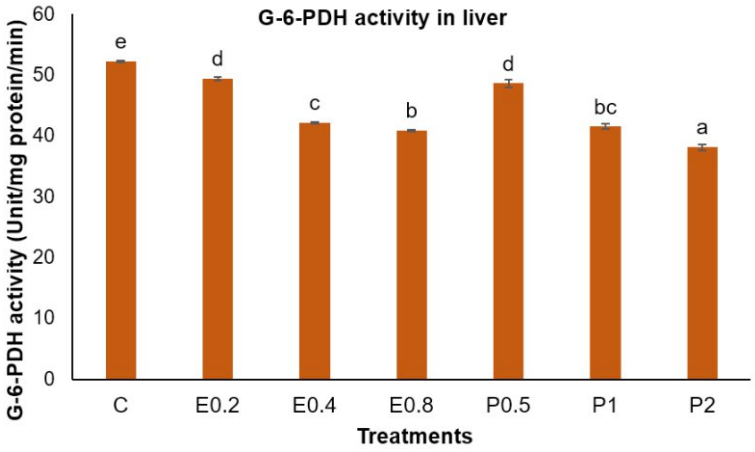
Jebarson Solomon J

Major Advisor: Dr. Subodh Gupta

A 60-day feeding trial was conducted to assess the effect of dietary green tea (*Camellia sinensis*) waste (GTW) on fat deposition of striped catfish, *Pangasianodon hypophthalmus.* Initially, crude extracts were prepared from GTW using different solvents viz., acetone (50%), acetonitrile (50%), ethanol (80%), methanol (100%) and water. GTW extract prepared using methanol (100%) was found to have higher bioactive compounds and highest antioxidant activity. Thus, methanolic extract of GTW was selected for incorporating in diet.

The growth performance was found to be increased with the increase in GTW extract and powder up to inclusion level of 0.4% and 1% respectively, after which it decreased. The whole-body total lipid content was highly reduced in P2 treatment group followed by P1, E0.8 and E0.4 treatment groups and no significant difference was observed between P1, E0.8 and E0.4 treatment groups. In body indices HSI, VSI and MFI were found to be significantly ($p<0.05$) reduced with increase in inclusion of GTW extract as well as powder. In digestive enzymes, amylase activity was decreased and protease and lipase activities were increased in treatment groups than control. In metabolic enzymes LDH, MDH, G-6-PDH and malic enzyme activities were significantly ($p<0.05$) lower in treatment groups than in control.

Fatty acid composition of muscle and total viscera were improved with decreased saturated fatty acids (SFAs) and increased monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs) with dietary inclusion of GTW extract as well as powder. The results of the present study indicate that diets supplemented with GTW powder at 2% largely reduce whole body fat content although it affects growth performance. While, GTW extract at 0.4% and GTW powder at 1% inclusion in diet enhanced growth performance along with reduction in fat deposition in *P. hypophthalmus.* In this context, dietary inclusion of GTW powder at 1% is recommended for the reduction in fat deposition in *Pangasianodon hypophthalmus.*



CIFE/2020/FPB002/SR

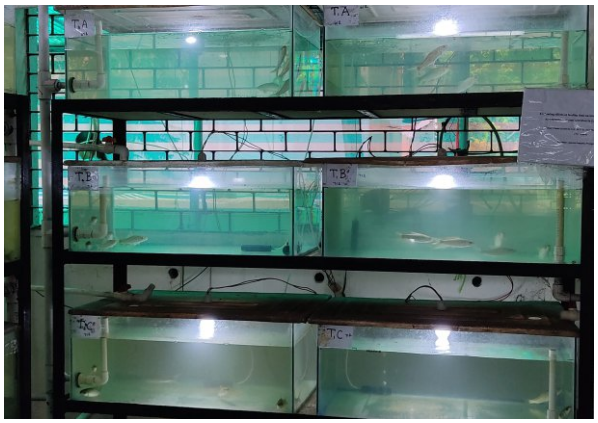
Evaluating Effects of Feeding Time on Intestinal Molecular Clock and Digestive Enzyme Secretion in *Labeo rohita*

Komuhi N B

Major Advisor: Dr. S. Dasgupta

The present study investigates the intestinal molecular clock and its entrainment by feeding regimes and photo-cycle. Besides, the impact of feeding regimes and photo-cycle on digestive enzyme activity was a subject of the investigation. The current study was carried out on the rohu juveniles (22.8 ± 0.01 g) maintained on different feeding regimes and photo cycles for 60 days. The control fish were fed with balanced commercial feed at 8.00 and 20.00 h under a natural LD cycle of (13.22 L ± 0.05, 10.77 D ± 0.05), whereas the treatment groups were kept at 24 L and fed with the same diet at 8.00 h (T1), 20.00 h (T2), 8.00 and 20.00 h (T3) and random feeding (T4) daily for 60 days.

The study estimated the time kinetics of amylase, protease, trypsin, chymotrypsin and lipase activities in the foregut, midgut and hindgut. The expression of clock genes, Cry 3 and Per 3, was determined in the hindgut. Amylase, protease and trypsin activity was higher in the foregut and midgut two hours after feeding. Chymotrypsin's activity peaked at 2 hours in the foregut, and no uniform activity in the midgut. Hindgut showed higher amylase activity at 6 hours compared to foregut and midgut. Lipase activity was prominent in the foregut and midgut. The lipase activity peaked at 4 h and 2 h in the midgut and hindgut, respectively. The Per 3 and Cry 3 transcripts in the hindgut were up-regulated at a time closer to the feeding time in a day.



Daily twice feeding exhibited two distinct peaks of Cry 3 and Per 3 mRNA expression, whereas such up-regulation was absent in the random-fed rohu, clearly indicating that the feeding schedule synchronizes the clock genes in the gut. Per 3 and Cry 3 expression in the hindgut under the natural photo-cycle appears to be influenced by the last meal delivery time. In conclusion, the data show that: (1) the photo-cycle impacts enzyme activity depending on location in the gut, and (2) the feeding regime is a strong signal that entrains this peripheral oscillator in the gut of rohu.

CIFE/2020/AQC006/SR

Effect of Dietary Algal Oil Supplementation on Growth Performance and Physio- Metabolic Changes in *Channa striata* (Bloch, 1793)

Parvathi Priya

Major Advisor: Dr. Thongam Ibemcha Chanu

A 60-day feeding trial was conducted to study the effects of replacement of fish oil with microalgal oil in the diet of *Channa striata* fingerlings in terms of growth performance, feed utilization and physio-metabolic responses. Six iso-nitrogenous (40% crude protein) and iso-lipidic (8% lipid) practical diets were prepared with three different lipid sources (T1, 100% fish

oil; T2, 100% algal oil; T3,100% veg oil; T4, 50% fish oil and 50% algal oil; T5, 50% fish oil and 50% veg oil; T6, 50% algal oil and 50% veg oil). Two hundred seventy fingerlings (2g±0.01) were randomly distributed in six experimental groups in triplicates with the stocking of 15 fish per 200L tank. Feeding of fish was done to satiation by using respective experimental diets throughout the experimental period.

Highest ($p<0.05$) growth performance, nutrient utilization and digestive enzyme activity was exhibited by fish fed 100% algal oil containing diet. No histopathological sign was observed in the intestine of fishes fed different lipid sources. Hepatic lipid deposition significantly varied among different groups. PUFA, especially DHA and n-3/n-6 ratio was highest in the fish fed algal oil. Inclusion of algal oil significantly ($p<0.05$) increased the liver and muscle SOD activity in T4 and T6 groups, while the liver catalase activity did not vary significantly ($p\geq0.05$) among the groups. The G-6-PDH activity was significantly lower in the group fed algal oil. Hence, it is concluded that algal oil can be used in the diet of *Channa striata* fingerling by completely replacing fish oil without any detrimental effect for a period of 60 days. However, the combination of 50% algal oil and 50% veg oil is more economical than an algal oil based diet.

CIFE/2017/AQC710/SR

Evaluation of Nutraceutical Properties of Selected Microalgae and their Putative Role on Growth and Health of Penaeid Shrimp

Sandeep K.P.

Major Advisor: Dr. Ambashankar

A tropical estuarine ecosystem, Muttukadu estuary, Tamil Nadu, India, was studied for microalgae diversity for an extended period of 18 months. The selected microalgae isolated were screened for nutraceutical properties by evaluating the nutritional profiling, antioxidant properties, growth kinetics, and antibacterial properties. *Thalassiosira weissflogii, Chaetoceros gracilis, Tetraselmis* sp, and *Arthrospira maxima* were selected for further studies. The experiment to evaluate the efficiency of different microalgae in larval rearing of Penaeus indicus showed that the survival, growth, and stage conversion rate were significantly ($p<0.05$) higher in a combination of *T. weissflogii: Tetraselmis* sp followed by *T. weissflogii: C. gracilis.*

The nutrient profiles of these microalgae confirmed the nutritional superiority of *T. weissflogii* in terms of lipid, protein, and essential fatty acids (EFA) over the others. The results of the feeding experiment conducted in *Penaeus vannamei* post larvae showed that 1% dietary supplementation of *Tetraselmis* concentrate and 1.5% *Thalassiosira* concentrate resulted in significantly higher growth performance compared to control and other treatment. The results inferred that adding microalgae to the *P. vannamei* nursery diet improved the growth and survival and enhanced health conditions. An intense blue pigment, C-Phycocyanin (CPC), was extracted from a locally isolated cyanobacterium, *A. maxima,* and supplemented in *P. vannamei* diet. The results revealed that P. vannamei fed with CPC800 (800 mg of CPC kg-1 of feed) and CPC1600 showed a significantly higher ($P<0.05$) percentage of weight gain, average body weight, average daily gain, specific growth rate, and feed conversion ratio compared to rest of the treatments.

The gut microbiome, hematology, and histopathological analyses further corroborated the results of the enhanced health status of *P. vannamei* fed with diets containing CPC supplementation compared to control. The present study also showed the beneficial effect of dietary CPC on WSSV control in *P. indicus* and enhanced growth and health of animals fed with 800 mg kg-1 of CPC. Hence, the comprehensive results of the present study would help to develop functional feeds for penaeid shrimps against bacterial diseases and also showed the strategies for improved larval survival and growth using specific combinations of potential microalgae.

CIFE/2016/FNT601/SR

Utilisation of *Chromolaena odorata* Leaf Meal and its Protein Concentrate Fortified with Nutraceutical in the Diet of *Labeo rohita* Fingerlings

Sajina K A

Major Advisor: Dr. N.P. Sahu

This experiment was conducted to evaluate the potential of *Chromolaena odorata* leaf meal (COLM) or its protein concentrate as a replacer of de-oiled rice bran (DORB) and soybean meal, respectively in the diet of *Labeo rohita* and *Myristica fragrans* (MF) as an additive in the form of powder (MFP) and ethanolic extract (MFE) to enhance the nutrient utilisation. In the first experiment, the gradient replacement of DORB was done with COLM in the diet of *L. rohita* fingerlings. Four semi-purified iso-nitrogenous diets (330 g Kg-1 CP) with different combinations of COLM and DORB such as T1 (30% DORB + 0% COLM), T2 (20% DORB + 10% COLM), T3 (10% DORB + 20% COLM) and T4 (0% DORB + 30% COLM). The T3 group exhibited significantly highest WG, SGR, PER, digestive enzyme activities, and amylase mRNA expression, in vitro & in vivo digestibility and metabolic enzyme activities.

In the second and third experiments, the T3 diet was selected to add MFE at 0.5 – 2% further. The dietary inclusion level of MFE at 0.5% and 1% showed improved feed intake and growth and immune responses. The third experiment was conducted to explore the maximum inclusion of COLM (30%) by supplementing graded level (0.5 - 2%) MFE. The improvement in feed intake and growth performance was reported in the groups supplemented with 1 and 2% MFE. There was also a healing effect on epithelial erosion in the distal parts of the intestine due to the higher inclusion of COLM in the diet. In the fourth experiment, protein concentrate (COLPC) was prepared from COLM and was used as a replacer of soybean meal in the diet. There was a reduced survival rate, growth, depressed feed intake with lower apparent protein digestibility, digestive, metabolic enzyme activities and elevated stress level associated with the higher inclusion (C60) of COLPC.

The experimental fish exhibited the highest growth, higher feed intake, digestive and metabolic enzyme activities, dry matter digestibility and reduced stress enzyme activity with both dietary supplementation of 1% MFE and 2% MFP. Even though MFP at a higher dose and MFE in combination with COLM significantly reduced erythrocyte levels, it improved serum protein, globulin and WBC than the control group. The MFE could be included in the diet of *Labeo rohita* from 0.5% to 1% to augment the reduction in feed intake when fed with COLM, and at 2% inclusion level, it could reverse the epithelial erosions due to the higher inclusion of COLM in the diet of *Labeo rohita* fingerlings. However, the use of protein concentrate was found to be of little benefit when compared to the COLM with MFE.

CIFE/2015/FNT503/SR

Utilization of Dhaincha (Sesbania) Leaf Meal in the Diet of *Labeo rohita* (Hamilton, 1822)

Sudhanshu Raman

Major Advisor: Dr. Ashutosh D Deo

Three experiments were conducted to study the utilization of Sesbania leaf meal (SLM) in the diet of *Labeo rohita.* After six days of fermentation with B. subtilis, the crude protein content and level of five amino acids of SLM increased, but ANFs, ether extract, crude fiber, and nitrogen-free extract decreased after

fermentation. In experiment II, nine isonitrogenous (C:0%SLM, T1:10% RSLM, T2: 20%RSLM, T3:30% RSLM, T4: 40% RSLM, T5:10% FSLM, T6:20% FSLM, T7:30%FSLM, T8:40% FSLM) diets were prepared and fed to *Labeo rohita*. The weight gain was highest in the T7 group, and the least was recorded in the T4 group. The protease, lipase, and amylase activity of *L. rohita* intestine were significantly affected by higher protease activity in T7 group and the least in T4 group. The amylase activity and lipase activity were recorded highest in the control group.

There was also a decrease in CP level in *L. rohita* carcass in the group fed with raw SLM-based diet which may be due to toxic effects of ANFs. However, carcass CP (%) level was comparable with the control group with highest in 30% FSLM based diet-fed group. In the experiment III, fingerlings were fed with a basal diet containing fermented SLM (30%) as a control, whereas the other four experimental basal diets were supplemented with bile acid, citric acid, and xylanase in different combinations, viz. T1 (bile acid+ citric acid), T2 (bile acid + xylanase), T3 (citric acid + xylanase) & T4 (bile acid+ citric acid+xylanase).

The result of experiment III showed that weight gain (%), specific growth rate (SGR), and FCR were significantly improved. The weight gain (%), SGR, PER were significantly higher in the T4 group, whereas FCR was lowest in T4 group. The least weight gain percentage, SGR, and PER were recorded in the control group along with the highest FCR. Treatments supplemented with a combination of bile acid, xylanase, and citric acid showed enhanced lipase and amylase activity along with increased bioavailability of minerals. It was concluded that dietary supplementation of bile acid, citric acid, and xylanase enzyme in a 30% fermented SLM-based diet can enhance the growth performance of the *L. rohita.*

CIFE/2016/FPB603/SR

Evaluation of Mucuna leaf Meal-Based Diet on the Growth and Reproductive Performance of *Cyprinus Carpio* (LINN, 1758)

Hafeef Roshan K T

Major Advisor: Dr. Ashutosh D Deo

Three experiments were conducted to evaluate the effect of Mucuna leaf meal-based diet on the growth and reproductive performance of Cyprinus carpio. In the first experiment, Invitro evaluation of nutrient and antinutrient profile of Mucuna bracteata leaves (MLM) collected from parts of Calicut (Kerala, India), were examined. The results of proximate analysis of MLM revealed the presence of high crude protein (28.14% ±0.20) and carbohydrate (41.08% ±0.89). The results of phytochemical analysis showed the presence of tannins, phytates, trypsin inhibitors, saponins, oxalates and L-Dopa (30.4 mg/100 g).

For second and third experiments, four isonitrogenous (32% crude protein) and iso-caloric (356 kcal DE/100 g) diets were prepared by substituting DORB (de-oiled rice bran) with MLM: C (30% DORB, 0% MLM), T1 (20% DORB, 10% MLM), T2 (10% DORB, 20% MLM), T3 (0% DORB,30% MLM. In the 2nd experiment of 60 days, growth was comparable to that of the control group in the T3 group. Except for amylase activity, which increased significantly in the T2 group, the digestive enzyme activity was unaffected. In the T2 group, both muscle and liver alanine aminotransferase (ALT) activities were significantly increased ($p<0.05$). In the T2 and T3 groups, malate dehydrogenase (MDH) and lactate dehydrogenase (LDH) activities were significantly ($p<0.05$) higher.

Furthermore, the activities of hepatic superoxide dismutase (SOD) and catalase were significantly increased ($p<0.05$) in the T2 and T3 groups. In the third experiment, a 120-day feeding trial evaluated the effect of feeding MLM, which had a considerable impact on reproductive function. Gonadosomatic index (GSI), diameter, and percentages of developmental stages of oocytes, plasma sex steroids and vitellogenin dynamics were investigated. All groups exhibited normal gonadal maturation except in the T3 group. Lower plasma levels of E2 in females were observed in the T3 group. The results showed that total replacement of de-oiled rice bran with MLM i.e., the inclusion of 30% MLM supported growth, but, only 20% MLM inclusion is recommended to attain an optimal reproductive function.

CIFE/2017/AQC707/SR

Effect of Khejri, Prosopsis cineraria on Growth and Immunity of Rohu, *Labeo rohita* (Hamilton, 1822)

Rohitash Yadav

Major Advisor: Dr. N.K. Chadha

Seven experiments were conducted to study the effect of Khejri, Prosopis cineraria pod, and seed meals (KPM and KSM) and their extracts on the growth performance and physio-metabolic response of *Labeo rohita* fingerlings. The results of experiment IA revealed that dietary khejri pod meal (KPM) inclusions did not influence the growth performance and feed conversion of rohu, *L. rohita* fingerlings . Based on the results, dietary Khejri pod and seed meal could replace 150 g kg –1 DORB and GNOC, respectively, in the diet of *L. rohita*. Based on the polynomial regression, optimum KPM and KSM inclusions for maximum growth responses were 7.0 and 7.4 %, respectively. Dietary KPM inclusions did not affect growth, feed conversion, protein retention, and survival in *L. rohita* fingerlings.

The digestive, metabolic & stress enzyme activities, haematological and serum biochemical indices were independent of dietary KPM inclusion. Dietary KSM inclusions did not affect growth, feed conversion, protein retention, survival, and body indices of rohu fingerlings. Digestive (except protease), & stress enzyme activities, haematological and serum biochemical indices did not vary in *L. rohita* fingerlings. 65% ethanolic extracts prepared from khejri pod and seed meal exhibited significantly higher antioxidants and antimicrobial properties against *Edwardsiella tarda* and *Aeromonas hydrophila*. 0.5% dietary inclusion of khejri pod and seed extracts (KPE and KSE) enhanced the growth performance, feed conversion, protein retention, and digestive enzyme activities in rohu fingerlings. Fish were challenged with pathogenic *A. hydrophila* and stress enzyme activities, serum proteins, glucose content, respiratory burst activity, and haematological indices were enhanced. Higher survival (%) recorded in fish fed with 0.75% KPE inclusion. Dietary KSE supplementation significantly affected the growth performance, nutrient utilization, and body indices in rohu fingerlings.

Based on the results, it can be concluded that khejri pod and seed meal could be incorporated in the diet at 15% inclusion level to substitute 50% deoiled rice bran and groundnut oil cake. 65% ethanolic khejri pod and seed extracts could be supplemented in the diet at 0.5% inclusion levels to enhance the growth performance and feed conversion of rohu fingerlings. Similarly, for better immunity and survival against *A. hydrophila* infection, fish could be fed with 0.75% and 0.50% dietary KPE and KSE inclusions, respectively.

CIFE/2018/AQC812/SR

Developing Intensive Culture Techniques of Calanoid Copepod, *Acartia* sp. as a Live Feed for Marine Finfish Larval Rearing

Balakrishna Chintada

Major Advisor: Dr. Ritesh Ranjan

The present study was conducted to develop the intensive culture protocol of *Acartia bilobata* and to determine the effect of salinity, algal diets, initial stocking densities, and algal concentration on production parameters. *A. bilobata* could tolerate a wide range of salinities from 15-35 ppt. Further these salinities were used to assess the effect on reproductive parameters. Average daily egg production, total population growth and intrinsic rate of population growth was significantly higher at 25 and 30 ppt ; however, the egg hatching success was significantly similar in all tested salinity except at 15 ppt. *A. bilobata* reproductive performance was significantly higher at salinity 30 and 25 ppt.

An experiment was planned to test three microalgal species namely, *Isochrysis galbana, Cheatoceros muelleri, Nannochloropsis occulata* in 7 diet combinations on various production parameters. A significantly higher egg production, hatching success and superior adult survival was observed in the *I. galbana* fed group. Higher survival to adults, short development time, and early maturity were observed in groups fed with *I. galbana* which has ideal for maximizing culture productivity and hence recommended for intensive culture of *A. bilobata.* Another experiment was planned to assess the effect of initial copepod stocking density and micro-algal concentration on the reproductive parameters. Total accumulated egg production increased up to the density of 1000 adults L-1. The synergistic effect of stocking density and algal concentration significantly impacted 16 and 24 hr hatching success. Copepod adult survival decreased significantly with the increase in stocking density.

The result suggests that moderate stocking density of 1000 adults L-1 with the highest algal concentration (5x105 cells mL-1) is optimal for higher reproductive performance of *A. bilobata.* The suitability of copepod nauplii was tested for the first feeding of Indian pompano, and orange-spotted grouper larvae. The higher proportion of PFAs, especially DHA in the copepod and higher DHA to EPA ratio contributed to the improved larval growth rates and survival. The results suggest that incorporation of at least 1 and 2 copepod nauplii as a feed with rotifers improve the survival rate of Indian pompano and orange spotted grouper respectively and this will help in producing quality seeds of the same.

CIFE/2014/FNT404/SR

Studying Protein Sparing Effect of Lipid by Supplementation of Ractopamine and L-Carnitine in The Diet of *Labeo calbasu* (Hamilton, 1822)

Ranjan Singh

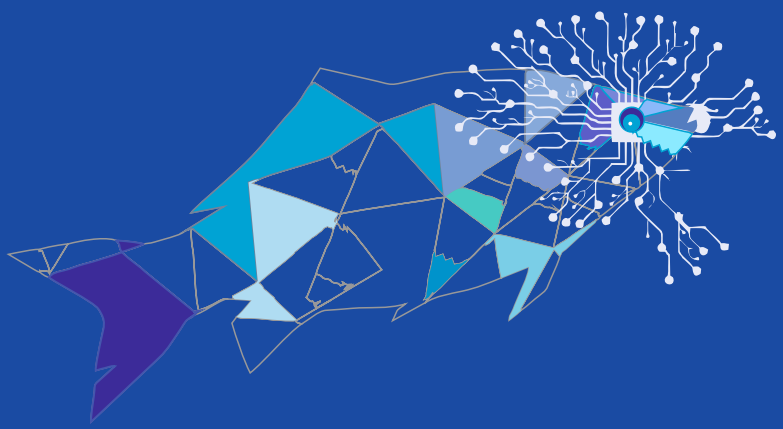
Major Advisor: Dr. K.K. Jain

Three experiments were conducted to assess the growth performance, digestive response, metabolic responses, fatty acid profile, amino acid profile and texture analysis of *Labeo calbasu* fingerlings by dietary supplementation of L- carnitine and ractopamine. First feeding was conducted with incorporation of L- carnitine in *L. calbasu* fingerlings. Total nine diets [CP35L6, CP30L9, CP25L12, T1P35L6 (1gm L-car), T2P35L6 (2gm L-car), T1P30L9 (1gm L-car), T2P30L9 (2gm L-car), T1P25L12 (1gm L-car) & T2P25L12 (2gm L-car)] were prepared.

The result showed that dietary supplementation of L-carnitine improves the growth performance (WGP, SGR, FCR and PER), highest growth is recorded in T2P35L6 group (35% protein, 6% lipid & 2gm L-car). Digestive enzymes (lipase and protease) and metabolic enzymes (HK, G-6-Pase, F-1,6-BPase G-6-PDH, AST and ALT) and CPT-I enzyme activity have significant changes. Second experiment feeding trial was conducted with incorporation of ractopamine in *L. calbasu* fingerlings. Total nine diets [CP35L6, CP30L9, CP25L12, T1P35L6 (10mg Rac), T2P35L6 (20mg Rac), T1P30L9 (10mg Rac), T2P30L9 (20mg Rac), T1P25L12 (10mg Rac), & T2P25L12 (20mg Rac)] were prepared. The result showed that dietary supplementation of ractopamine improves the growth performance (WGP, SGR, FCR and PER), highest growth is recorded in the T2P35L6 group (35% protein, 6% lipid & 2gm L-car). Digestive enzymes (lipase and protease), metabolic enzymes (HK, G-6-Pase, F-1,6-BPase G-6-PDH, AST and ALT) significantly change.

A subsequent third feeding trial was conducted with dietary supplementation of L- ractopamine and carnitine to assess the synergetic effect on the growth performance on *L. calbasu* fingerlings. Results showed that improved growth performance (WGP, SGR and PER), highest growth was reported at T2 group (30% protein, 9% lipid, 20mg Rac & 2 gm L-car). Digestive enzymes (lipase and protease), metabolic enzymes (G-6-Pase, F-1,6- BPase G-6-PDH, AST and ALT), CPT-I enzyme activity, blood parameters (glucose, albumin, globulin and A:G ratio) amino acid and fatty acid profile also significantly changes. It can be concluded that dietary supplementation of ractopamine (20 mg kg-1) and L-carnitine (2 gm kg-1) shows protein sparing effect of lipids in *L. calbasu* fingerlings.

3.4 Aquatic Animal Health



Referral Laboratory under the National Surveillance Programme for Aquatic Animal Diseases

CIFE/2022/402/EF

Project duration:2022- 2025

Principal Investigator
Dr. K.V. Rajendran

Co-Principal Investigators
Dr. Megha K Bedekar
Dr. Jeena K

Budget: Rs. 53.70 lakhs

Funding agency
Pradhan Mantri Matsya Sampada Yojana (PMMSY), Ministry of Fisheries, Animal Husbandry and Dairying, Govt. of India

PCR analysis of shrimp samples collected from Haryana (inland saline aquafarms) (12 samples each consisting of 3 pooled samples) revealed the presence of *Enterocytozoon hepatopenaei* (EHP) in a significant number of samples. Though not confirmed through sequencing, presence of IMNV in shrimp samples were detected using nested PCR from these samples. However, WSSV was not detected in any of these samples. These observations indicate that pathogens other than WSSV have also to be strictly screened before the post-larvae are supplied and stocked in inland saline aquafarms.

Understanding Molecular Basis of Host-Pathogen Environment Interaction of Tilapia Lake Virus Disease

CIFE/2019/403/EF

Project duration:2019- 2023

Principal Investigator
Dr. K.V. Rajendran

Co-Principal Investigators
Dr. Megha K Bedekar
Dr. Saurav Kumar

Budget: Rs. 86.33776 lakhs

Funding agency
National Agricultural Science Fund (NASF)

Gut microbiome profile of tilapia experimentally-challenged with TiLV alone and co-challenged with TiLV and *Aeromonas veronii* was investigated. The domain-level microbiome diversity in TiLV-infected fish showed significant reduction with dominance of Proteobacteria and Firmicutes which might have significant influence on the disease outcome. At the genus-level, the dominance of *Acinetobacter* at 10 day post-infection (dpi) coincided with significant reduction in the domain-level diversity and the highest fish mortality. The Shannon diversity index showed fluctuations and was the lowest on 8 dpi coinciding with the high viral load in the liver. Co-infected fish also showed significant reduction in the domain-level diversity. This group showed significant difference in the overall microbiome composition at Phylum level, especially at early stages of infection, with the complete absence of Proteobacteria, the most dominant phylum in control fish. At Genus level, *Cetobacterium* showed significant dominance at an early stage with lower Shannon diversity index coinciding with mortality. Peak viral load was also detected at the early stage (~ 57.4-fold increase than the fish infected with TiLV alone). In short, the highest viral load in both TiLV alone and co-infected fish coincided with the lowest gut microbiome diversity.

A sensitive diagnostic tool and identification of the most reliable target tissue are essential for sensitive detection of TiLV. Two qRT-PCR assays targeting TiLV genome segments 1 & 10 were standardised and employed to determine the viral load in liver, brain and spleen of experimentally-infected tilapia. An increasing viral load in the early stages of infection and a decline in the later stages were noticed. The assays detected consistently higher viral load in the liver than other tissues and, based on this, it is proposed that the liver can be the best target tissue for the reliable detection of TiLV. Considering the high sensitivity, qRT-PCR assay targeting genome segment 10 can be recommended as a highly reliable detection tool for TiLV.

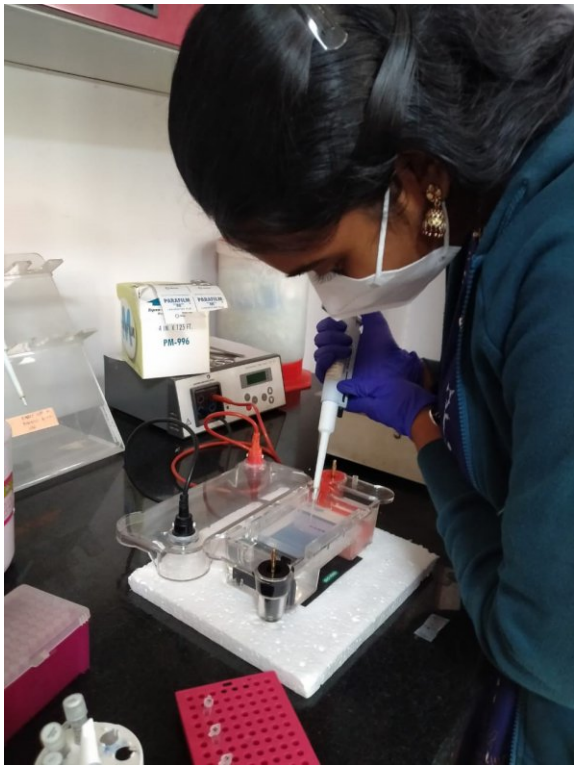
CIFE/2020/AAH004/SR

Time-Course Tissue-Level Variation of Tilapia Lake Virus (Tilv) Load in Experimentally-Infected Tilapia

Jancy Robina A

Major Advisor: Dr. K.V.Rajendran

Tilapia lake virus disease (TiLVD) caused by Tilapia lake virus (TiLV) is a highly infectious disease causing heavy mortality and huge economic losses in the global tilapia culture industry. Various diagnostic tools based on molecular biology, serology and cell culture identified different tissues such as liver, brain, spleen, gill, kidney, connective tissue, heart, mucus, gut and gonad as the targets of TiLV replication. The variety of target sites of replication *in vivo* highlights the pantropic nature of TiLV. Identification of the target tissue which shows a high level of viral load at an early stage of infection will help in rapid, reliable and sensitive detection of TiLV. In the present study, conventional and real-time PCR-based detection and quantification were used to determine the viral load in liver, brain and spleen tissues of experimentally-infected tilapia at 4, 7, 9, and 11 days post-infection (dpi). Preliminary detection of TiLV was done using conventional RT-PCR assay targeting TiLV genome segments 1, 3, 5, 9 and 10.



The assays targeting segments 1 and 10 were found to be highly sensitive in comparison with segments 3, 5, and 9. Based on this, two qRT-PCR assays targeting TiLV genome segments 1 & 10 were standardized. Subsequently, the viral load was determined following the standardized qRT-PCR assays. In the assay targeting TiLV segment 10, the average viral load at 4, 7, 9 and 11 dpi in liver was estimated to be 3.6×10^7, 2.1×10^8, 1.6×10^8 and 1.5×10^8 viral copies/100 ng RNA, respectively. At these time points, the average viral load observed in the spleen was 2.1×10^6, 2.6×10^7, 9.0×10^6 and 1.0×10^7 viral copies/100 ng RNA, respectively. However, a comparatively low viral load was observed in the brain (5.3×10^4, 1.1×10^6, 1.8×10^7 and 9.4×10^5 viral copies/100 ng RNA, respectively). Similarly, in the assay targeting TiLV segment 1, the average viral load in the liver at these time points was estimated to be 3.2×10^6, 1.6×10^7, 2.3×10^7 and 9.6×10^6 viral copies/100 ng RNA, respectively. In the spleen, the average viral load at these time points was 6.7×10^4, 1.6×10^6, 1.2×10^6 and 9.9×10^5 viral copies/100 ng RNA, respectively. As in segment 10, the viral load in the brain was found to be comparatively lower with 2.3×10^3, 1.1×10^5, 9.4×10^5 and 1.0×10^5 viral copies/100 ng RNA at 4, 7, 9 and 11 dpi, respectively.

Analysis of the viral load of TiLV in the tissues revealed an increasing trend in the early stages of infection and a steady decline in the later stages of infection. The observations made in the study highlighted the liver tissue as the main target of TiLV, owing to the comparatively higher abundance of the virus in the tissue at all time points post-infection. Therefore, the study proposes that the liver tissue can be the best target tissue for reliable detection of TiLV. Further, the newly designed real-time PCR assay targeting TiLV genome segment 10 showed better sensitivity of detection and can be used for the reliable detection of the virus.

Characterization of Mucosal Immunoglobulins in Tilapia and Development of ELISA for Diagnosis of Tilapia Lake Virus (Tilv) Infection

CIFE/2019/404/EF

Project duration: 2019- 2022

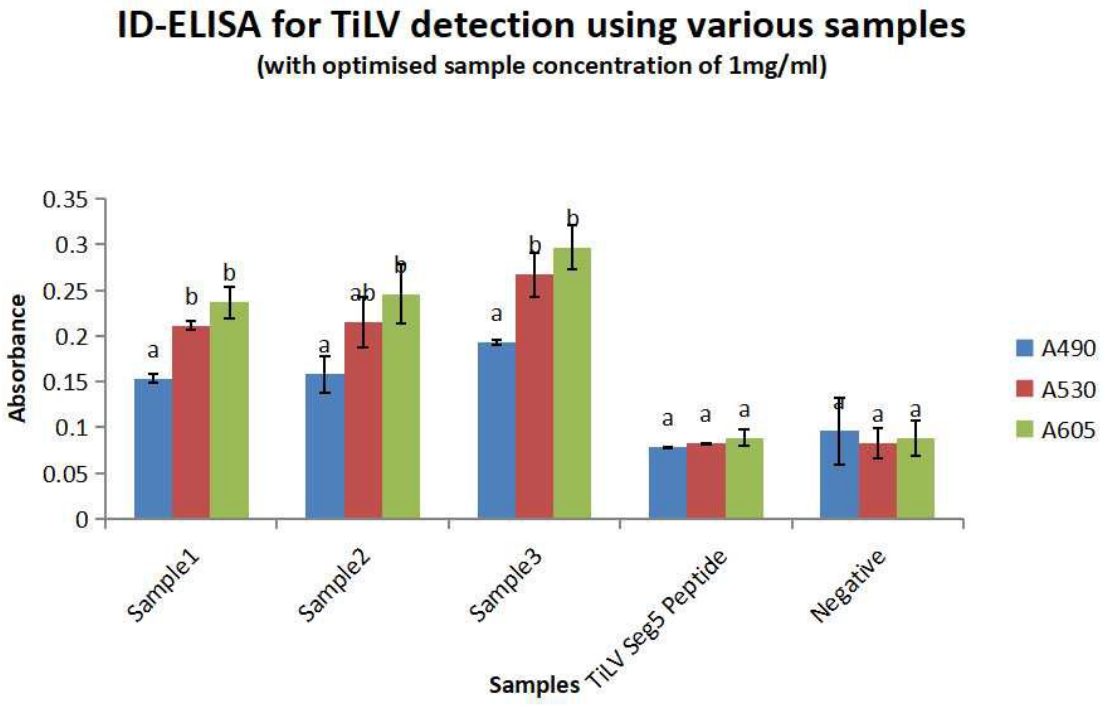
Principal Investigator
Dr. Megha Bedekar

Co-Principal Investigator
Dr. K.V. Rajendran
Dr. Jeena K

Budget: Rs. 29.00 lakhs

Funding agency
Department of Biotechnology, New Delhi

Fish sample of both clinical and subclinical nature (both clutch from same source) infected with TiLV were received. The clinically infected group displayed severe symptoms, while the subclinical fishes showed less or no symptoms. Samples were subjected for TiLV specific RT-PCR amplification for virus detection. Histopathological findings revealed the TiLV infective alterations and deforming changes fish in fish tissues. The study revealed that TiLV infection results in severe haematological disturbance (Hb, RBC, PCV, MCV, and MCHC) by significant differences from the control as evidenced by multivariate and univariate analysis. The TiLV-infected fish showed a significant reduction in RBC and Hb. Virus Showed pathology in OnlL cell line that caused syncytia, cell shrinkage, rounding and complete destruction of monolayer rounding and destruction of monolayer as effect. iELISA for detection of TiLV is developed which has the sensitivity and specificity of iELISA were 85.33% and 51.22%, respectively. The assay shows a high prevalence of TiLV infection with a high PPV of 76.19% and a low NPV of 65.62%. The ROC curve for the produced iELISA was generated from the plot of sensitivity vs 1-specificity across several cut-offs and it revealed a closer top left region from where the cut off (0.10075) is picked, giving stronger discriminant ability of diagnostic tests. A slide agglutination test spot assay is also developed. iELISA test is effective to detect TiLV in mucus and is established as a non-invasive TiLV screening method.



Development of Monoclonal Antibody against *Flavobacterium columnare* and its use in Rapid Disease Diagnosis

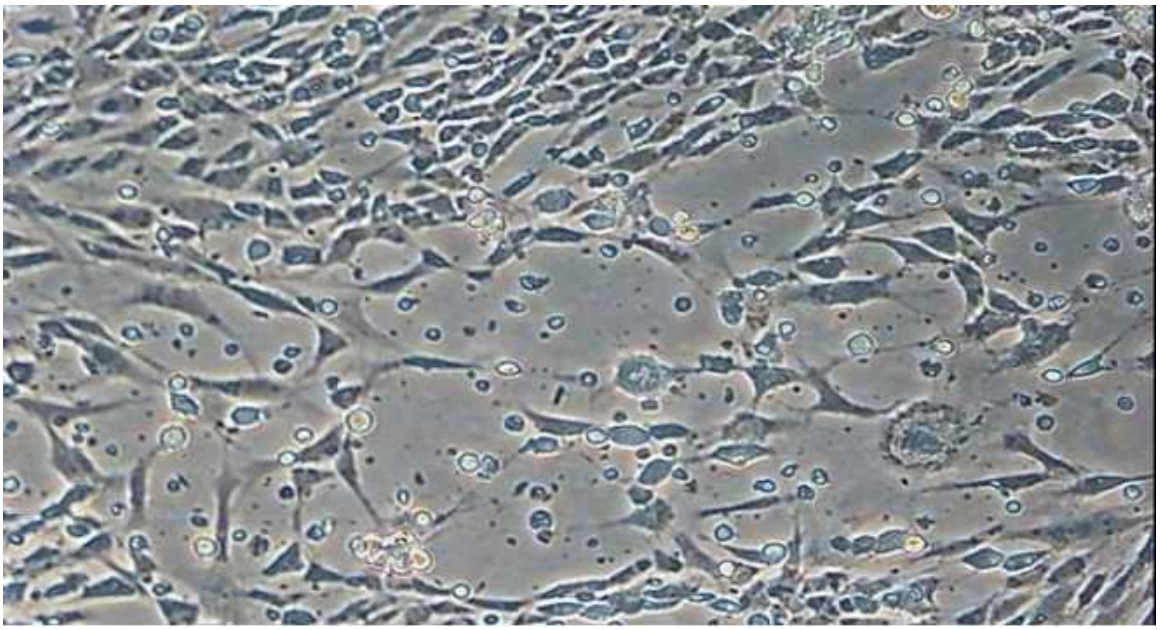
CIFE/2019/01/IF

Project duration:2019- 2022

Principal Investigator
Dr. Megha Bedekar

Co-Principal Investigator
Dr. K V Rajendran
Dr. Gayatri Tripathi
Dr. Jeena K

Bacterial diseases cause considerable loss to the freshwater aquaculture industry. Among the bacterial pathogens, *Flavobacterium columnare*, is the most important affecting a wide range of economically important fish species *viz* Indian Major carp, ornamental fish, catfish and tilapia. In this project, development of monoclonal antibodies against *F. columnare* was done with an aim to develop a diagnostic test. Cell Line: SP2/01 Ag14 is procured from National Centre for Cell Sciences (NCCS), Pune. Mice were sensitized with flavobacterium recombinant protein following two sub cutaneous boosters and one intravenous booster. After that booster cells were collected by sacrificing the mice and cell fusion protocol was taken up adding 10:1 lymphocytes and myeloma cells in presence of one ml of sterile polyethylene glycol (PEG) (Hybrimax, sigma, USA), The cells were conditioned and incubated in selective media containing IMDM with 20% fetal bovine serum (FBS) with HAT (Hypoxanthine Aminopterin Thymidine) supplement. The fused cell suspension was seeded into the 24 well tissue culture plate. Screening of 200 passives and suspected fish by Molecular, Microbiological and indirect ELISA testing was done. Sensitivity and specificity of PAb-indirect ELISA was tested against pure culture DNA PCR that recorded 85% sensitivity and 100 percent specificity. Sensitivity and specificity of MAb-indirect ELISA was tested against pure culture DNA PCR that recorded similar to that of PAb-ELISA. From mixed culture rohu and catla were positive, whereas mrigal samples were negative for the test. Suspected tilapia stock were negative for *F. columnare*, whereas some of the samples of goldfish were positive for *F. columnare* infection. Flavobacterium infection was recorded in months from September – January. The MAb-Indirect ELISA test optimized for *F. columnare* which requires less upstream processing of sample compared to PCR. ELISA can be exploited as a diagnostic tool for screening.



Applications of CRISPR/Cas system in Molecular Detection of Fish and Shrimp Diseases

CIFE/2022/405/EF

Project duration:2022-2025

Principal Investigator
Dr. Megha Bedekar

Co-Principal Investigators
D. KV Rajendran
Dr. Kiran Rasal
Dr. Kundan Kumar
Dr. Jeena K

Budget: Rs.10.00 lakh/First Year

Funding agency
DBT, GoI

Tilapia Lake Virus of Tilapia and White Spot Syndrome Virus of shrimps are the major threats in the aquaculture industry. Though there are high throughput diagnostics available for detection of these pathogens in the laboratory, field-oriented tests for diagnosis are still awaited. Recently, clustered regularly interspaced short palindromic repeats/CRISPR-associated (CRISPR/Cas) based nucleic acid detection technology has been developed with the advantages of rapidity, simplicity, and a low cost. Hence, the aim of this project is to develop the novel technology for aquaculture virus detection.

Samples suspected for TiLV were received from tilapia farms. Mostly, fish were showing symptoms of redness on fins, darkening of skin, popeye and loss of appetite. Tissues such as gill, liver kidney and mucous were collected for testing. The semi-nested PCR for segment 3 is carried out for TiLV confirmation in research samples. With a few modifications, the Deepika et al. (2015) method was employed to purify the TiLV antigen. Screening of local shrimp farms for WSSV was done and DNA was extracted from the gills and stomach tissues of the WSSV infected shrimp samples using DNAzol reagent. Isolated DNA was quantified at purity of the DNA (260/280). PCR was performed from the isolated DNA using selected genes. To generate the positive control amplified gene fragments were cloned in pTZ R/T vector.

Screening of *Escherichia coli* Isolates for MDR and Molecular Characterization of Integron Associated Resistance

CIFE/2020/AAH002/SR

Angel Ayana K. J.

Major Advisor: Dr. Jeena K.

The imprudent use of antibiotics has resulted in the development of antimicrobial resistance (AMR), which is a serious public health concern. AMR can spread from one system to another. *Escherichia coli* is a priority pathogen due to its widespread levels of AMR and is the most common gram- negative pathogen of public health importance. AMR transmission occurs through the antimicrobial resistance genes (ARGs) harbored on the extrachromosomal mobile genetic elements in bacteria. Integrons are mobile genetic elements known to be the primary source of transferable resistance genes and serve as the reservoirs of AMR genes within microbial populations.

In the present study, 50 *E. coli* isolates from shrimp farms of Maharashtra and Gujarat were confirmed using biochemical and molecular approaches followed by phenotypic antibiotic susceptibility testing and detection of class I integrons. Further, variable regions of integrons were evaluated for the presence of antibiotic resistance genes. This was further correlated with the phenotypic antibiotic susceptibility and the antibiotic resistance genes detected in the isolates. All the isolates used in the study were resistant to at least one antibiotic. Of the 50 isolates, 50% (25 isolates) were detected to be resistant to multiple drugs (MDR) and 60% were identified to possess multiple antibiotic resistance index (MAR) >0.2. MAR index varied from 0.076 to 0.61. Highest resistance was exhibited by the isolates to erythromycin (100%) followed by trimethoprim (50%), oxytetracycline (48%), and ciprofloxacin (44%). Hundred percent of the isolates showed susceptibility to colistin, and cefotaxime. Seventy eight percent of the isolates were intermediately resistant to Kanamycin and 68% to Streptomycin. Class 1 integrons were detected from 96% of the isolates. All MDR isolates harbored ESBL producing blaSHV. The variable region sequences were subjected to Comprehensive Antibiotic Resistance Database (CARD) BLAST analysis which could retrieve different AMR gene families (12) conferring resistance to Aminoglycoside, Tetracycline, Macrolide, Fluoroquinolone and Cephalosporins. Integrons encoding for antibiotic resistance are significantly present in *E. coli* from shrimp farms. Indiscriminate use of antibiotics can further increase the multiple drug resistance in bacteria and prevalence of the integrons.

Synthesis and Characterization of Biogenic Silver Nanoparticles using Papaya Leaf Extract and its Antibacterial Effect on *Edwarsiella tarda* in fish

CIFE/2020/AAH007/SR

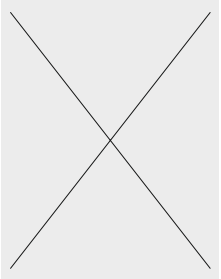
S. Surya Teja

Major Advisor: Dr. K. Pani Prasad

Indiscriminate use of the supplements, specifically antibiotics as growth promoters, prophylactics and therapeutics has led to the emergence of antimicrobial resistance. Different strategies are being employed to combat the phenomenon of antimicrobial resistance in aquaculture, among which nanoparticles have gained a lot of importance. Plant mediated synthesis of silver nanoparticles are more advantageous because of their rapid extraction strategies, modification methods and less bio hazardous nature. In the present study, papaya leaf extract silver nanoparticles (CPL- AgNPs) were synthesized, characterized, and evaluated for their antibacterial effect on *Edwardsiella tarda* in tilapia fish. CPL-AgNPs were measured as 93.6 nm by Dynamic Light Scattering (DLS) technique and TEM measured the average size as 10-35 nm Zeta potential of the synthesized nanoparticles was -36.2 mV indicating moderate stability of synthesized silver ions. SEM characterization revealed that the CPL-AgNPs are round in shape and are densely clumped and getting well conjugated to the extract. FTIR analysis indicated high O-H stretching, C-H bond and C=O carbonyl group formation. The synthesized particles at a concentration of 50 µg/mL showed MIC and 100 µg/mL showed MBC for *E. tarda* bacteria. Fishes were treated with different concentrations of CPL-AgNPs (110, 120, 130, 140, 150, 160 and 200 mg/L) by immersion. LC_{50} concentration of 131.16 mg/L showed higher protection against *E. tarda* infection. There was recovery of typical symptoms like skin lesions. The fishes became active and started feeding. CPL-AgNPs were found to have immuno-modulatory effects and helped in increasing disease resistance and treatment. Further studies are needed to assess the toxic effects of CPL- AgNPs, their mechanism of inhibition and practical application at farm level can lead to better development and commercialization.

CIFE/2022/AAH601/SR

Studies on Integron and Transposon Mediated Transfer of Antibiotic Resistance Genes in Bacteria from Shrimp Culture System and their Mitigation



Ranjit Kumar N

Major Advisor: Dr. M.M. Prasad

Antibiotic resistance is one of the major concerns for rapidly growing food sectors, including shrimp aquaculture. In this study, 192 samples, comprising of pond sediment (n= 60), rearing water (n= 60), cultured shrimp (n= 60) and source water (n= 12) from 60 shrimp ponds located at 12 geographical locations (L1-L12) of Andhra Pradesh (AP), India were collected for heterotrophic bacterial isolation.

A total of 2304 bacterial isolates were selected and identified by conventional microbiological methods which revealed four different morphological groups with Gram negative rods being predominant (61.3%). Further, 16S rRNA sequencing of randomly selected isolates confirmed the presence of 35 species belonging to 16 genera of heterotrophic bacteria. The dominant bacteria genera were *Vibrio* sp. (38.5%), followed by *Bacillus* sp. (19.7%), *Tenacibaculum* sp. (6.4%), *Halomonas* sp. (6%), *Pseudomonas* sp. (5.3%) and *Staphylococcus* sp. (5.1%). Antimicrobial susceptibility studies of all isolates showed maximum resistance towards oxytetracycline (23.4%) followed by erythromycin (12.7%), co-trimoxazole (10%), ciprofloxacin (9.6%), chloramphenicol (6.0%) and 11.9% of the resistant isolates were multi-drug resistant (MDR). Bacterial isolates from shrimp samples exhibited significantly higher resistance to oxytetracycline (26.67%, $p<0.01$) followed by isolates from water (23.89%) and sediment (19.58%) samples with positive correlation between samples. Among different locations, bacterial isolates from location L6 exhibited significantly ($p < 0.01$) higher antibiotic resistance towards oxytetracycline for shrimp (66%), sediment (60%), and water (60%) samples. Similarly, Gram positive rod (82%), Gram negative rod (71.1%), Gram positive cocci (85.7%) and Gram negative coccobacilli (60%) from location L6 were found more resistant (paired t-test, $p\leq0.01$). PCR assays of different antibiotic resistant genes (ARGs) revealed the presence of *tetA* (51%), *sul1* (20.9%), and *tetM* (10.6%) among the bacterial isolates, while other genes accounted for less than10%. Higher multiple antibiotic resistance (MAR) index (>0.2 to 1) and epidemiological cut-off values (non-wild type phenotypes, 90%) towards oxytetracyline indicated shrimp aquaculture ponds as high-risk sources for antibiotic resistant bacteria. The most prevalent ARG and mobile genetic element (MGE) detected in MDR isolates were *tetA* (47.5%) and *int1* (46.2%) respectively. With *in-vitro* conjugation experiments, overall transfer frequency was found in the range of $1.1x10^{-9}$ to $1.8x10^{-3}$.

The results from bacterial inactivation studies with different disinfectants showed that the Fenton"s reagent (2 mM Fe^{2+} + 20 mM H_2O_2) reduced the total heterotrophic bacterial count by 2.65 Log at the end of 60 min treatment, whereas, chlorination (2.5 mg Cl_2 L^{-1}), and H_2O_2 (50 mM H_2O_2) decreased the count by 2.35 and 1.38 Log respectively. Similarly, treatment with the same concentrations of disinfectants inactivated tetracycline resistant bacterial counts by 1.66 Log (Fenton"s reagent), 1.57 Log (chlorination), and 1.43 Log (H_2O_2) at the end of 60 min. However, complete inhibition of bacteria was noticed in both cases when treated with higher disinfectant concentrations. This study indicates that antibiotic resistant bacteria were widely distributed in shrimp culture environments and harboured different ARGs and MGEs which can act as an important reservoir of drug-resistance.

Improvement of Water Quality and Fish Health in Integrated Freshwater Aquaculture System through Treatment of Animal Manure (Under NEH)

CIFE/2019/8/IF

Project duration:2022-2025

Principal Investigator
Dr. Arun Sharma

Co-Principal Investigators
Mr. Dhalong Saih Reang
Dr. T. I. Chanu
Dr. Vidya Shree Bharati
Dr. A. K. Verma
Dr. Megha Kadam Bedekar

Launch workshop and three days training program was organized by ICAR-Central Institute of Fisheries Education, Mumbai in collaboration with the State Fisheries Department, Superintendent of Fisheries Office Gandacherra, Dhalai District Tripura from 21/10/2022 to 23/10/2022. A total of 30 participants/ Farmers from different ADC village councils attended the program which includes 23 males and 7 female participants. For demonstration purposes, 10,000 fish fingerlings were released including species like Singi, Koi, IMC, and minor carps.

Demonstration: Under the NEH scheme, the project at Gandatwisa block under Dhalai district of Tripura in collaboration with the Department of Fisheries, Govt. of Tripura. North East Hill (NEH) scheme is a developmental scheme of the North East Hill region sponsored by the Central Govt. Farmers were selected in consultation with the fisheries department. Altogether three farmers were selected in the first year. Integrated fish farming like pig cum fish, duck cum fish, and poultry cum fish farming system model is developed with the inputs like poultry, piglet, ducklings, poultry feed, duck feed and pig feed and sheds etc.

Application of Heterologous Prime and Boost Immunization Strategies for Augmentation of Immune-prophylaxis in Tilapia *Oreochromis niloticus*

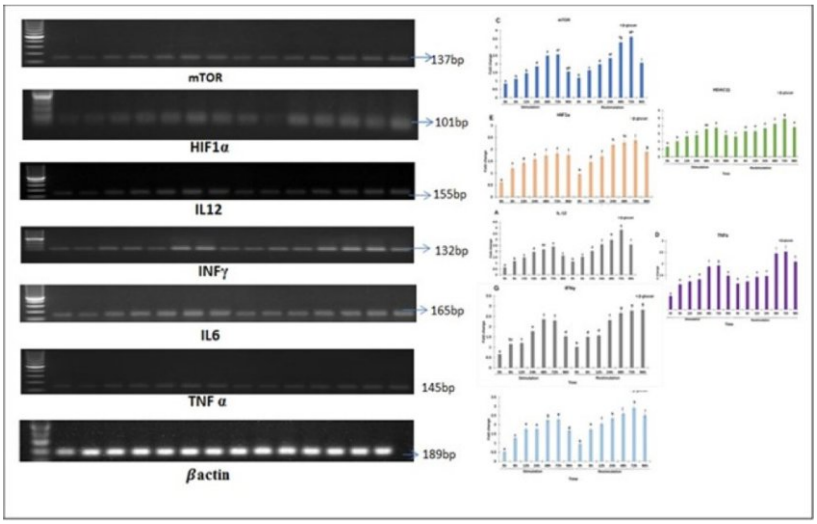
CIFE/2022/15/IF

Project duration:2022-2025

Principal Investigator
Dr. Jeena K.

Co-Principal Investigators
Dr. Rajendran K. V.
Dr. Pani Prasad K.
Dr. Gayatri Tripathi
Dr. Megha Bedekar
Dr. Madhuri Pathak

Immunization, specifically vaccination is one of the most effective approaches in preventing disease outbreaks and spread and works on the characteristic principle of specific recognition of antigenic epitopes by the lymphocytes, production of specific immunoglobulins and retention of memory of the encounter for facilitating an elevated response in subsequent attack by the same antigen. The project aims at elucidating the mechanisms of innate immune memory and its potential in immunization of fish.



During the reporting period, Nile tilapia, *Oreochromis niloticus* (30±5g) were procured. Experimental design for immune training of acclimatized fish was set up using βglucan as the training ligand at a concentration of 20mg/Kg fish. Time point sampling of anterior head kidney tissues were carried out at 6, 12, 24, 48, 72 and 96 h post stimulation and re-stimulation. Samples were processed, total RNA extracted, cDNA synthesis was done. Expression profiling of trained immunity markers such as mammalian Target of Rapamycin (mTOR), Hypoxia Inducible Factor 1Alpha (HIF1a), and Histone Deacetylase (HDAC) and proinflammatory cytokines (IL-6, IL-12, IFNγ and TNFα) were done using β actin as internal control.

The expression patterns of all the markers profiled showed a significant elevation post stimulation and restimulation. Post stimulation the significant elevation was observed at 24h-48h, whereas post restimulation, the significant fold change in the target gene expressions were observed at much earlier time point viz., 12 h. The results indicate the potential of β glucan as a potential training ligand for fish that can induce the trained immunity.

Evaluation of Innate Immunity in *Oreochromis mossambicus*

CIFE/2020/AAH008/SR

Thatikonda Bhargavi

Major Advisor: Dr. K.Pani Prasad

In recent years, there has been a rapid development in the field of fisheries, particularly with regard to aquaculture. Intensive aquaculture practising systems brought the problem of diseases, which hindered aquaculture production drastically. The present study is aimed to evaluate the alternate complement activity and antibacterial activity of mucus after oral administration of levamisole. Levamisole, an anthelminthic drug with immunomodulatory activity, was used in this experiment. The drug was administered to the experimental fish, *Oreochromis mossambicus* (Mozambique tilapia), through the feed for 10 days, and then control feed was given to all the treatment groups for the remaining experimental period. The effect of the levamisole was evaluated for every 5 days of interval, i.e., (Day 5,10,15,20,25 and 30) by tests such as alternative complement activity (ACH50), Nitro blue tetrazolium assay (NBT), Total MPO content, lysozyme activity, total serum protein, Superoxide dismutase assay (SOD), Catalase (CAT), antimicrobial activity of skin-mucus and serum. Fish fed with 50mg/kg, 125 mg/kg, and 250mg/Kg of levamisole showed an increase in the ACH50, NBT, Total MPO content, Total serum protein, SOD, CAT when compared to the control. However, an increase in SOD and CAT in serum is not desirable. The lysozyme activity in levamisole-fed fishes did not significantly differ from the control group during the experimental period. Mucus did not show any zones of inhibition against *E. tarda*, but serum formed. The dosage of 50 mg/Kg feed showed better results when compared to fishes fed with 125mg/Kg and 250mg/Kg of levamisole feed. The above results indicate that levamisole acts as an immunomodulator and can be a better immunostimulant if used with the 50mg/kg in feed in the tilapia.

Ontogeny and Tissue Specific Expression Profiles of Recombination Activating Gene (RAG) during Development in Nile Tilapia, *Oreochromis niloticus*

CIFE/2020/AAH003/SR

Chovatia Ravikumar Mansukhbhai

Major Advisor: Dr. Gayatri Tripathi

Recombination activating genes (RAGs) mediates the process of rearrangement and somatic recombination (V(D)J) to generate different antibody repertoire. Studies on the expression pattern of adaptive immune genes during ontogenic development are crucial for fish immunization. In the present study, Nile tilapia was taken to explore the relative expression profile of RAG genes in the developmental stages of Nile tilapia. The developmental stages of Nile tilapia, i.e., unfertilized egg, 0, 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28 and 30 days post-hatch (dph) and kidney, blood, gill, liver and spleen tissues from adult fish were collected and the cDNA synthesis was carried out. Specific primers for RAG-1 and RAG-2 of Nile tilapia were designed using Gene runner software and their annealing temperature (Tm) was optimized by gradient PCR. Consequently, PCR was performed to confirm the specific amplification of RAG-1 and RAG-2 genes. The amplified PCR products were sequenced by sanger sequencing for confirmation using the BLAST tool. Quantitative real-time PCR (qRT-PCR) gene expression of RAG-1 and RAG-2 were noticed in all the developmental stages; however, a significant increase was observed after 12 dph and peaked at 24 dph, followed by a gradual decrease till 30 dph. Tissue-specific gene expression profiling revealed that the highest expression of RAG-1 and RAG-2 was observed in the kidney, followed by spleen, gill, liver and blood. However, the expression of RAG-2 was high in liver tissue compared to the RAG-1 gene. 3D modelling of RAG-1 and RAG-2 protein were depicted using a Swiss-model server and Ramachandran plot analysis displayed 87.9% and 88.4% residues of RAG-1 and RAG-2 proteins in the most favoured regions. Phylogenetic tree analysis of both the genes revealed that Nile tilapia had the most genetic similarity with the Cichlidae family. The study's findings explored the suitable timing of lymphoid maturation that could be technically used for the adoption of strategies followed to increase the resistance of fish larvae for mitigating mortality at larval stages.

Study on Pharmacokinetics of Florfenicol in Common carp, *Cyprinus carpio*

CIFE/2020/AAH004/SR

Ashish P. M.

Major Advisor: Dr. K. Paniprasad

Florfenicol, a derivative of chloramphenicol, is a potent broad spectrum antibiotic drug, active against most of the disease-causing bacteria in fish. The present study was undertaken to explore the pharmacokinetics of florfenicol following single-dose administration of in-feed incorporated medicated feed at 15mg/kg body weight in common carp *(Cyprinus carpio)*. Following the single oral administration, blood and tissue samples were collected at 0, 2, 3, 4, 6, 8, 12, 16, 24, 32, 48, 64, 96 and 128 h. Plasma and tissue samples were analysed for florfenicol (FF) and its major metabolite florfenicol amine (FFA) concentrations using Liquid chromatography with tandem mass spectrometry (LCMS/MS) technique. The drug was absorbed rapidly after administration and a Cmax of 7203 ng/mL at 4h (Tmax) was observed. The data was fitted into one-compartmental open model to obtain other pharmacokinetic parameters using PK Solver 2.0 to obtain the predicted values for Cmax of 5747.84 at 6 h (Tmax), absorption half-life (t½ka) of 1.42 h, elimination half-life (t½β) of 11.72h, distribution volume (V/F) of 0.00195 (mg/kg)/(ng/mL), apparent total clearance of

the drug from plasma after oral administration of 0.000115 (mg/kg)/(ng/mL)/h, $AUC_{(0-\infty)}$ of 130192.70 ng/mL·h and Mean residence time of the drug in the body (MRT) of 18.97 h were noted for FF. The metabolite FFA was also observed in all the tissues. The observed Cmax value of FFA, 26.4 ng/L was observed at 30.45 h (Tmax) post administration, t½ka of 19.28 and t½β of 23.16 h signifying its formation in the body post the drug metabolism. It was also found that FF was extensively distributed in all the tissues in quantifiable amounts that exceed the MICs of most of the bacterial pathogens. Hence, the outcome of the study is helpful to establish the safety and usage of florfenicol for the treatment of bacterial infections in common carp.

Study on Tissue Depletion and Withdrawal Period of Florfenicol in Common carp (*Cyprinus carpio*)

CIFE/2019/AAH909/SR

Sunanda Allakonda

Major Advisor: Dr. K. Rajendran

Florfenicol is a broad spectrum antibiotic analog of thiamphenicol, known for its outstanding effects against various pathogenic bacteria causing diseases in fish. The aim of this study was to evaluate the depletion and withdrawal period in common carp (*Cyprinus carpio*). Fish with an average weight of 20 ± 3.0 g were administered Florfenicol in-feed at a dose of 15 mg/kg body weight per day for 10 consecutive days. Post the feeding window, muscle tissues were collected at different time points viz., 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 days and stored in -20 °C. The muscle tissue samples were analyzed in LC-MS/MS to determine the concentration of the drug at different time points. Withdrawal period of Florfenicol and its major metabolite Florfenicol amine were calculated using log transformed linear regression analysis. As per EU, the MRL of Florfenicol is 1000 µg/kg and withdrawal time 500 °days, as established by Directive 2004/28/EC. The withdrawal period of Florfenicol in common carp muscle when administered at 15 mg/kg body weight per day was estimated to be 1.89 days or 45.36 h. Further, the complete elimination time for Florfenicol and Florfenicol amine at concentration (0.001 ng/g) at an average temperature (28.4 °C) was estimated to be 11.23 days or 318 °days and 16.91 days or 480.2 °days respectively. Hence the study forms a base for further studies on the use of Florfenicol and for future applications in treatment of bacterial disease in fish.

Evaluation of Dietary Supplementation of Paraprobiotic *Lactobacillus* rhamnosus on Growth and Immune Responses in *Labeo rohita* (Ham.) against *Edwardsiella tarda*

CIFE/2020/AAH009/SR

Venerability Dhar

Major Advisor: Dr. R.P. Raman

The present study evaluated the paraprobiotic effect of heat-inactivated *Lactobacillus rhamnosus* on growth, immunological response and disease resistance against *Edwardsiella tarda* infection. Heat inactivation of viable cells of *L. rhamnosus* was done at 75°C for 1 h. For preparation of paraprobiotic supplemented diet, the heat-inactivated bacteria were added to the basal diet (control) at three different inclusion levels i.e., 10^6, 10^7 and 10^8 cells g^{-1} diet. Fish were fed with these diets for ten days and the feed was changed to a non-supplemented diet (basal diet) thereafter. From the onset of feeding with different diets blood and serum samples were taken to assess the immunological parameters. Fish were challenged

intraperitoneally with virulent strain of *E. tarda* on the fourteenth day of the feeding trial and the relative percent survival was recorded for the next 15 days. Immunological parameters *viz.*, Nitroblue tetrazolium (NBT) activity, myeloperoxidase activity (MPO) and total serum protein content showed significant difference ($p < 0.05$) in all the dietary groups compared to control. However, the same immunological parameters showed a decreasing trend after the 10 days feeding period with the paraprobiotic, wherein they were fed with non-supplemented basal diet. After a challenge with *E. tarda*, the highest relative percentage survival was recorded in T_3 groups, whereas the lowest RPS was recorded in the T1 group. The specific immunity was significantly influenced by the paraprobiotic *L. rhamnosus* feeding as evident from the bacterial agglutination titre. Percentage weight gain, specific growth rate and FCR showed no significant difference ($p > 0.05$) between the treatments and control group. The results obtained from the present study indicates that the application of heat-killed *L. rhamnosus* resulted in higher total serum protein concentration, a concentration of 10^7 cells g^{-1} resulted in higher MPO activity, whereas a concentration of 10^8 cells g^{-1} resulted in increased NBT activity, nevertheless it is undeniable that the incorporation of different levels of paraprobiotic have no significant impact on growth parameters but positively enhances immunological parameters of *Labeo rohita*.

CIFE/2020/AAH006/SR

Study on Antiparasitic Effect of Castor, *Ricinus Communis* extracts against Argulus Infestation in Goldfish (*Carassius auratus*)

Samad Sheikh

Major Advisor: Dr. R.P. Raman

Argulosis is a major concern for the ornamental fish industry, particularly the goldfish trade, as it is highly prone to argulid parasites. There is currently a call for eco-friendly and affordable treatments due to the adverse effects of chemical-based parasiticides on the host and environment, one such measure is phytotherapy. The present study was conducted to evaluate the antiparasitic efficacy (AE%) of castor (*Ricinus communis*) leaf extracts against *Argulus* infestation on goldfish under *in vitro* and *in vivo* conditions. The phytochemical analysis of castor leaf extracts showed the presence of alkaloids, flavonoids, phenols and saponins in ethanol, methanol and aqueous extracts. The activity of castor leaf extracts under *in vitro* condition was performed in the range of 1.0 to 3.0 g L^{-1} against adult *Argulus japonicus.* The *in vitro* antiparasitic efficacy of 100% in ethanolic and aqueous extract of castor leaf were found on 12 h for adult *A. japonicus* at 2.0 and 2.5 g $L^{-1,}$ respectively. However, the median effective concentration (EC_{50}) of ethanolic and aqueous extract of castor leaf against *A. japonicus* on 12 h were found at 1.24 g L^{-1} and 1.39 g L^{-1}, respectively. In the bioassay, the 72 h LC_{50} of aqueous extract for goldfish was found to be 1.58 g L^{-1}. Notably, under *in vivo* condition, the estimated 72 h EC_{50} value of aqueous extract against *A. japonicus* was 1.17 g L^{-1} and the calculated therapeutic index was 1.355 which indicates relatively safe dose for *in vivo* application for argulosis in goldfish. The present study shows that the aqueous extract of castor leaf can be recommended as a promising potent antiparasitic agent against *A. japonicus* under *in vivo* condition. However, its effects on pond condition and mode of action of the extract needed to be studied further.

CIFE/2020/AAH001/SR

Histology and PCR-Based Screening of Freshwater Prawn, *Macrobrachium rosenbergii* for Pathogens Infecting Hepatopancreas

Amala Jiji

Major Advisor: Dr. K. V Rajendran

White tail disease caused by Macrobrachium nodavirus (MrNV) severely impacted prawn farming in India with severe mortality and substantial economic losses. In the present study, different life stages (post-larvae, sub-adult, and adult) of *M. rosenbergii* were collected from different parts of India (Kerala, West Bengal, and Maharashtra). These animals were screened for pathogens infecting hepatopancreatic tissue using histological analysis and polymerase chain reaction (PCR). Pathogens targeted for PCR detection included hepatopancreatic parvovirus (HPV), infectious hypodermal and haematopoietic necrosis virus (IHHNV) and *Enterocytozoon hepatopenaei* (EHP).

A total of 50 animals consisting of post-larvae, adults and sub-adults were subjected to histological analysis and majority of the post-larvae (collected from Kerala) showed eosinophilic to basophilic, intranuclear inclusions in the tubular epithelium of hepatopancreas typical of hepatopancreatic parvovirus (HPV) infection. Pathological changes including nuclear hypertrophy, chromatin margination and necrotic changes in the hepatopancreatic tubular epithelium were evident. Some sub-adult animals from West Bengal showed small and lesser intranuclear inclusions and also showed necrotic changes in hepatopancreas but no indication of any pathogen. A total of 95 animals were subjected to PCR screening for HPV, infectious hypodermal and haematopoietic necrosis virus (IHHNV) and *Enterocytozoon hepatopeanei* (EHP) using pathogen-specific primers. The prevalence of HPV was found to be the highest in samples from Kerala and the samples from West Bengal showed the highest prevalence of EHP. The sequence analysis of the HPV-specific PCR amplicons showed 95-96% similarity to the capsid protein gene of HPV reported from shrimp. However, EHP-specific amplicons showed 100% identity with the spore wall protein gene of EHP reported from shrimp. The present report forms the first record of HPV infection in *M. rosenbergii* from India and the first record of EHP in the freshwater prawn.

3.5 Genetics & Breeding

Fig. Handing over of genetic lly sel ed Ma ock to NFFBB

Improvement of Harvest Body Weight of *Clarias magur* through Genetic Selection

CIFE/2017/02/IF

Project duration:2017- 2022

Principal Investigator
Dr. Shrinivas Jahageerdar

Co-Principal Investigator
Dr. Thongam Ibemcha Chanu
Dr. Shamna N
Dr. Sikendra Kumar
Dr. Arun Sharma
Dr. Sunil Kumar Naik
Mr. J Krishnaprasad
Dr. P. Sreenivas Rao
Mr. R.R.S.Patnaik
Mr. Hasan Javed

Clarias magur (Hamilton 1822) is an Indian catfish popularly known as Magur and has the potential to be a candidate species for freshwater aquaculture in India. Magur fetches a better market price due to its high consumer preference, good taste, and nutritional profile. Selective breeding offers an opportunity for continuous genetic gain for traits under selection, which is permanent. ICAR- CIFE is implementing a genetic selection program of magur to improve the harvest body weight and enhance the breeding efficiency and survivability. It was found that the non-genetic factors like batch, stock, pond, and sex significantly affected the harvest traits. The difference in body weight at stocking contributed to a significant variation (12.5 %) to the body weight at harvest. The present genetic selection program of magur was aimed to produce strains suitable for both mono and polyculture systems.

The results indicated no significant difference in the harvest body weight of magur cultured in both the systems; hence, a single strain can perform equally well in both the culture systems. The heritability of harvest BW was estimated using different methods viz., ANOVA (0.45±0.08), REML (0.44±0.07), parametric bootstrap (0.44±0.07), asymptotic sampling (0.44±0.07), jackknife (0.43±0.01), and Bayesian (0.43±0.07) using BLUP predictions. Among the methods used, the results indicated the Bayesian methods to be more robust, followed by non-parametric bootstrap. The project has achieved 21 per cent cumulative improvement in the harvest body weight over two generations. The genetically selected stock was given to the NFFBB, Bhubaneswar for propagation and seed production in an official ceremony held on 25th April 2022 at CIFE, Mumbai by Shri. Jatindra Nath Swain, IAS Secretary, Department of Fisheries GoI, New Delhi in presence of Dr. J.K. Jena, DDG (Fisheries Science), ICAR, Dr. Ravishankar, Director, CIFE and other dignitaries.

Genetic Analysis of Growth and Reproductive Performance of Selectively Bred *Clarias magur*

CIFE/2020/FGB002/SR

Kishor Gowda B

Major Advisor: Dr Shrinivas Jahageerdar

In the study, non-genetic factors affecting the growth and reproductive traits were quantified, and the genetic parameters were estimated for selectively bred individuals. Growth traits were measured and recorded on the 2020-born individuals stocked in the two earthen ponds. The sampling was done every 28 days from 301 to 441 days of pond age. The non-genetic factor, sex and pond had a significant effect on growth traits. The heritability estimates at 441 days of pond age for body weight, total length, head width and body depth are 0.66±0.17, 0.43±0.15, 0.35±0.14 and 0.03±0.06, respectively. The genetic correlations between the various growth traits were positive and high (0.66 to 0.93), and so were the phenotypic correlations (0.35 to 0.96). The reproductive traits were measured and recorded during the spawning seasons from 2016 to 2021. The non-genetic factor, spawning age, significantly affected all the reproductive traits; contrastingly, spawning year and the pond significantly affected BSW and ASW only. The heritability estimates for the before stripping weight (BSW), after stripping weight (ASW), total egg weight (TEW) and egg weight related to body weight (EBI) were 0.42±0.07, 0.49±0.07, 0.36±0.08 and 0.26±0.07 respectively.

Genetic correlations between the reproductive traits ranged from -0.41 to 0.98 and the phenotypic correlations from -0.05 to 1.05. The spawning success record was from 1032 animals; overall success was 37.60%, 41.69 % for males and 34.85% for females. Heritability estimate for the spawning success is 0 for combined, 0.016±0.05 for males and 0 for females. The heritability estimates of both growth and reproductive traits suggest that improvement of these two groups of traits is possible. The genetic correlation between the BSW and TEW suggests that selecting magur for body weight resulted in the correlated response by improving the TEW. The heritability estimates for the spawning success indicate that it can be improved by standardising the management practices in broodstock and breeding procedures. Hence, improving the body weight of magur may also improve the egg production traits in magur.

Genetic Improvement of Growth and Breeding Efficiency of *Clarias magur* Through Selective Breeding

CIFE/2022/10/IF

Project duration:2021- 2024

Principal Investigator
Dr. Shrinivas Jahageerdar

Co-Principal Investigator
Mujahidkhan A. Pathan
S.K. Nayak
Thongam Ibemcha Chanu
Arun Sharma
Shamna, N.,

Technical Personnel
P. Srinivasa Rao
Hasan Javed

The proposed research work aims to enhance the growth and breeding efficiency of magur through genetic selection and optimising the aquaculture practice. The specific objectives are a) to quantify the effect of non-genetic effects on body weight and selected reproductive traits; b) to estimate the heritability of body weight and selected reproductive traits and genetic and phenotypic correlations among them and estimate the breeding values; c) to estimate response to selection for body weight and selected reproductive traits; d) to develop suitable selection methods; e) to develop BMP and demonstrate the culture of genetically selected magur in field conditions.

During 2022, the breeding of magur stock was carried out in July at CIFE Powarkheda Centre, while the breeding of magur was spanned from mid-July to late October at CIFE Balbhadrapuram Centre. 43 families were produced at Balabhadrapuram and 25 families at Powarkheda, totalling 68 families. They include 44 half-sib families and 22 full-sib families. As many as 1,416 Magur fish were PIT-tagged at Balabhadrapuram and 425 at Powarkheda. Aquaculture of tagged fish is going on at both farms.

The average body weight of magur at tagging at Balabhadrapuram was 23.80 ± 0.35 gm, and the total length was 14.27 ± 0.09 cm, and that at Powarkheda was 17.48 ± 0.55 gm and 11.17 ± 0.63 cm. Annual sampling was carried out at both farms, and observations were recorded on body weight and other growth-related traits. The yearly sampling at Balabhadrapuram was carried out on 24 and 25 March 2022, and a total of 483 animals were measured. The annual sampling at Powarkheda was carried out on 5th April 2022, and a total of 127 fish were measured.

Six monthly samplings were carried out at both farms, and observations were recorded on body weight and other growth-related traits. The six monthly sampling at Balabhadrapuram was carried out on 7 and 8 October 2022; a total of 212 fish were measured. At Powarkheda, the sampling was carried out on 15th October 2022, and 362 fish were measured. Maintaining the genetic variance in the breeding nucleus is essential; hence a suggestion was given to keep the breeding nucleus open. For this purpose, the magur stock was collected from Kaikluru (AP) and transported to Balbhadrapuram. These fish were bred during the breeding season of 2022. The genetically selected stock was given to the NFFBB, Bhubaneswar, for propagation and seed production in an official ceremony held in April 2022 at CIFE, Mumbai. Work on the effect of varying dietary protein levels on the growth and gonadal development of Clarius magur is in progress.

Exogenous Hormonal Manipulation in Environmental-endocrine Relation in Breeding Performance and Mating Behavior of *Clarias magur*

CIFE/2022/03/IF

Project duration: 2022- 2025

Principal Investigator
Dr. Thongam Ibemcha Chanu

Co-Principal Investigator
Dr. S. Jahageerdar
Dr. Arun Sharma
Dr. Dhalongsaih Reang
Dr. Kapil Sukhdhane
Dr. Babitha Rani A.M.

Magur fish reared in captivity exhibit some form of reproductive dysfunction. In females, failures are observed in oocyte maturation, ovulation and spawning, while in males, reduced milt production and insensitiveness to stripping are observed. These dysfunctions are due to the fish in captivity not experiencing the conditions of the spawning grounds, and as a result there is a failure of the pituitary to release the maturational gonadotropin, and luteinizing hormone (LH). Vitellogenesis appears to progress normally in the above-mentioned fish, but at the onset of the spawning season, the post-vitellogenic oocytes fail to undergo FOM and ovulation, and become atretic. This is the most common type of reproductive problem encountered in magur brooders and this work has been taken up to explore the possibilities for hormonal manipulations and environmental stimulation to induce FOM, ovulation and spawning of a multitude of *Clarias magur.*

During 2022, magur fingerlings were collected from two different places; one stock from Naihati, West Bengal and another from ICAR-CIFE Kakinada centre (F2 generation). Fishes were reared in a wet lab facility of Aquaculture Division, CIFE Mumbai in separate tanks and fed with commercial feed (40% CP). Preliminary trial for 60 days was conducted at a wet lab to check the performance of fish under an artificial rain/shower system with different water flow rate (100 lit/h; 200 lit/h and 400 lit/h). Stress level, feeding rate and growth performance were analysed. The result showed that feed acceptance rate was lower at higher flow rate (400 lit/h). Stress parameters like Cortisol increased (56±0.04) in high water flow rate compared to lower (32±0.01) and medium (39±0.3) flow rate. Similar observation for SOD and Catalase enzyme activities at higher flow rate with higher values. Estradiol hormone was also analysed and level was not detected due to age and size of fish. Heterogeneous growth was observed in higher flow rate.

Evaluation of Genotoxicity and Teratogenicity of Indigo Dyes in Zebrafish

CIFE/2020/FGB004/SR

M. Porkodi

Major Advisor: Dr. N.S.Nagpure

Textile dyeing, indigo dye from denim industries, wastewater is considered one of the most important sources of environmental pollution affecting aquatic ecosystems. This study assessed the toxicity of natural and synthetic indigo dyes in zebrafish (Danio rerio) embryos up to 120 h post-fertilization (hpf) using endpoints of teratogenicity and genotoxicity. The gene expression of DNA repair genes viz. ERCC1 and FEN1 genes have been studied in zebrafish embryos following exposure to the Indigo dyes. The acute toxicity of both the Indigo dyes was assessed by performing the zebrafish embryo toxicity test (ZFET) using ten different concentrations such as 1.56, 3.125, 6.25, 12.5, 25, 50,100, 200, 400, and 800 mg/l. A total of 24 embryos were exposed to each concentration, and mortality was recorded at different time intervals up to 120 h. The highest mortality of 90% was observed in zebrafish embryos exposed to both the Indigo dyes at 800 mg/l concentration after 120 h. Using the Proc Probit procedure, the LC50 values for natural and synthetic Indigo dyes were respectively determined as 350.51 mg/l and 304 mg/l. Various teratogenic effects such as egg

coagulation, tail detachment, yolk sac edema, pericardial edema, and tail bend were observed in zebrafish embryos following exposure to the natural and synthetic dyes at different concentrations and time intervals.

The study found no significant difference between the teratogenic effects caused by the natural and synthetic dyes. The comet assay was used to assess the DNA damage in zebrafish following exposure to the LC10 concentration of natural Indigo dye (23.45 mg/l) and synthetic Indigo dye (16.42 mg/l) for 120 h. Analysis of the comet assay data revealed that there was significant DNA damage in zebrafish embryos exposed to the Indigo dyes as compared to the negative control. Further, the data revealed there was no significant difference in DNA damage between the two Indigo dyes. The histological investigation of the zebrafish embryos revealed morphological alterations following exposure to the indigo dyes. The gene expression studies revealed upregulation of the DNA repair genes, viz. FEN1 and ERCC1 genes in zebrafish embryos exposed to the LC10 concentration of the Indigo dyes. The present study thus indicated that the Indigo dyes used in the textile industries could induce teratogenic and genotoxic effects in aquatic organisms.

Identification and Phenotyping of Different Geographical Populations of Copepod *Heliodiaptomus viduus* (Gurney, 1916)

(CIFE/2020/FGB001/SR)

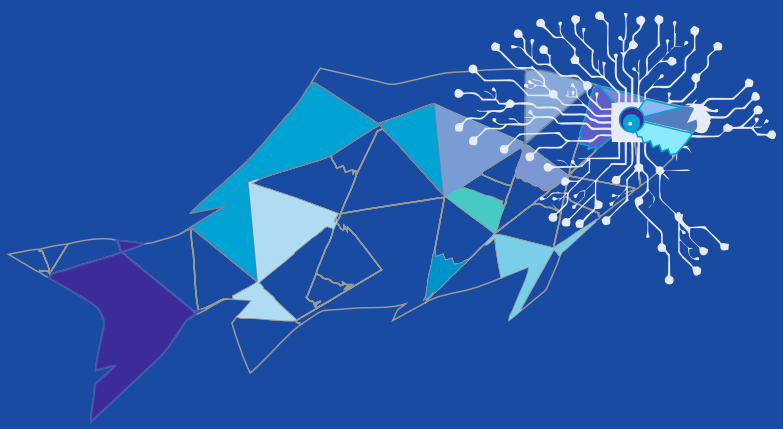
Deepak Kumar

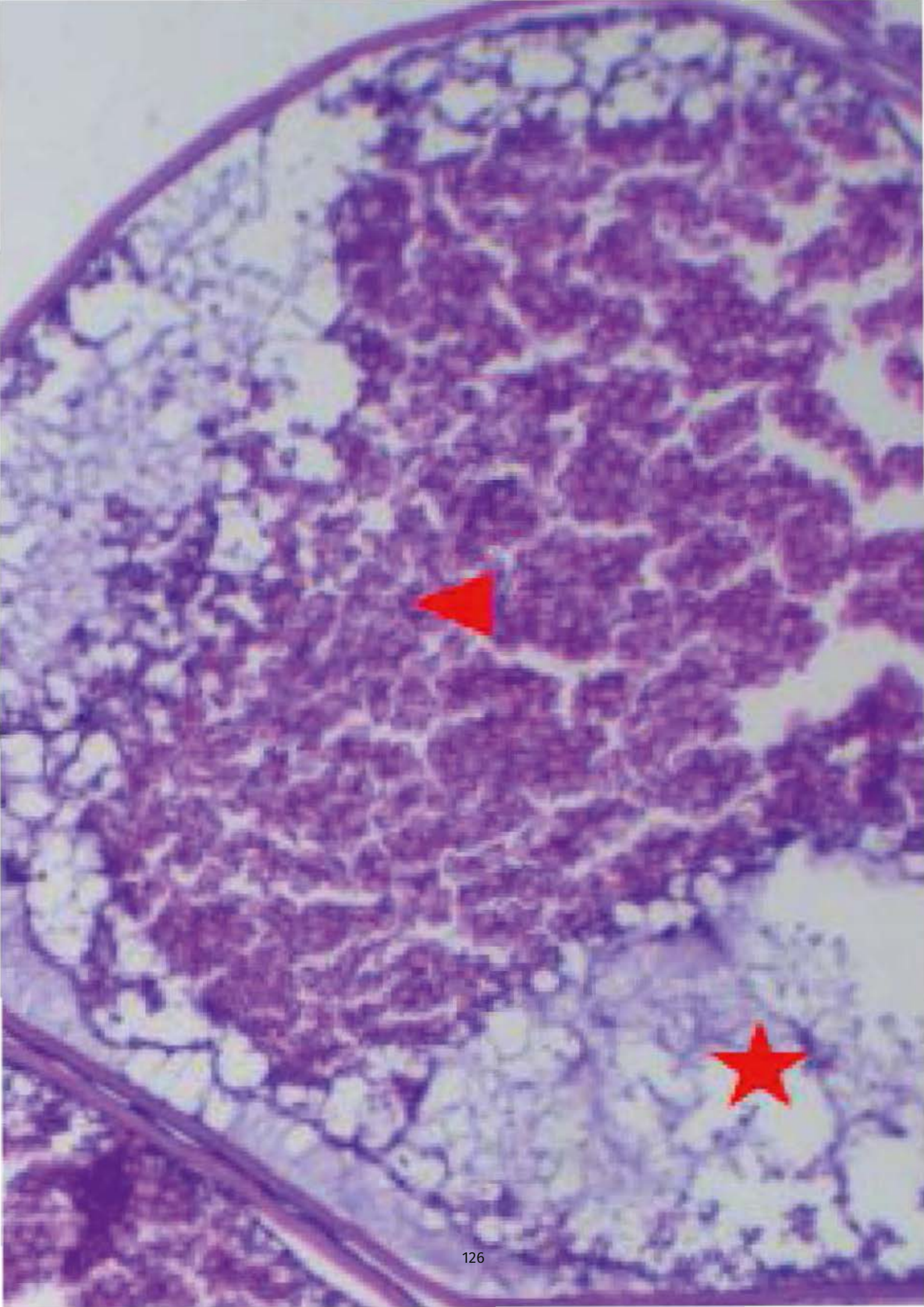
Major Advisor: Dr. Sunil Kumar Nayak

Zooplankton is an excellent food source for farmed fish in the aquaculture industry, particularly for fry, fingerlings, and juveniles. The three most important groups of zooplanktons are Rotifera, Cladocera, and Copepoda. There is limited information on morphometric and meristic traits of the copepod population, and hence the present study was undertaken. Sixteen morphometric and eight meristic traits were identified and digitized for 1089 individuals belonging to Madhya Pradesh (MP), Haryana (HR), and Maharashtra (MH). 25 truss measurements were taken for stock structure analysis. The data was retrieved using image j software. There were 562 females and 527 males. The average total length in HR, MH, and MP stocks was 1.86±0.27mm, 1.82±0.25mm, and 1.79±0.38mm respectively. Haryana stock showed significantly higher value for most of the traits than other stocks. Sex-wise, females showed significantly higher value for most of the traits. All the traits were predicted as a function of total length. In the present study, there was no variation in the meristic traits.

A factor analysis was conducted to delineate the stocks based on truss network. Top three factors had eigenvalues greater than one. The scree plot and plot for variance suggested that the first three factors with eigenvalues 20.45, 8.60, 2.32 are significant and explained 100% of the total variation and were further analysed to estimate the meaningful loadings of the traits. The factor analysis showed no separation among stocks. The discriminant analysis based on the first three factors gave a correct classification of 65.14%, 31.73%, and 22.79% for HR, MH, and MP stocks, respectively. The mt-COI gene analysis using DNA barcoding confirmed that the species used in the present study is Heliodiaptomus viduus. Rearing of copepod was done in suitable environmental conditions. The proximate composition analysis revealed the average protein, lipid, ash, moisture and carbohydrate content to be 62.38%, 9.045%, 7.53, 54.11% and 32.38 % respectively. The information generated in the present study will be helpful for population diversity study and genetic selection programs of copepod Heliodiaptomus viduus.

3.6 Biotechnology & Nanotechnology





Studies on Synthesis and Toxicity of Bioconjugated Carbon Nanotubes in Zebrafish Model

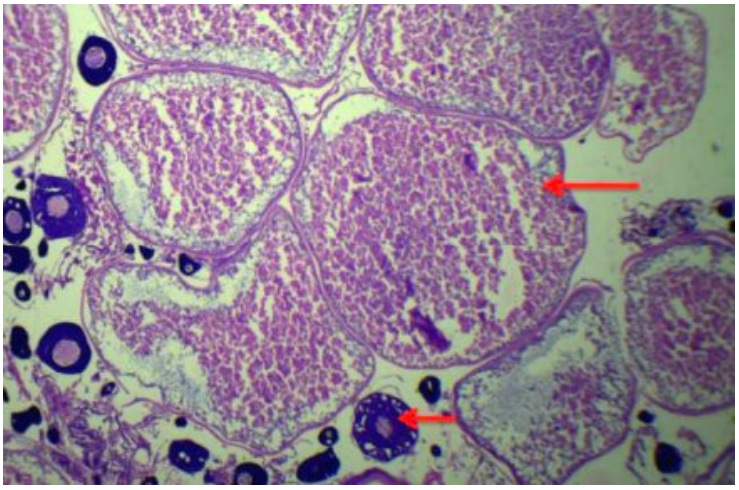
(CIFE/2019/3/IF)

Project duration:2019- 2022

Principal Investigator
Dr. Rupam Sharma

Co-Principal Investigator
Dr. Mujahidkhan Pathan
Dr. Gireeshbabu P. (ICAR-NRCM, Hyderabad)
Dr. Aparna Chaudhari
Dr. Gayatri Tripathi
Dr. Pravin Walke (Univ. of Mumbai)
Dr. Nalini Poojary

The toxicity of different types of carbon nanotubes (CNT) was screened at cellular and genome levels. At the LC20 dose of the respective ZFET, no histological changes were recorded. However, necrotic tip of intestinal villi, damaged villi with erosion of epithelial layer, necrosis of villi and complete necrosis of the columnar epithelial cells were observed in different MWCNTs (BSA-MWCNTs, COOH-MWCNTs, OH-MWCNTs, P-MWCNTs), respectively at LC50 dose of ZFET tested in adults. Histological investigation was conducted to understand toxicity and it showed disturbances like hyperemia, notochord deterioration, somite disorganization, tissue malformation, abnormal trunk, muscle fiber distortion, etc. In gill, hyperplasia and fusion of secondary lamellae, increased number of mononuclear cells, thickened primary lamellae, rupture of primary lamella at the base and accumulation of CNTs were evident at LC_{50} dose of different MWCNTs.



To study the damage at genome level, Comet assay was conducted in the embryos of the experimental fish at LC_{20} values of all the CNTs. H_2O_2 was used as positive control. All the CNTs showed slight DNA damage as compared to the negative control.

Nanodelivery of Conspecific Kisspeptin to Enhance Sexual Maturity and Gonadal Development in *Catla catla*

CIFE/2021/601/EF

Project duration:2020- 2023

Principal Investigator
Dr. Rupam Sharma

Co-Principal Investigators
Dr. Sunil Kumar Nayak
Dr. Mujahidkhan Pathan
Dr. Gireesh Babu (ICAR-NRCM, Hyderabad)
Dr. Aparna Chaudhari

Funding Agency
DST-NANOMISSION, Govt. of India

Catla attains sexual maturity at 2.5 to 3 years of age, while other IMCs (rohu and mrigal) attain maturity during their second year. It attains sexual maturity late, both in captive and natural conditions. So, for broodstock development, aquaculturists have to wait more than three years for maturity and seed production of catla. To shorten the age at sexual maturity and minimize the cost of broodstock development, intervention at molecular and hormonal level is required. It has been determined that kisspeptin is a potent regulator of reproduction, especially for the beginning of puberty. Kisspeptin stimulates FSH and LH production and secretion in the pituitary through the hypothalamus, which controls growth and reproduction of the gonadal tissue. However, half-life of the kisspeptin is highly unstable and short. Therefore, with the help of nanotechnology

we have conjugated kisspeptin with chitosan nanoparticles since nanoparticles sustain the shelf life of kisspeptin and also help in slow release of drugs.

Present study was conducted to see the effect of nanoparticle conjugated kisspeptin on gonadal development in *L. catla.* Chitosan nanoparticle was conjugated with the exogenous conspecific kisspeptins, kiss1 and kiss2. The study showed the effect of the nano-conjugated kisspeptin in increasing body weight of the fish. Histological examinations of gonads revealed enhanced gonadal development in treated fish in comparison to controls. This was also supported by hormonal analysis. These findings firmly demonstrate the role of exogenous kisspeptin in enhancing gonadal development, which lowers the age of maturity in *L. catla*.

Role of Nanoconjugated Conspecific Kisspeptin in Gonadal Development of *Labeo catla* (Hamilton, 1822)

CIFE/2020/FGB006/SR

Shreyasi Kar

Major Advisor: Dr. Rupam Sharma

The study was conducted to see the effect of nanoparticle conjugated kisspeptin on gonadal development in *L. catla. Labeo catla* were stocked in 12 experimental ponds at ICAR-CIFE, Powarkheda Centre. Chitosan nanoparticle was conjugated with the exogenous conspecific kisspeptins, kiss1 and kiss2. The size of the synthesized particles of chitosan and chitosan conjugated kisspeptin were 119.8 nm and 159.8 nm, respectively. The zeta potentials of both the particles were recorded as 25.2 mV and 24.5 mV. The loading efficiency of kisspeptin has been determined in the range of 70% and 70.69%. Both the nanoconjugated kisspeptins were injected @ 0.25mg/kg BW and its effect was evaluated in the fish. Statistical analysis showed the effect of the nano-conjugated kisspeptin in increasing body weight of the fish. Histological examinations of gonads revealed enhanced gonadal development in treated fish in comparison to controls. This was also supported by hormonal analysis. These findings firmly demonstrate the role of exogenous kisspeptin in enhancing gonadal development, which lowers the age of maturity in L. catla.

Effects of Chitosan-Carbon Nanotube Conjugated Nonapeptides on Reproduction in *Clarias magur* (Hamilton, 1822)

CIFE/2016/FGB603/SR

K.S. Wisdom

Major Advisor: Dr. Rupam Sharma

The study was undertaken to investigate the effect of congeneric teleost nonapeptides (isotocin and vasotocin), delivered through chitosan conjugated single-walled carbon nanotubes (CNTs), on reproductive output in general and milt release in particular in Clarias magur. The oxidized carboxylated SWCNT (COOH-SWCNT, 16nm diameter and 10µm in length) were coated with chitosan polymer. Chitosan-COOH-SWCNT (COOH-SWCNT-CS) nanohybrids were characterized by FTIR, TGA, Raman spectroscopy, FEG-SEM, TEM and EDS. To evaluate the toxicity of COOH-SWCNT-CS and COOH-SWCNT, Micronuclei test of blood cells, comet assay of liver tissue and histological analysis of liver and kidney tissues were conducted with different doses, 0.05mg/ml, 0.1mg/ml, 0.5mg/ml, 1mg/ml, 5mg/ml and 10mg/ml. Fish receiving COOH-SWCNT developed more micronuclei and DNA damage than in COOH-SWCNT-CS treatments. Histological observations revealed severe liver cell damage at higher concentrations of COOH-SWCNT. However, kidney tissue remained unaffected in all treatment groups.

To study the effect of nonapeptides on the reproductive output of magur, chitosan-carbon nanotube-nonapeptides nanocomposites were developed abbreviated as COOH-SWCNTCSPeP.

Two experiments were conducted during the breeding season to study the effect of COOH-SWCNTCSPeP and COOH-SWCNTCSPePs on the milt release through stripping. Both naked and nonconjugated formulations were successful in stripping the male in both the experiments. The mRNA expression of selected reproductive genes i.e., 3βhsd, 17βhsd, Cyp17a1a, Cyp11a1a, StAR gene, LH and FSH in experiment 1 was analysed to decipher the effect of nanoformulations at the molecular level. Nonapeptide treatment resulted in the upregulation of the transcript level of genes observed. The mRNA expression was sustained for longer durations in the nanoconjugated groups compared to naked formulations. Histological analysis revealed the concentration of spermatozoa were more in peptide injected groups. Synergistic effects of nonapeptides and OvatideTM had a positive impact on GSI. Thus, the present formulations were successful in stripping the male catfish to obtain the milt with significant reproductive success.

In vitro Differentiation and Characterization of Fish Muscle and Optimization of Plant-based Scaffolding Towards Whole Cut Seafood Production

CIFE/2021/600/EF

Project duration: 2021- 2023

Principal Investigator
Dr. M. Goswami

Co-Principal Investigators
Dr. Reza Ovissi (Virginia Polytechnic Institute and State University (VT), USA)
Dr. Lexi Duscher (Virginia Polytechnic Institute and State University (VT), USA)

Budget : 33.37 lakhs

Funding Agency
Good Food Institute, USA.

An international project, in collaboration with Virginia Polytechnic Institute and State University (VT), USA with the financial support from Good Food Institute, USA, was developed to initiate work towards development of whole cut cultivated seafood for the first time in the country. During the first year, we achieved some significant results to lead cultivated seafood research. Healthy fingerlings of Labeo rohita (body weight: 15 to 20 g) were maintained at the Central Wet Laboratory, ICAR-CIFE, Mumbai. Prior to explant preparation, the donor fish were transported to the laboratory and processed for explant preparation. Once the cell started radiation, half of the medium was replaced with a spent medium in the culture flask. A continuous muscle cell line from Labeo rohita designated as LRM has been developed with 38 passages and maintained in the cell culture facility of the institute. The developed cell line was authenticated using DNA barcoding and other standard techniques.

To optimise the growth of the cell line, cells were tested with different concentrations of serum and growth factors with an aim to use the lowest possible serum concentration to maintain the cell line. Attempts are also being made to maintain the cell line in serum free conditions. The LRM cell line was tested for attachment to a 2D scaffold for proliferation. The LRM cells adhered to a 2D scaffold and attached cells were viable when stained with phalloidin. A 70-75 % revival rate was achieved when the LRM cells were cryopreserved. The cell line is being characterized for understanding myogenesis and adipogenesis which is crucial for cultivated seafood production. Myogenic gene expression studies were carried out. The expression of MEF2A, Mrf-4, MyoD was observed at different passage levels and the data is being analysed. In addition to Labeo rohita, attempt has been made to develop fish muscle cell bank from some commercially important fish and crustacean species like Clarias magur, Pangasianodon hypophthalmus, Channa striata, Lates calcerifer, Oreochromis niloticus and Scylla serrata to provide muscle cells required for cultivated seafood development in the country.

Significant Achievements :

- Development of a continuous muscle cell line (LRM) from *Labeo rohita*.
- Good Food Institute has recognised our cell culture facility as National Smart Protein Innovative Hub on Cultivated Seafood.

CIFE/2020/FBT003/SR

Development and Growth Optimization of Muscle Cell Culture from *Pangasianodon hypophthamus* (Sauvage,1878)

Himansu Shankar Nage

Major Advisor: Dr. Mukunda Goswami

Cell line has been used as an in vitro tool to carry out various research in life sciences. The fish cell has been established as a promising tool for studying many key issues of aquaculture covering fish growth, disease, reproduction, genetics, and biotechnology. The present study aimed to develop a cell culture system from muscle tissue of Pangasianodon hypophthalmus, which is an important candidate species for aquaculture as well as ornamental concerns. A cell culture system developed from the muscle tissue of P. hypophthalmus was designated as PHM. The primary culture was established from muscle tissue through the explantation method and successfully subcultured up to the 5th passage. The PHM cells were maintained in Leibovitz's- 15 medium supplemented with 10% FBS (Fetal Bovine Serum).

The live cells were examined through DAPI staining under a fluorescence microscope. The growth optimization of PHM cells was done at different incubation temperatures ranging from 20 to 32 ºC and FBS concentration from 5-15%. The maximum growth rate of PHM cells was recorded at 28 ºC temperature and 10% FBS. The doubling time and plating efficiency of PHM cells were evaluated and it was 40 h and 19% respectively. The PHM cells were characterized for species authentication using DNA barcoding. The sequence analysis reveals to confirm the species of origin. The PHM cell growth was examined in a 2D scaffold through counter staining of DAPI and Phalloidin. The PHM cells showed 70% revival ability after cryopreservation using the slow freezing method. The PHM cells would play an important tool in studying in vitro myogenesis for the production of cultured meat.

CIFE/2022/05/IF

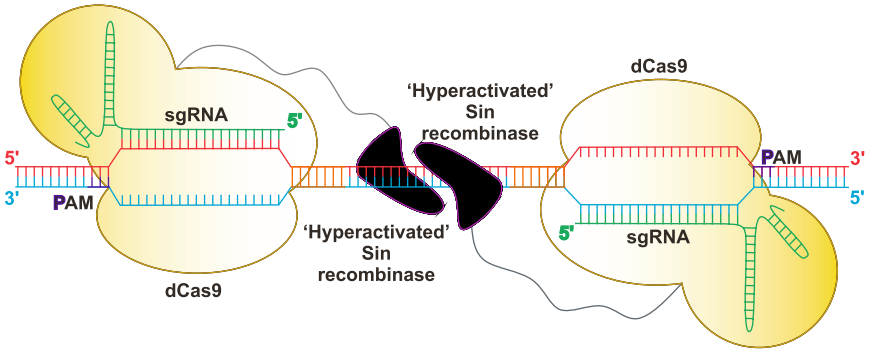
Evaluation of RNA-guided Recombinase (RGR) Platform for Cell-Independent and Safer Genome Engineering in Zebrafish Vertebrate Model

Project duration:2022- 2025

Principal Investigator
Dr. Arvind A. Sonwane

Co-Principal Investigators
Dr. Aparna Chaudhari
Dr. Manoj P. Brahmane
Dr. Mujahidkhan A. Pathan
Dr. Kiran D. Rasal

This project envisages use of a novel genome engineering platform, RNA-guided Recombinase (RGR) platform developed 'in-house'. It consists of a fusion protein of nuclease-null or dead Cas9 (dCas9) and 'hyperactivated' recombinase with relaxed target specificity. It is guided through a pair of guide RNAs (gRNAs) to its target. The genome targeting of this platform is through gRNA-dCas9 component and is programmable. The genome



engineering of this platform is recombinase action based, safer and cell-independent and through 'hyperactivated' recombinase component. The platform previously has been found to carry out precise targeted DNA integration at several pre-determined genomic loci in bovine genome in vitro in cultured cells. The advantages of the RGR platform are improved specificity, safety and its cell-independent nature.

The present project is to test the RGR platform in vivo in the zebrafish vertebrate model for targeted DNA integration as well as correction/creation of mutation(s). In this, the zebrafish genome has been searched for locations of the RGR platform target sites and found to have ~3 x 106 such sites (~1.2 x 105 sites/chromosome) throughout the genome. Currently, the platform components have been designed and constructed to target selective genes of commercial importance like myostatin, leptin and its receptor, etc.

CIFE/2020/FBT006/SR

Construction of RNA-Guided Recombinase (RGR) Platform Components for Targeted Transgenesis in Zebrafish

Pragati Padhan

Major Advisor: Dr. Arvind A. Sonwane

Zebrafish is a vertebrate model organism of choice and is commonly used as a reporter animal in biomedical studies. Identification/validation of permissive loci suitable for the generation of reliable reporter animals will be very useful. An in vivo-based methodology for the identification of multiple insertional loci suitable for the generation of reliable reporter animals in mice has been developed and several such loci including Enah-Srp9 intergenic region have been identified. The present study explored the suitability of the region orthologous to this in zebrafish for this purpose using RNA-guided recombinase (RGR) platform as a tool for targeted transgenesis. RGR platform is made-up by fusing 'hyperactivated' recombinase with relaxed target specificity with nuclease-null or dead Cas9 (dCas9) protein. RGR platform, with the help of a pair of guide RNA (gRNA) and dCas9 identifies the targets in transgene DNA and genomic DNA and hyperactivated recombinase recombines them resulting in targeted transgenesis.

The target site for the RGR platform (Sin RGR) the present study has selected has a typical structure of 5'-CCN(74)GG-3' and being dimeric in nature requires a pair of gRNA that are expressed here through a multiplex gRNA expression system based on pSQT1313 vector. The components include i. RGR expression plasmid; ii. Donor DNA and iii. Plasmid expressing a pair of gRNA. The zebrafish Enah-Srp9 intergenic region was screened for the presence of 5'-CCN(74)GG-3' RGR target sites and a total of 5 different such sites were located. Further, a small region containing one of the sites was amplified and inserted in the pCG vector to construct the donor DNA. The gRNAs were designed to target the selected RGR target site and a multiplex gRNA expression plasmid based on the pSQT1313 system was constructed. The constructed recombinant plasmids were confirmed through colony PCR and Sanger DNA sequencing. These RGR components including RGR expression plasmid can be used for RGR-mediated targeted transgenesis in zebrafish embryos and testing the suitability of the selected locus as a novel 'permissive locus' for the generation of reporter zebrafish in future.

Identification of Epigenetic Markers Associated with Growth Performance in *Clarias magur* (Hamilton, 1822)

CIFE/2021/02/IF

Project duration:2021- 2024

Principal Investigator
Dr. Kiran D. Rasal

Co-Principal Investigators
Dr. Aparna Chaudhari
Dr. Manoj P. Brahmane
Dr. Mujahidkhan A. Pathan
Dr. Dhalongsaih Reang

This study is intended to identify growth related epigenetic markers (DNA methylation pattern) in *Clarias magur* being selectively bred at ICAR-CIFE. The fin tissue samples (200 nos) were collected from five highest and five lowest magur families ranked according to breeding values at ICAR-CIFE Powarkheda Centre and ICAR-CIFE Kakinada Centre. Methylome (bi-sulphite) sequencing by Illumina platform was done for five high growth and five low growth fish for high-throughput identification of global DNA methylation patterns. A total of 194 million clean reads were generated. Pre-processed, high quality reads were mapped against the Anabas genome and 83.44% reads were mapped uniquely. Methylation status with single-base resolution the methylcytosine (mC) sites were identified by scanning the whole genome. It was found that 111 sites and 390 sites were 100% methylated in high growth and low growth individuals, respectively. Further analysis is being carried out.

Development of SCAR & PCR RFLP Based Strategies for Identification of *Clarias magur* and *Clarias gariepinus* Hybrid

CIFE/2020/FBT004/SR

Limbola Maharshi Lakhabhai

Major Advisor: Dr Aparna Chaudhari

Traditionally *C. magur* was identified based on its morphological characteristics, but the presence of the invasive C. gariepinus as well as the natural and intentional hybrids have made identification challenging. DNA barcodes were found to be of limited use. It is now well recognized that interspecific hybrids can cause genetic introgression and threaten the genetic stability of the pure parental species. The present study was undertaken to develop SCAR and RFLP based strategies for the efficient identification of C. magur and C. gariepinus and their hybrids. In continuation of previous studies, RAPD profiles were generated with OPC-01, OPC-04, OPC-05, OPH-08 and Ran-06 primers. The 10 selected diagnostic RAPD bands were TA cloned into pTZ57R/T vector and commercially sequenced using the universal m13 F and R primers. The sequences showed no significant homology with any reported sequences in NCBI, and were used to develop specific SCAR primer sets.

Two sets of primers were then selected such that the gDNA of each species generates one band each in a multiplex PCR, while both bands are amplified in the hybrid. Seven such multiplex primer sets have been tested here and seen to produce diagnostic agarose gel profiles. The six different magur – gariepinus band combinations were M513 – G319 bp; M513 – G784 bp; M449 – G784 bp, M413 - G319 bp; M449 – G319 bp; and M413 - G784 bp. One multiplex PCR was done with 3 primer sets that amplified one band of 513 bp in magur and two bands of 319 and 784 bp in gariepinus. All the 3 bands could be seen in the hybrid. Nuclear α-tropomyosin genes of C. magur (554 bp) and C. gariepinus (573 bp) were already sequenced. The same PCR primers were used to amplify ~ 1 Kb sequence from the parental species and the hybrid. Clustal alignment showed near complete identity of the hybrid with magur (99.61%), which was 90.33% for magur & gariepinus and 89.92% for gariepinus and hybrid. RE PvuII produced 2 bands (393 and 575 bp) for magur, and 3 bands (187, 416, and 449 bp) for gariepinus. RE digestion with MscI did not cut magur sequence, and produced 2 bands (850 and 202 bp) for gariepinus. Both the hybrids had the same pattern as magur, so this can

identify only *C. gariepinus*. This study reports seven multiplex PCRs that generate diagnostic amplicons for identification of *C. magur, C. gariepinus* and their hybrid. These will need to be further screened on a large scale to be developed into a single diagnostic test for species identification.

(CIFE/2016/FBT601/SR)

Identification of Growth Associated SNPs in *Clarias magur* (Hamilton, 1822) using RNA-Sequencing

Chandan Haldar

Major Advisor: Dr. Aparna Chaudhari

Marker assisted selection and genomic selection can support selective breeding programmes by permitting selection at early stages of growth. NGS technologies enable use of SNPs as effective markers for genomic selection and explain 90% of the genetic differences between individuals. A genetic selection programme for improved body weight of magur is currently underway at CIFE, and 5 high and 5 low body weight (B.W.) brooder pairs were selected with average B.W. of 278±21 g and 201±10 g, and bred to produce F1 generation. Tissues (brain, gonad, kidney, liver and muscle) were collected from the selected parents and 10 offspring each. Equal quantities of tissues from each specimen were pooled and cDNA was prepared from total RNA. Finally, cDNAs of each family were pooled in equimolar quantities and barcoded separately. The ten barcoded paired-end cDNA libraries were sequenced on Illumina MiSeq platform. A total of 9 GB transcriptome data with 78.96 million high-quality reads was obtained.

De novo transcriptome assembly resulted in 52,237 contigs with an average length of 917 bp and N50 length of 1330 bp. Sequences of 27 full length and 23 partial growth related genes were obtained. A total of 38,519 SNPs were mined from RNASeq1 of which 19,849 were validated using HRM and transcriptome resequencing approach (RNASeq2). Growth association revealed 634 and 739 SNPs to be associated with high and low growth, respectively. 157 genes were associated with high growth (HG) in both RNASeq1 & 2. One myoglobin gene was uniquely expressed in HG fish and multiple copies are present in magur. Cathepsin L, IGF II, and IGFALS genes showed significantly higher expression in the HG group, 52, 3.5, and 2.1-fold. Genotype information was retrieved at 48 SNP loci in 40 contigs of 44 extreme growth performing individuals (22 highest and 22 lowest) of F2 generation. Thirteen growth-associated SNPs were identified with differential allele frequency >0.25 and the genotype frequencies were in Hardy Weinberg equilibrium. Out of these, 7 SNPs were located in the UTR region, and 6 were in the coding region, of which only 1 in TRIP11 gene was non-synonymous. Four synonymous SNPs were predicted to alter codon preference, and 3 major alleles associated with HG were the preferred codon. The major allele in trip11.1947G>A SNP (Val to Met) was associated with low B.W., and the minor allele present in high B.W. fish is predicted to increase protein stability. Finally, 157 genes and 634 SNPs associated with high B.W. have been found that can be used as markers in the selective breeding programme.

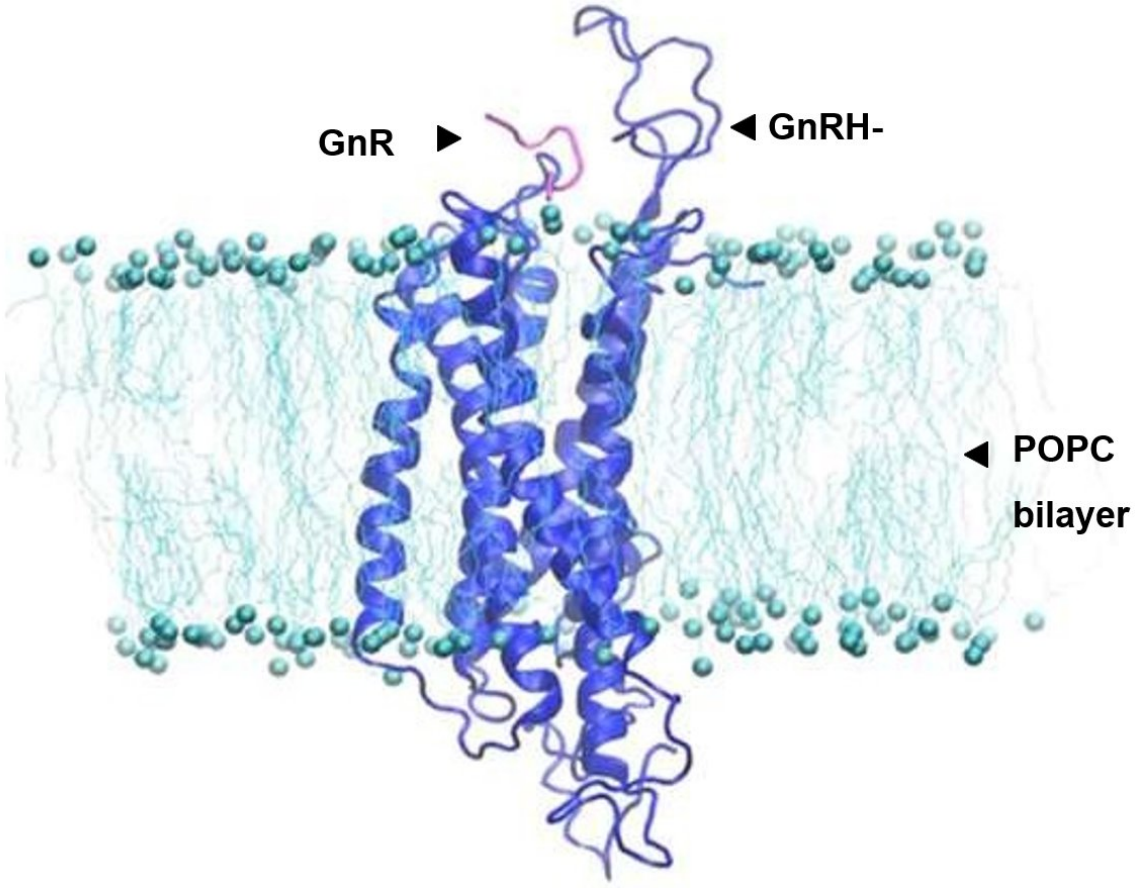
CIFE/ 2015/FBT503/SR

Studies on GnRH-Receptor Interaction in *Clarias magur*

Mukesh Kumar

Major Advisor: Dr. M. Goswami

Induced breeding in Magur is encumbered by the non-release of milt by magur males on being injected with commercially available gonadotropin releasing hormone (GnRH) analogues. In this study, full open reading frame



sequences of *C. magur* gonadotropin releasing hormone receptors GnRH-R1 (1137 bp) and R2 (1125 bp) were generated. Comparative studies on the catfish GnRH (cfGnRH) with other vertebrates showed variation at amino acid positions 5, 7 and 8 of the decapeptide. The effect of amino acid substitutions at these positions was investigated in silico in terms of ligand – receptor (GnRH-R1) affinity by docking using Haddock server, and the stability of binding was tested by molecular dynamics simulation using GROMACS 5.0. Gly6 (L-form) was replaced with Gly6 (D-form) to enhance peptide stability in vivo. The order of binding energy of the ligands was modified catfish (cfm) GnRH > chicken (c) GnRH II > chicken (c) GnRH I > salmon (s)GnRH > catfish (cf)GnRH. For in vitro studies, HEK cells were transfected with the expression construct of C. magur receptor GnRH-R1 at 27% transfection efficiency and the order of ligand binding was determined by inositol-phosphate assay.

This was cfmGnRH> CPE (crude chicken pituitary extract) > Buserelin (LHRH agonist) > Ovatide (sGnRH). For GnRH-R2, the binding order in HEK cells was CPE > Ovatide > cfmGnRH> Buserelin. In vivo studies were carried out by inducing magur breeding with cfmGnRH, sGnRH and Buserelin. cfmGnRH enhanced the absolute fecundity of magur females, at the dose 20 g Kg-1 B.W. In conclusion, this work reports the full length sequences and characterisation of C. magur GnRH receptors 1 and 2 that belong to Type II class. This work also resulted in a novel induced breeding agent for magur, the modified catfish GnRH that showed the best binding with magur GnRH- R1 in in silico, in vitro studies, and also resulted in ~36% increment in fecundity over the commercial analogue in vivo.

CIFE/2022/06/IF

Development of Reference DNA Mini-barcodes and High Resolution Melting (HRM) Profiles for Authentication of Fish Species in Processed Products

Twenty fish species were collected from the Indian Coast. The total genomic DNA was isolated and the mitochondrial cytochrome c oxidase subunit I was amplified and sequenced. The primers for mini-barcodes have been designed.

Project duration:2022- 2025

Principal Investigator
Dr. Annam Pavan Kumar

Co-Principal Investigators
Dr. Aparna Chaudhari
Dr. A.K. Jaiswar
Dr. Manjusha L.
Dr. Gireesh Babu (ICAR-NRCM)
Dr. Pankaj Kumar (ICAR-CIFT)

CIFE/2020/FGB007/SR

In silico Characterization of FSH and Associated Factors and Identification of the Putative Modulators in Selected Fish Species

Lalremruati

Major Advisor: Dr. Shrinivas Jahageerdar

Aquaculture is the fastest growing food sector supplying food and nutrition to humans. Several factors constrain aquaculture, and the primary concern is controlled breeding. Reproduction is the biological process in which an organism produces offspring and gives rise to young ones. In fish, Follicle Stimulating Hormone (FSH) plays a vital role in reproduction for the production of steroid hormones. FSH-α and FSH- β form a dimer that binds to the FSH receptor (FSHR) in the gonads. In the present study, twenty-five factors associated with FSH were annotated in twenty-one species. FSH-α, β, and FSHR of seven fish species, including African catfish and Magur were characterized. The proteins' primary, secondary, and tertiary structures were predicted by in-silico approaches, and the ligand binding sites were identified. Further, the putative modulators of the FSHR were identified.

The amino acid sequences of FSH- α, β, and FSHR of the seven fish species ranged from 116 to 118, 95 to 138, and 366 to 369, respectively. The conserved domain analysis of FSH- α showed that it belonged to Hormone_6 superfamilies (Glycoprotein hormone superfamilies), FSH-β to GHB-like superfamilies (Glycoprotein hormone beta chain), and the FSHR to LRR superfamilies (Leucine-rich repeat). Only the extracellular domain (ECD) of the FSHR was studied. The secondary structure analysis showed the presence of a high percent of random coils followed by alpha-helix and beta-turn in all three proteins. The tertiary structure of FSH- α and FSHR was predicted by homology modelling, and that of FSH- β by hybrid modelling approach. The human FSH crystal structure (PDB ID- 4ay9) was used as the template for the protein structure prediction. The validation of tertiary structures was carried out by PROCHECK and ERRAT, and the results suggested that the predicted structures were accurate. Docking and Molecular Dynamic simulation revealed that the dihydropyridine derivatives, i.e., 2-Oxo-1,2-dihydropyridine-4-carboxylic acid methyl ester (PubChem ID- 223838161), is capable of causing structural conformational changes in the magur FSH-FSHR complex and thus can act as a putative modulator of fish FSH.

CIFE/2017/FBT704/SR

Sequencing and Characterization of Coding Regions of Selected Genes of the Steroidogenic Pathway of *Channa striata* (Bloch, 1793)

Darshiny M. P.

Major Advisor: Dr. Aparna Chaudhari

The major constraints in the induced breeding of this species are the difficulties in the extraction of milt by stripping and assessing the gonadal maturity stages of the male. The sequence information on the reproduction-related genes of this species was not available, and hence this work was carried out to obtain the coding sequences of five genes of the steroidogenic pathway of *C. striata* which could help find solutions using molecular tools. Steroidogenesis is the synthesis of biologically active steroids which are involved in gonadal development, growth, and maturation. The five selected genes of this pathway were steroidogenic acute regulatory protein (star), cytochrome P45017 (cyp17), cytochrome P450 aromatase (cyp19a), 3 beta-hydroxysteroid dehydrogenase (hsd3b), hydroxysteroid 17-beta dehydrogenase (hsd17b) and the lengths of the coding sequences generated are 534, 507, 504, 450 & 535, respectively. The primers for these genes designed using the global transcriptomic data of *C. argus*, a closely related species, were all located entirely in the open reading frame. The sequences were quality checked with BioEdit software and NCBI BLASTn homology search revealed high similarities with other members of the Channidae family.

Expected conserved domains were also present in the predicted proteins, the Rossmann-fold NAD(P)(+)-binding domain characteristic to SDR family genes in 3β-hsd (between 2-147 a.a.) and in 17β-hsd (between 1-178 a.a.). The SRPBCC lipid binding domain belonging to START domain superfamily was present in the StAR protein (between 59-178 a.a). This partial sequence information can be used to generate the full-length sequences for complete molecular characterization and for expression studies, which would provide detailed insight into their regulation at various stages of maturity. This could lead to a biomarker profile that indicates the correct stage of testicular development in *C. striata*, as this is currently a major hurdle in the success of induced breeding of this species.

CIFE/2020/FBT008/SR

Molecular Characterization of Selected Genes in Hypophyseal Axis of *Channa striata* (Bloch, 1793)

Prachi Dattatraya Asgolkar

Major Advisor: Dr. Kiran D. Rasal

Although seed production technologies using induce breeding are standardized, asynchronous maturation of murrels create serious concerns during the breeding season. Thus, understanding of the reproductive biology of murrel is pre-requisite for developing strategies for up-scaling the seed production. This study attempted to identify coding sequences of hypophyseal-axis genes associated with reproduction

in *C. striata*. Available high-throughput sequence data of *Channa argus* were used for designing primers for selected genes such as dopamine receptor (DR), gonadotropin-releasing hormone (GnRH), luteinizing hormone (LH), luteinizing hormone receptor (LHR), and follicle-stimulating hormone receptor (FSHR), etc. A total RNA was isolated from brain tissues of mature snakehead murrel and further cDNA were prepared. The amplification of DR exhibited cDNA of 550 bp size which encodes 180 amino acids (aa). The deduced aa sequence of DR of murrel revealed the presence of seven transmembrane (7-TM) G-protein couple receptor (G-PCR) and phylogenetic analysis depicted close association with *Channa spp*. RACE-PCR of GnRH in snakehead murrel resulted 275 bp size of cDNA which encodes 90 aa and deduced aa sequence revealed sequence similarity with salmonids and other catfishes.

This study has identified the presence of salmon type GnRH (sGnRH) decapeptide sequence viz., pGlu-His-Trp-Ser-Tyr-Gly-Trp-Leu-Pro-Gly, which is conserved across teleost's. In addition to these, GnRH amplified sequence also consists of the cleavage site (Gly-Lys-Arg) and a 30 amino acid associated peptide (GAP) regions. PCR amplification of FSH resulted in a cDNA of 500 bp which encodes 150 aa and conserved domain search analysis revealed the presence of glycoprotein hormone β-chain homologues belonging to cystine knot superfamily. Amplification for FSHR and LHR showed a coding sequence of 450 bp which encodes 140 aa and 250 bp which encodes 85 aa, respectively. The deduced sequence of FSHR exhibited presence of 7-TM receptor domain, which is included in rhodopsin receptor subfamily of G-PCR. Computational analysis revealed that the FSH, FSHR, and LHR sequence had 75-96% similarity with Channa species and other catfish. The present study has identified the partial coding sequences of DR, GnRH, FSH, FSHR and LHR of *C. striata*. This sequence information could be useful for delineating full length coding regions and regulatory elements. The availability of sequence information for those reproduction related genes could be useful for understanding maturation and reproduction processes in *C. striata*.

Molecular Characterization of Nematode Parasite Infecting Fish of Barvi Reservoir, Maharashtra

CIFE/2019/FBT908/SR

Gowhar Iqbal

Major Advisor: Dr. A. Pavan Kumar

Accurate identification of parasites of fish is essential to formulate the preventive strategies and to study the host-environment relations. The present study characterized the nematode parasites of the fishes caught from the Barvi reservoir using the nuclear 18S rDNA (SSU) sequence. The nuclear 18S rDNA (SSU) was amplified into two overlapping amplicons and sequenced to identify the species based on the sequence similarity with the NCBI GenBank database.

The sequences (both the fragments) showed 98% similarity with the species of Eustrongylides. The average genetic distance value between the present study sample and species of Eustrongylides was 0.003. In the phylogenetic tree also, the sequence was clustered with the species of Eustrongylides with significant bootstrap values. This parasite has a complex life cycle involving two intermediate hosts: a paratenic and a definitive host. Fish is an intermediate host and the fish-eating birds are the final host for this species. Eustrongylides spp. has been recognized as a zoonotic parasite that may pose a public health risk to consumers. The agricultural runoff and eutrophication of water bodies are indirectly enhancing the oligochaete population in the water bodies facilitating the transfer of the parasite from one host to another. In conclusion, the present study identified the nematode parasite of the fish caught from the Barvi reservoir, as a species of Eustrongylides. The species level identification could not be possible due to the insufficient /lack of reference sequences in the database. It indicates the knowledge gap with respect to the species-specific molecular markers for nematode parasites of the fish.

CIFE/2016/FBT602/SR

Large Scale Production and Pre-Clinical Toxicity Trials on WSSV DNA Vaccine

Ubaid Qayoom

Major Advisor: Dr. Aparna Chaudhari

The present study reports an effective and biosafe vaccination strategy to be administered in shrimp at hatcheries before distribution to grow-out ponds. Biosafety is an important concern associated with the use of DNA vaccines and a decontamination procedure is also reported that can be best regulated at hatcheries. Nanoparticles of pharmaceutical grade chitosan conjugated with the vaccine construct were formulated and the mean size was 5.6 nm with 99.09% particles sized <105 nm. P. vannamei PL were vaccinated by immersing in a minimum volume of vaccine solution at the dose 10 µg/g shrimp BW for 30 min with constant aeration. WSSV challenge through the immersion route was optimized and it was seen that only PL >50 mg were susceptible.

Vaccinated PL showed >70% relative percent survival compared to controls. And the protection lasted at least 60 days, the most extended period tested so far. At Day 75 post-vaccination 4053 copies/100 ng gDNA were detected indicating that the shrimp are likely to be protected through the culture period. Further, lab and commercial use of recombinant DNA vaccines is stringently regulated, and reproducibility of upscaled processes, purity and stability of the product, results of pre-clinical trials in mammals and biosafe procedures are considered by the regulatory authorities before granting permission for field trials. Upstream and downstream processes were developed for fermenter scale production of the plasmid vaccine in collaboration with the ICT-DBT Bioenergy Resource Centre, Mumbai. Among the 3 media tested, M2 (defined medium with glycerol) performed best. At the fermenter scale (3 L), the plasmid volumetric yield and specific yield of ~7.67 mg/L and ~0.0018 g/g dry cell weight were obtained with 448.04 ± 69.57 plasmid copies per cell. Downstream processes, including alkaline lysis, primary purification by salt precipitation and tangential flow filtration, reduced RNA and other contaminant levels with no significant plasmid loss.

A single anion exchange chromatography step was used as a polishing step. An overall recovery of 75.49% plasmid was achieved. The preclinical trials were performed in rodents with the upscaled product formulated into chitosan conjugated nanoparticles in collaboration with ICMR-NIRRH, Mumbai. No acute toxicity or genotoxicity was detected. No significant changes were observed in haematological and biochemical profiles upon exposure to various vaccine doses. Comet assay and micronucleus test showed no signs of genotoxicity in the vaccinated animals. A patent application has been filed for this formulation that works in prophylactic and therapeutic modes and protects Penaeid spp against WSSV.

CIFE/2015/FBT501/SR

Studies on White Spot Virus Entry Mechanism in *Penaeus monodon* (Fabricius, 1798)

Gulshan Kumar

Major Advisor: Dr. Aparna Chaudhari

White spot virus (WSV) that causes white spot disease in shrimp results in huge economic losses. Till today, there is no specific cure for this disease. Several shrimp proteins have been reported to act as receptors for WSV but none confirmed with gain of function experiments. In this study, a complementary DNA (cDNA) expression library was constructed from P. monodon gill total RNA using a technique called

Switching Mechanism at 5‘ end of the RNA Transcript (SMART) to identify WSV receptors through gain of function approach. Totally, 230 colonies were obtained from the S-fraction (500 bp - 1 Kb) and only 2 from the L-fraction (1-3 Kb). The recombination frequency and average insert size were 62% and ~360 bp respectively. Since, the quality of the cDNA library was unsatisfactory for further work, a candidate gene approach was applied. Four candidate WSV receptors namely PmRab7, PmGLUT1, PmCTL (C-type lectin) and PmCRT (calreticulin) were transfected into a WSV nonpermissive cell line, SSN1 and virus permissiveness was tested by PCR amplification of viral vp28 gene after virus challenge. The gene was successfully amplified from untransfected and challenged Sf9 cells serving as positive control but not from SSN1. Thus, none of the candidate receptors were singly sufficient to make SSN1 cells permissive to WSV. Protein-protein docking was performed between VP28 trimer and the candidate receptors mentioned above to analyze the stability of complexes. The identified binding energy per unit of buried surface area of 8.46-11.82 cal mol-1 /Å2 is just enough to pay the entropic loss. Hence, it was concluded that none of these candidate receptors interacts with VP28. Atomistic molecular dynamic (MD) simulation of VP28 without its transmembrane domain performed in water at physiological pH showed multiple dissociation events of the trimer without major conformational changes. Free energy of dissociation values show that VP28 trimer is eight times less stable than the structurally similar Class III baculovirus envelope glycoprotein gp64, and possibly adopts a unique fusion mechanism. This work suggests a high likelihood of co-involvement of more than one host receptors in mediating WSV entry.

Analysis of Muscle Transcriptome of *Labeo rohita* Exposed with Heat Stress

CIFE/2020/FBT005/SR

Pokanti Vinay Kumar

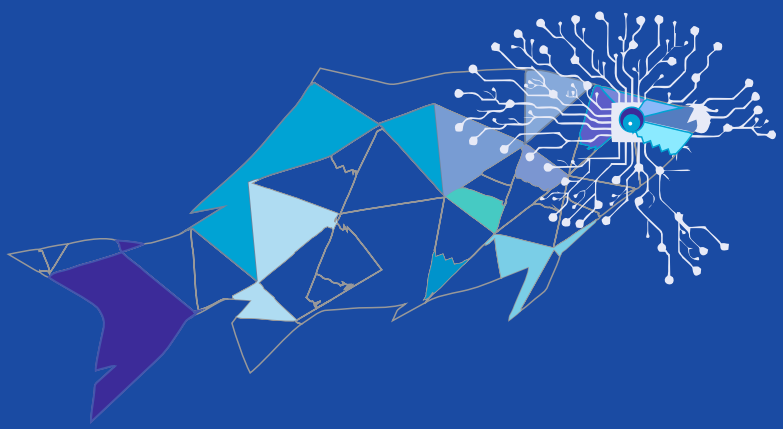
Major Advisor: Dr. Manoj Brahmane

Transcriptome data in rohu with response to heat stress was analyzed by using computational tools. Illumina pair-end sequencing resulted in 125 Gb of raw data and further reads were filtered and trimmed, which resulted in 484 million quality reads. Reference-based assembly of reads was performed using Labeo rohita genome (ASM412021v1) and a total of 90.17% of reads were successfully mapped. A total of 37,462 contigs were assembled with N50 of 1854 using the reference genome. The differential expression analysis revealed a total of 107 transcripts (15 up-regulated, 37 down-regulated, and 55 neutrally-regulated) were found to be differentially expressed (DEGs) as compared to the control group (Log2FC>2, p<0.05). Gene enrichment analysis of DEGs indicates that transcripts were associated with molecular function categories such as ATP binding, protein folding, metal ion binding, DNA and tRohu, Labeo rohita is one of the most important candidate species in aquaculture due to its taste and public preference. Recently rohu aquaculture facing serious concerns due to an increase in feed cost, diseases, unavailability of quality seeds and climate change, etc. The feeding and breeding biology of rohu is well-studied, but the physiological responses to stress or climate change at the molecular level are less understood. Thus, the temperature is one of the important abiotic stress factors which affect fish physiology as well as its growth. Currently, next-generation sequencing approaches are immensely utilized for understanding biological questions in several organisms. The recently published draft genome of rohu opens an avenue to study the biology of carp more precisely. In the present study, generated muscle transcription factor binding, etc. Biological categories were also identified, such as fatty acid biosynthesis, transcription regulator complex, lipid metabolic process, etc.

Key differentially expressed transcripts such as All-trans-retinol 13-14 reductase, serpin1, acyl-desaturase like protein, myozenin, glucose 6-phosphatase, and transcription factors such as histocompatibility a beta chain, protocadherin fat 4, PGC-1 and ERR induced regulator, etc were identified in muscle tissue of rohu in response to high temperature. The randomly selected differentially expressed transcripts were validated by RT-qPCR and found consistent expression

patterns of the selected transcripts with the RNA-Seq data. This study identified the key biomarker SERPINH1, which showed significant up-regulation (2 to 3-fold) in heat-treated muscle tissue of rohu. This study suggested a few transcripts linked with thermal adaptation and their regulations in muscle tissues for maintaining homeostasis. This work generated valuable transcriptome data of muscle tissue of rohu, which will be used for further investigation of their association with thermal/cold stress. This will be further helpful for the identification of stress-responsive biomarkers linked with thermal adaptations in the farmed carps.

3.7 Aquatic Environment Management



Study on the Occurrence, Impact on Biotic Communities and Development of Integrated Technologies for Remediation of Emerging Pollutant Triclosan

(CIFE/2021/700/EF)

Project duration: 2021- 2024

Principal Investigator
Dr. Kundan Kumar

Co-Principal Investigators
Dr. S. P. Shukla
Dr. Saurav Kumar

Budget
64 Lakhs

Funding agency:
Department of Science and Technology, New Delhi

Triclosan (TCS) is a widely used pharmaceutically active chemical that is regularly detected in treated wastewater and degraded aquatic environments. The study was taken up to investigate the toxicity of TCS on the freshwater algae *Chlorella vulgaris* and *Spirulina platensis*, both living and dead biomass, and how these algae might remove triclosan from light-exposed culture medium. The acute toxic (96-hour) effects of TCS on the common freshwater algae *C. vulgaris* and *S. platensis* were determined by detecting growth, pigments, and protein content. A significant decline in growth rate, pigments (chlorophyll a, chlorophyll b, and carotenoid), and protein content were recorded in TCS exposure concentrations ranging from 0.1 to 4 mg L^{-1}. In the present study, the 96h IC_{50} value for *C. vulgaris* was 1.493, while the *S. platensis* was 1.035 mg L^{-1}. The study revealed that TCS potentially be toxic to freshwater algae of aquatic ecosystems.

In the bioremediation study, the effect of contact time on TCS removal by *C. vulgaris* (live and dead biomass) with a concentration of 2 mg L^{-1} (72h- IC_{50}) was assessed by HPLC and the result displays maximum removal efficiency in the 6th hours. Based on contact time, the remediation experiment was conducted for six hours with five different concentrations of TCS (1, 2.5, 5, 10, and 20 mg L^{-1}) by *C. vulgaris* and *S. platensis* (live and dead biomass). Both algal biomasses demonstrated varying degrees of efficacy. *C. vulgaris* live algae biomass showed a removal rate of 85 percent when exposed to 1 mg L^{-1} of TCS, whereas *S. platensis* live algae biomass showed a removal rate of 76.5 percent. However, at higher TCS concentrations (20 mg L^{-1}), *C. vulgaris* and *S. platensis* have removal efficiencies of 36.9% and 31.1%, respectively, for live biomass. The results revealed that the TCS removal efficiency decreased with an increase in TCS concentration. *C. vulgaris* dead biomass removal efficiency of TCS was 69.62%, and *S. platensis* was 66.95% at the concentration of 1 mg L^{-1} of TCS. According to the study conducted, removal potential was more for live algae than the dead algae, and *C. vulgaris* has more removal efficiency than *S. platensis*. The study provides baseline information and data to overcome the lack of efficient removal technologies based on live and dead algae biomass for TCS removal.

Evaluation of Oxidase Enzyme (Laccase)-Mediated Triclosan Degradation in Water and its Effect on Aquatic Organisms

(CIFE/2020/AEM007/SR)

Shilpa Pradeep

Major Advisor: Dr. Saurav Kumar

Triclosan (TCS) is a broad-spectrum antibiotic which falls under the category of emerging contaminants and has proven toxic to various aquatic organisms. The present study aims to estimate the optimum conditions of pH, temperature and concentration of laccase enzyme needed to achieve the maximized degradation of triclosan and to evaluate the effects of this enzyme-mediated triclosan degraded water on aquatic organisms. Firstly, the laccase enzyme activity was demonstrated using ABTS, and time-dependent increased intensity of the colour (green ABTS radical cation (ABTS+)) was noticed. According to Lineweaver–Burk equation, the Vmax and Km were estimated as 11.37 µM min-1 and

0.44 mmol, respectively. Response surface methodology along with Box-Behnken design was used to find the optimum values of these variables. The pH, temperature and laccase concentration combinations 5, 30°C, 1 U/mL and 5, 40°C, 0.625 U/mL, gave a significantly higher percentage of degradation efficiency 90.64% and 98.72% respectively. After analyzing the concentration of residual TCS in the 17 experiments using RSM, the best combination chosen for the final experiment was pH 4.93, temperature 39.77 and laccase concentration of 0.912 U/mL giving a percentage degradation efficiency of 96.56%. Bioassay studies were conducted in *Chlorella vulgaris* and P*angasianodon hypophthalmus* (striped catfish) to evaluate the effects of laccase-treated triclosan solution. The percentage inhibition (12%) in algal cell counts was significantly less in the group exposed to TCS treated with enzyme compared to the group exposed to TCS alone (44%). In addition, the catalase activity in gills and liver tissues in the treatment group exposed to enzyme-treated TCS was significantly lower than the one exposed to TCS alone. However, the SOD activity in the treatment group exposed to enzyme-treated TCS was significantly higher than in the treatment group exposed to TCS alone. The results of the present study reveal that the most significant factor affecting the laccase-mediated TCS degradation is pH, followed by temperature, and the concentration of the laccase enzyme has limited influence and the laccase-mediated TCS degradation could reduce the endpoint toxicity of TCS to aquatic organisms.

A Study on Occurrence and Environmental Risk of Triclosan in Selected Water Bodies of Mumbai

(CIFE/2020/AEM002/SR)

Ganesh Kumar T

Major Advisor: Dr. Saurav Kumar

Triclosan (TCS) [5-chloro-2-(2, 4-dichloro phenoxy) phenol] is a broad-spectrum antibacterial biocide used widely in pharmaceutical and personal care products. It is detected in water and sediment matrices of the different aquatic systems and harms the aquatic organism. In the present study, the occurrence of triclosan was estimated from the water, sediment and organism in Versova creek and Mithi river of Mumbai using an isocratic reversed-phase HPLC. A sensitive and specific detection method for quantification of TCS in the water, sediment and organism was developed and validated according to ICH guidelines. The method was linearized (0.1-16 mg/L) and the regression equation obtained y = 12.175x+0.654 (R2 =0.9994) with LOD and LOQ of 0.109 and 0.332 mg/L respectively. The estimated mean concentrations of triclosan for five-month samplings in Mithi river (water: 0.72 mg/L, sediment: 1.22 mg/kg and organism: 0.33 mg/kg) were found to be higher than Versova creek (water: 0.27 mg/L, sediment: 0.31 mg/kg and organism: 0.21 mg/kg). Pearson correlation and principal component analysis were used to predict the correlation of TCS concentrations to various physiochemical parameters showing a strong correlation between COD (r=0.87) and TOC (r=0.46). The environmental risk of TCS in Versova creek and Mithi river in terms of risk quotients (RQs) for different aquatic model organisms was estimated and results denoted the high risk of TCS (RQ >1) in both the aquatic environment. The bioaccumulation factor (BAF) was calculated based on the TCS level detected in water and sediment to organisms of respective aquatic bodies. In both the sampling site, the values BAFW >1 indicate TCS is bioaccumulative in organisms (*Conus* sp. and *Eichhornia* sp.). The present study generates the baseline information of occurrence of TCS in two distinct aquatic systems and it greatly helps in suggesting the management strategies to limit and regulate the triclosan in different products in daily use.

Assessment and Management of Priority Abiotic and Biotic Stresses in Aquaculture Production Systems of selected districts of Bihar and Jharkhand

(CIFE/2020/005/IF)

Project duration: 2020- 2023

Principal Investigator
Dr. Kishore Kumar Krishnani

Co-Principal Investigators
Dr. Arpita Sharma
Dr. Swadesh Prakash
Dr. Md Aklakur
Dr. Saurav Kumar
Dr. Kapil Sukhdhane

Survey was conducted in various villages of Muzaffarpur and Samastipur districts in Bihar, and Ranchi and Hazaribagh districts in Jharkhand during March 2022 wherein 19-fish farms / ponds / forming clusters were selected based on the stocking density / intensification (Extensive / Semi-intensive / Intensive culture / biofloc / enclosure systems), cultured fish species, existing farming practices (diversification) with the prevalence of pathogens. Composite samples were collected from the selected fish farms and various physicochemical parameters were measured. The study examined bacterial diversity in the green slime/mucus of rohu, milkfish, pearl spot using metagenomics.

The study evaluated medicinal and aromatic plants (MAPs) for ammonia and nitrite removal as well as bactericidal activities. Identified micronutrients, functional moietics and bioactive compounds of MAPs using ICPMS, FTIR and LC-MS, respectively. Some of the MAPs were found to be effective in removing ammonia and nitrite. Aqueous extracts of some of the MAPs were bactericidal against *Aeromonas hydrophila, Edwardsiella tarda*, *Staphylococcus sp., E. coli,* and *Vibrio sp.* The study also evaluated bio-stimulating and stress alleviating effects of promising and microencapsulated medicinal and aromatic plants (MAPs), lignocellulosic porous materials (bagasse and *Luffa*) and electron donors on *Pangasius* and rohu. Abiotic stresses caused by ammonia and nitrite and biotic stresses have been mitigated by lignocellulosic-assisted bioremediation and MAPs singly and in combination with electron donors with the result of higher growth of fishes, which have been further supported by the determination of stress and growth parameters. Isolated & characterized environmentally important bacteria from aquaculture system under controlled conditions using 16S rRNA & FAME analysis. A NASS panel discussion on Climate Resilient Fisheries and Aquaculture in Maharashtra was also organised on 07-03-2022 at CIFE, Mumbai.

Study of the Green Slime Associated Bacteria of *Labeo Rohita* (Hamilton 1822) and its Effect on Physicochemical, Bacteriological and the Growth Parameters

CIFE/2020/AQC004/SR

Divya Mehta

Major Advisor: Dr. Kishor Kumar Krishnani

A 90 days experiment was conducted to evaluate the physicochemical, bacteriological, oxidative stress, and growth performance of *Labeo rohita* in integrated mucus-hydrocolloidal-based bioremediation system developed by coupling fish green slime with different electron donors namely xanthan gum powder (ED1) and sweet potato powder (ED2) at different stocking densities. Rohu fingerlings (7.15 ± 0.05 g) were stocked in six different treatments following a 2×3 factorial design with two different stocking densities of 80 nos m-3 (T1, T2, T3) and 160 nos m-3 (T4, T5, T6) . Two electron donors ED1 and ED2 were supplemented in T2, T5, and T3, T6 respectively. T1 and T4 groups served as a control where no electron donor was supplemented. Among the treatments, the highest average body weight, average daily gain, specific growth rate, percentage weight gain and feed efficiency ratio were found in T3 treatment.

However, the total plate count (2.6×106 CFU ml-1) and nitrogenous waste removal efficiency i.e., TAN (97.6%) and Nitrite-N (99.99%) were found to be the highest in the T6 treatment while T5 treatment stands second. Maturation of bacterial biomass in the respective treatments was found to be the major mechanism behind TAN and nitrite-N mitigation while bio-stimulatory effects of electron donors were the underlying reason behind the maturation. Additionally, the highest level of catalase and SOD was observed in gill, muscle and liver of T1 and T4 treatments than other experimental groups which are indicative of stress aggravated to the culture organisms. The system with low stocking density coupled with sweet potato powder group had the maximum growth, whereas high stocking density group combined with sweet potato powder were most successful at removing nitrogenous contaminants. From this experiment promising probiotic bacteria have been isolated and identified as *Bacillus* spp. based on 16S rDNA and FAME approaches. This new innovative system has been coined as an integrated mucus-hydrocolloidal-based bioremediation system. This has future potential applications in species diversification and climate resilient aquaculture.

Analysis of the Antagonistic Potential of Green Slime Bacteria of Euryhaline Fish, *Etroplus Suratensis* (Bloch, 1970) in Freshwater

CIFE/2020/AQC012/SR

Treasa Merin Pious

Major Advisor: Dr. Kishor Kumar Krishnani

In the present investigation on the development of slime-hydrocolloidal based biostimulation system reared with euryhaline Pearl spot (*Etroplus suratensis*) in freshwater, two different biostimulators namely guar gum powder and tapioca flour, were used in two different stocking densities of Pearl spot culture to produce greenwater and to understand its effect on detoxification of the total ammonia nitrogen (TAN) and Nitrite-nitrogen from the system and its antagonistic effect against pathogenic bacteria. The study revealed that biostimulator supplementation could help enhance the growth of fish and can increase the rate of ammonia and nitrite removal from the culture system. Ion chromatography of water samples was done to get a more accurate picture of the carbon contents including inorganic C and total organic C fractions in the system. The microalgae present in the culture water were collected and observed for enumeration and identification. Mucus was collected from the fish to understand its composition and bacterial isolation. Alkali metal, alkali earth metal, micronutrient, and heavy metal composition of freshwater and brackish water fish mucus were compared and studied. Various physico-chemical and bacteriological parameters were found to be within optimum ranges.

Several bacteria, including a novel bacterium of *Bacillus* sp. were isolated for their promising antagonistic effect against pathogenic bacteria and ammonia tolerance. Of the 30 isolates, 11 bacteria and the mucus pellet and supernatant of some of the bacterial isolates showed antagonistic potential against several freshwater and brackish water pathogenic bacteria. By the findings of this study, among the products used as biostimulators, tapioca powder was more efficient than guar gum with better performance in terms of removal of ammonia and nitrite, physicochemical, bacteriological and growth parameters. Additionally, it has the potential to support stocking density as high as 80 no. m^{-3}. This study successfully demonstrated the

application of the slime-hydrocolloidal-based biostimulation system in the culture of pearlspot. Newly coined technology has future potential applications for achieving enhanced antagonism and diversification of pearlspot in freshwater and climate resilient aquaculture.

Low Cost Adsorbents for the Removal of Phosphate, Nitrate and Heavy Metals from Sewage-fed Aquaculture

CIFE/2021/03/IF

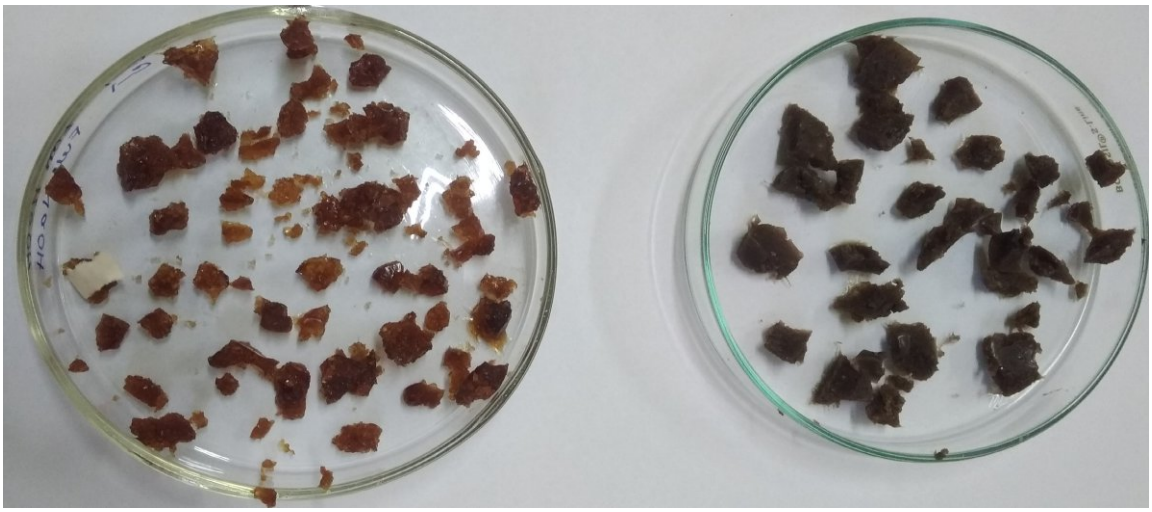
Project duration: 2021- 2023

Principal Investigator
Dr. Suman Manna

Co-Principal Investigators
Dr. Subhendu Datta
Dr. Sweta Pradhan
Dr. G.H. Pailan

Due to intensification in farming practices, a magnitude of chemicals and fertilizers are being used in both agriculture and aquaculture. Besides industrial effluents are dumped in the aquatic system where fish and other aquatic animals are cultured. Thus water quality and other environmental parameters are getting degraded day by day. In India, raw or partially treated sewage water is used for aquaculture practices, increasing the probability of disease occurrence. Farmers are reporting high mortality of fish which might be due to low dissolved oxygen and high ammonia content. Consumers' acceptance is also very poor for fish cultured in sewage water. Thus, purifying water with simple techniques like adsorption could be a possible method to address this problem. The study attempted to experiment with synthetic and natural adsorbents for the removal of pollutants like ammonia, nitrate, phosphate and heavy metals from sewage fed aquaculture.

Clay minerals like kaolnite, vermiculite, and bentonite are abundant in nature as deposits. These can be exploited for their functional properties in environment remediation due to their high surface area, high thermal stability, high cation exchange capacity, high water absorptivity etc. Bentonite was used as filler materials for the synthesis of superabsorbent polymer composites. The adsorbents were characterized for different physico-chemical parameters like water absorbency, functional group by FTIR spectroscopy, surface morphology by Scanning Electron Microscopy. FTIR analysis of clay based adsorbents showed different functional group like COO-, OH- etc. are present which are acting as potential adsorption sites. Removal ratio was calculated for some water quality parameters in sewage fed aquaculture. Removal ratio was higher for Adsorbent 1 and Adsorbent 2. Around 80-90% removal of phosphate and ammonia was achieved. Further study is continuing for validation of the result.



CIFE/2020/AEM008/SR

Toxicity and Microalgae Assisted Bioremediation of Benzophenone-3

Bhavana Dhawad

Major Advisor: Dr. Rathi Bhuvaneswari G

UV filters such as benzophenone-3 are used extensively in various personal care products (PCPs) and are recognized as the contaminant of emerging concern, finding their way into the environment via recreational activities and sewage discharge. But there is very scanty information about its ecotoxicological effect on aquatic organisms like microalgae. The present study was conducted to investigate the toxic effect of BP-3 on microalgae and to explore the bioremediation potential of *Chlorella vulgaris*. The acute toxicity experiment was conducted for a period of 96h following the OECD Guidelines 201 (OECD, 2011) at graded concentrations of BP-3, i.e., 0.01, 0.1, 0.5, 1, 3, 5 and 10 mg L-1 on the freshwater algae *C. vulgaris*. The result showed that growth was inhibited significantly at all the concentrations of BP-3. After 96h, the highest percent growth inhibition of 69.12% was observed at 10 mg L-1 BP-3 concentration. The 96h median inhibitory concentration (96h IC50) was found to be 3.09 mg L-1, revealing that BP-3 is toxic to aquatic organisms. Further, a study was conducted to investigate the efficacy of *C. vulgaris* for the biodegradation of BP-3. The biodegradation study was conducted for 10 days and the samples were analysed for BP-3 concentration at 2 days interval. The concentration of BP-3 (0.5, 1, 2 and 3 mg L-1) for the study was decided based on the result of the toxicity study (96h IC50). HPLC analysis revealed that the highest removal of 88.2% was achieved on the 10th day for the initial BP-3 concentration of 0.5 mg L-1 followed by 85.4% for 3 mg L-1 BP-3. Biodegradation (81.42%) was found to be the major removal process of BP-3, compared to bioaccumulation (1.40%), bioadsorption (2.30%), and abiotic removal (6%) during the experimental period. In the biodegradation process, benzophenone-1 (BP-1), one of the less toxic degraded products of BP-3 was identified as an intermediate metabolite. Overall, this research provides a better insight into the toxic effects of BP-3 on green alga and also provides a baseline information about the potential application of *C. vulgaris* for the bioremediation of BP-3 from contaminated wastewater.

CIFE/2020/AQC008/SR

Assessment of Chromium Toxicity on Growth and Physiological Responses of *Etroplus Suratensis* (Bloch 1790) Juveniles

Ramya V.

Major Advisor: Dr. Madhuri S. Pathak

The present study was conducted to assess the acute and chronic toxicity study of chromium (Cr) on growth and physiological responses of *Etroplus suratensis*, pearl spot. Acute toxicity test was conducted for 96hr with eight treatments of different Cr concentrations (30, 35, 40, 45, 50, 55, 60 and 65 ppm) and a control. Behavioral changes such as hyperactivity, loss of balance, excessive mucus secretion, and high rate of opercular activity were observed following the acute exposure. 96 hr LC50 value was found to be 41.83mg/l. Histological alterations in the gills and liver tissues were observed in all the treatments of acute toxicity tests. For chronic toxicity study, three sub lethal concentration of Cr such as one-tenth (4mg/l-T1), one-fifth (0.8mg/l-T2), one-hundredth (0.4mg/l-T3) and control (Without Cr) were chosen for 45 days exposure. During the chronic toxicity assay for 45 days exposure, significant reduction in average weight gain and specific growth rate was observed at 4 mg/l exposure.

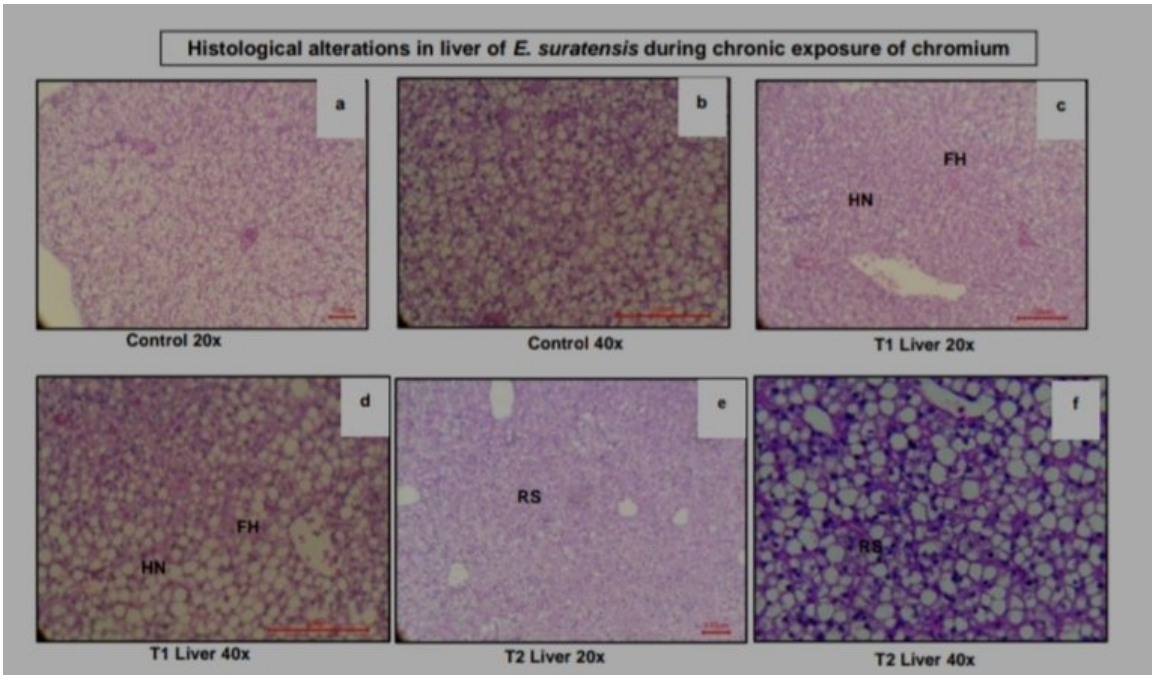


Figure 32: Histological alterations in the Liver of *E. suratensis* exposed to different chromium concentrations for 45 days. (a control 20x, b:control 40x, c: T1 20x,d: T1 40x,e: T2 20x,f:T2 40x)[RS- RBC scattered, FH- focal haemorrhage, HN- hypertrophied nucleus]

55

There was no effect on the survival of fish during chronic exposure. At the end of the experiment, significant changes in growth and physiological responses were observed. Significantly higher body weight, SGR, weight gain (%) was observed in control followed by T3 and T2. Additionally, antioxidant enzyme activities such as SOD and catalase in liver and gills, metabolic enzymes such as glucose, AST and ALT and myloperoxidase activity also were significantly higher at T1 followed by T2 and T3. Haematological parameters such as RBC, WBC, haemoglobin, haematocrit value, MCH also showed significantly lower values at T1 and T2 followed by T3. Histological alterations in gills and liver were observed with a degree of severity based on the sublethal concentrations of Cr, as the chromium concentration enhanced the degree of adverse effect on physiological parameters also increased. The findings of the present revealed that chromium content in freshwater should be less than 0.4 mg/l for *E. suratensis* farming.

Extraction, Purification and Applications of the Pigments from *Spirulina* (*Arthrospira*) *platensis*

CIFE/2020/AEM001/SR

Abhirami N.

Major Advisor: Dr. S. P. Shukla

The study aimed to assess the therapeutic and cosmetic role of the pigments extracted through downstream processing of commercially viable species *Spirulina platensis*. This includes the determination of octanol-water partition coefficient through the experimental shake flask method, evaluation of the photoprotective role of the pigments by estimating the in vitro Sun Protection Factor (SPF), and neuroprotective role by assessing the acetylcholinesterase inhibitory activity through both spectrophotometric and HPLC method. This was performed by culturing the biomass in the Schlösser medium where an appreciable growth was recorded accounting for 0.331 day-1 and a doubling time of 2.09 days. According to the dry weight versus wet weight curve, 13.9 percent of the weight of the wet biomass of *Spirulina platensis* is recovered after drying. According to the ICPMS analysis of the biomass, the

following heavy metals are present in concentrations (mg/kg (d.w)) ranging from 0.49 (Cr) to 0.468 (Cd), 0.0806 (Pb), 0.0771 (As), and 0.0247 (Hg). The biomass can hence be regarded as safe for therapeutic roles as the concentrations fall below the permissible limits.

The pigments phycocyanin, allophycocyanin, phycoerythrin, and carotenoids extracted from biomass showed considerable yield. The values recorded were; Phycocyanin (109.78 + 4.89 mg g-1 (dw)), Allophycocyanin (35.32 + 4.87 mg g-1 (dw)), Phycoerythrin (10.55 + 1.78 mg g-1 (dw)) and carotenoids 965.11 + 1.33 µg g-1 (dw)). The maximum total yield obtained was during the second freezing cycle i.e. 155.62 + 11.59 mg g-1 (dw). The log Kow values of phycocyanin (-0.42) and carotenoids (0.58) suggest the hydrophilic and hydrophobic nature indicating their lipid bilayer membrane transport characteristics. The photoprotective role of using multiple pigments is well understood from the SPF score 51.035 + 0.08c while using the combination of aloe vera: phycocyanin: carotenoids (1:1:1) rather than using phycocyanin alone with aloe vera base. Acetylcholinesterase inhibitory activity examined using HPLC and spectrophotometric method suggests the future prospects of using phycocyanin in cognitive impairments. The overall results provide evidence for the suitability of using extracted high purity pigments for use in therapeutic and cosmetic sectors.

Assessment of the Effect of Nanoplastics on selected Microalgae

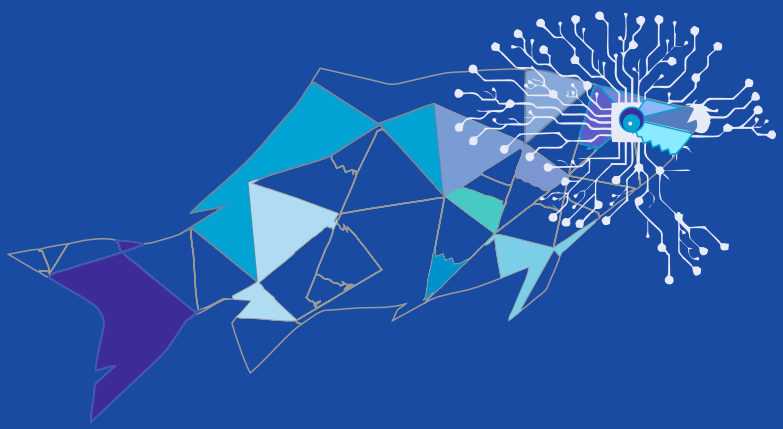
CIFE/2020/AEM004/SR

Pritam Sarkar

Major Advisor: Dr. Rathi Bhuvaneswari G.

Plastic litters are widespread in the aquatic environment. Larger plastics are fragmented into smaller pieces and form micro (<5 mm) and nano (<1µm or <0.1µm) scale plastics. Microplastics (MPs) toxicity has been greatly emphasized, but the study on nanoplastics (NPs) toxicity, especially on microalgae, remains limited. This study evaluate the effect of 0.1 µm polystyrene nanoplastics (PS NPs) on microalgae following OECD guidelines. The results showed significant differences in growth, pigments, protein contents and oxidative enzymes of *Chlorella vulgaris* and *Spirulina platensis* at graded concentrations of PS NPs (1 to 100 mg L-1). The growth rate reduced with increasing concentrations of NPs and maximum growth inhibition of 40.12% and 42.57% was observed at 100 mg L-1 treatment, in *C. vulgaris* and *S. platensis*, respectively. After 96 h, it was observed that chlorophyll-a content was reduced by 32.28% and 33.66% in *C. vulgaris* and *S. platensis* respectively at the highest treatment concentration. Carotenoid content was also reduced by 31.62% and 33.53% at 100 mg L-1 in *C. vulgaris* and *S. platensis* respectively. Adsorption of nutrients by NPs from the media could negatively affect the growth and pigment content of microalgae. In addition, scanning electron microscopy analysis revealed that NPs have adhered to the surface of *C. vulgaris* and caused slight deformation with uneven grainy surfaces. Infrared spectra also revealed that higher concentrations of NPs could cause metabolic changes in the microalgae. The present study confirms that nanoplastics could adversely affect the growth and metabolism of primary producers and provide insights into the potential interaction of NPs with microalgae.

3.8 Biodiversity and Sustainable Fisheries Management



Assessment of Species Diversity in Selected Families of Marine Fishes and Indigenous Freshwater Ornamental Fishes of Maharashtra

CIFE/2020/03/IF

Project duration: 2020- 2023

Principal Investigator
Dr. A.K. Jaiswar

Co-Principal Investigators
Dr. Annam Pavan Kumar
Dr. S. Monalisha Devi
Dr. Karankumar Ramteke
Dr. Shobha Rawat
Dr. Dayal Devadas
Dr. Pawan Kumar

Sampling for freshwater as well as marine fishes were conducted from different river systems and associated fish markets and landing centres. 80 species have been identified and morphological and molecular trait analysis is being processed. Two training programs have been conducted for 5 and 10 days.

CIFE/2015/FRM003/SR

Taxonomic Study of Selected Fishes of the Genus *Mystus* Scopoli,1777 from India with Special Reference to Kerala

Sangeetha M Nair

Major Advisor: Dr. A. K. Jaiswar

A total of eleven species of genus *Mystus* (nine from fresh collection and two from Zoological survey of India, Kolkata Museum) were examined for taxonomic study. Descriptive statistics of 27 morphometric variables of 11 species viz. *Mystus armatus, M. bleekeri, M. cavasius, M. gulio, M. keletius, M. malabaricus, M. ngasep, M. oculatus, M. prabini, M. seengtee and M. tengara* revealed significant variation in the values. The stepwise discriminant function analysis (SDFA) was performed for 27 transformed morphometric variables, explaining 82.16 % of total variation. Classification matrix, generated using 7 variables, showed successful classification of 100 % in *M. tengara, M. gulio, M. oculatus,* and *M. malabaricus,* whereas classification of 93.75 % was observed in *M. armatus,* 92.30 % for *M. cavasius,* 72.72 % for *M. bleekeri* and the 95.89 % in cumulative. An artificial key for the identification of *Mystus* from India was also generated in the study. Pug head deformity in *M. tengara* was also reported in the present study. Otolith or ear stone was selected for studying the hard parts and results revealed significant variation in five otolith shape indices (Ellipticity, Circularity, Form Factor, Rectangularity and Roundness).

Results of ANOVA of five otolith shape indices revealed maximum F-ratio of 49.223 and 30.621 in form factor and rectangularity, respectively, contributing maximum to species discrimination. Mitochondrial cytochrome c oxidase subunit I (COI) gene was used to develop the reference barcodes. A total of 27 reference DNA barcodes were generated for six species and the sequences were submitted to the NCBI GenBank. The average frequency of nucleotides is A: 24.5; T: 29.6; G: 17.5 and C: 28.4% with GC content of 45.9%. The GC content at codon 3rd base position is highly variable than the 1st and 2nd base positions. The present study used an integrated taxonomic approach to resolve the identity and distribution of *Mystus tengara*.

CIFE/2016/FRM003/SR

Diversity and Distribution of Fishes Of Family Lutjanidae in Andaman Waters and Biology of *Lutjanus Decussatus* (cuvier, 1828)

Ajina S M

Major Advisor: Dr. S. Dam Roy

The diversity of snapper fishes of family Lutjanidae and biology of checkered snapper Lutjanus decussatus (Cuvier, 1828) of Andaman, were studied during September 2019 to August 2021. The three major fish landing centres of Andaman and Nicobar Islands viz. Junglighat, Dignabad and Wandoor selected for the surveys to document the fishery characteristics, diversity studies and sample collection for the biological studies. A total of 45 species of Lutjanid fishes which belonging to 3 subfamilies and 9 genera identified and documented during the study period. Three species Lutjanus indicus, Pristipomoides auricilla and P. freemani were identified as new to the Andaman and a scorpion fish, Pontinus nigerimum also found as new to island and it was caught as bycatch of the fishery. The monthly biological and length frequency data of checkered snapper were collected from September 2019 to August 2021. A total of 692 specimens were dissected which 49% (n= 340, Wt= 62.78Kg) were males, 44% (n=304 were females, Wt= 53.82 Kg) and 7% (n=48, Wt= 7.36 Kg) were unidentified sex.

The gut content was analysed and each prey was identified to the lowest possible taxon and quantified based its numeric and gravimetric abundance. The diet composition, diet breadth and diet shift between the male, female and sexually undifferentiated fishes were analysed seasonally. The species was found to feed dominantly on crustaceans (QI of 6054.8029and % IRI of 93.00%) followed by teleost (QI of 311.03 and % IRI of 6.83%). The seasonal diversity indices, vacuity index, most preferred prey items and the Index of fullness of each sex were calculated and presented. All 7 stages of gonad were identified and frequency of mature and ripe gonads were seen from late monsoon to post monsoon month (July to November), it indicated the spawning season.

Gonado-somatic index also calculated for both the sexes and plotted against the month; two peaks observed in single breeding season. The growth and mortality parameters of L. decussatus were estimated and indicated that the species is a moderately fast-growing fish having the K value of 0.69/ year and L∞ (mm) of 310.80 mm and species having the longevity of 4.35 years. A three-habitat analysis study of L. decussatus were carried out from December 2020 to February 2021 along the various ecosystems of coral stretches of Andaman and it revealed that the species is mostly associated with the live coral; mainly with Acropora sp. and Porites sp. The present study generated a baseline data of snappers of Andaman and biology of L. decussatus which will help the fishery managers and breeders to make policies and captive rearing of the species.

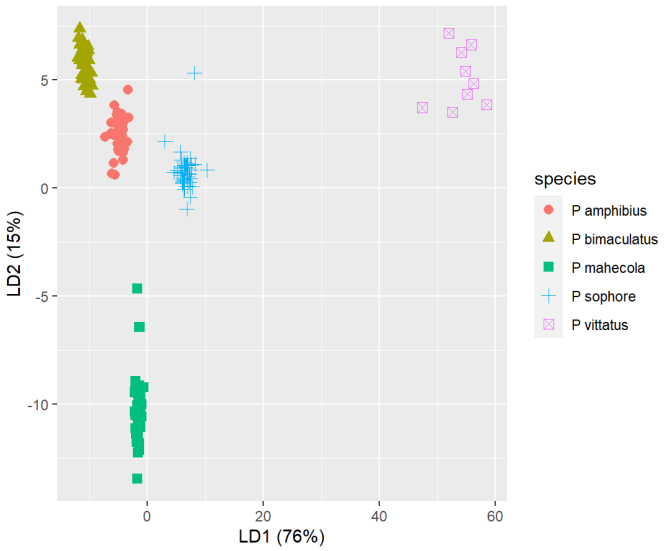
Study on Diversity of *Puntius* Hamilton, 1822 (Cyprinidae: Smiliogastrinae) in Selected River Systems of Maharashtra

CIFE/2020/FRM011/SR

Samir Kumar Chand

Major Advisor: Dr. A. K. Jaiswar

During the study on the diversity of *Puntius* Hamilton, 1822 species in the selected river system of Maharashtra, a total of 5 species were collected from various local freshwater fish markets. A comparative taxonomic study, based on morphology, morphometric and meristic traits was conducted on the five species collected during the study viz., *Puntius amphibius, P. bimaculatus, P. mahecola, P. sophore* and *P. vittataus* from selected river systems of Maharashtra. A total of 22 morphometric and 6 meristic traits, were measured and subjected to statistical analysis. Multivariate Analysis of Variance (MANOVA) also showed significant differences among the species. All the 22 morphometric measurements were subjected to discriminant function analysis, the first LDA coefficients of the factor analysis together explained 76% of the total variation among the morphometric traits (refer Fig.).



Diversity of Freshwater Catfishes (Siluriformes) in Selected River Systems of Maharashtra

(CIFE/2020/FRM009/SR)

Vineeth P

Major Advisor: Dr. A. K. Jaiswar

Catfishes of the order Siluriformes are the important fishes in the inland areas contributing to the commercial catches all over India and in Maharashtra. An attempt was made to study the diversity of catfishes inhabiting selected river systems such as the Ulhas river, Kalundre river, Savitri river, Ghod river, and Godavari river of Maharashtra. During the study, a total of nine species, belonging to five genera and three families, were recorded from different places such as Panvel, Bhiwandi, Poladpur, Roha, Mahad, Ambegaon, and Nashik. A comparative taxonomic study, based on morphology, morphometric and meristic traits, was conducted on the nine species collected during the study. A total of 20 morphometric and 7 meristic traits were measured and the species with sufficient sample size, required for statistical analysis, only were subjected to analysis.

In catfishes, the largest otolith is known to be lapillus which is less studied and was observed to vary among species with the morphological features like rostrum, posterior, anterior, excisura,

and margins showing variation among 9 species under five genera. The genera *Mystus* has been found to have kidney shaped otoliths, whereas in others, it is elliptical to oblong. During the study, Mitochondrial COI gene were amplified and the sequences were generated for 24 specimens of 8 species belonging to 5 genera. A neighbor-joining tree was constructed with distinct clusters by using the K2P model. The study suggests for a more detailed study on assessing the diversity of catfishes, needed for the conservation and sustainable management of threatened catfishes in Maharashtra.

Status of Coral Reef in Outer Gulf of Kachchh Region, Gujarat

CIFE/2016/FRM005/SR

Katira Nareshbhai Nathabhai

Major Advisor: Dr. Geetanjali Dheshmuke

The status of the coral reef ecosystem of the outer Gulf of Kachchh has been studied for the occurrences of the scleractinian corals and reef diversity. To understand the status of coral reef diversity using the Line Intercept Transect (LTI) method, questionnaire-based socioeconomic analysis, and environmental assessment were conducted monthly from November 2017 to February 2019 on three selected sites viz., Okha, Mithapur, and Shivrajpur of the outer GoK. Shivrajpur has the highest proportion of live coral cover at 72%, followed by Mithapur and Okha. A total of 23 scleractinian coral species were recorded under 12 genera and eight families. Shivrajpur had the highest number of scleractinian coral species (22 species), followed by Mithapur, and Okha. The species of family Poritidae contributed the most to the assemblage, followed by the Faviidae and Merulinidae. An average relative abundance revealed that *Dipsastraea favus* formed dominant species in the outer GoK, followed by *Pseudosiderastrea tayamai* and *Goniopora pedunculata.*

A total of 29 species of reef-associated flora belonging to 24 genera and 17 different families were recorded, with dominance of Phaeophyceae, followed by Rhodophyceae. *Ulva lactuca* contributed maximum to the biomass, followed by *Sargassum cinereum.* Okha shore revealed the maximum seaweed diversity in the post-monsoon season. A total of 39 species of reef-associated fauna belonging to 35 genera and 30 different groups are recorded. Gastropods were found to be the most diverse, followed by Crustaceans. Shannon-Wiener index, Pielou's evenness, and Margalef's richness index were applied to assess the diversity of the coral reef and reef-associated flora and fauna. The highest diversity of the scleractinian corals was found at site Shivrajpur (H'=2.58), followed by Mithapur (H'=1.89) and Okha (H'=1.78).

The physico-chemical parameters viz., water temperature, salinity, pH, and DO2 play a significant role in the growth and survival of the reef ecosystem in outer GoK. The mean water temperature and salinity of Okha, Mithapur, and Shivrajpur were 26 °C and 34 ppt, 26 °C, and 35 ppt and, 27 °C and 34 ppt, respectively, and the mean pH values were 7.73, 7.91, and 7.84, respectively. Similarly, the mean dissolved oxygen levels at Okha, Mithapur, and Shivrajpur were 6.50, 6.22, and 6.59 mg/lit, respectively. The reef ecosystem of the outer GoK generates maximum revenue by catch of finfish followed by shellfish. The maximum revenue per annum was generated at Mithapur reef (₹ 1,47,620) followed by Okha (₹ 1,30,310) and Shivrajpur (₹ 1,09,540). However, this revenue is under threats, sixteen coral species were found to be bleached, especially due to human-induced stress such as local tourism, traditional fishing practices, and shoreline pollution. The maximum proportion of the colony scale bleaching was observed in *G. pedunculata* (34 %) followed by *D. favus* (31%). Mithapur had the highest percentage of relative dead coral cover accounting for 12.62% of total coral cover, followed by Okha (6.45%), and Shivrajpur (0.41%). However, according to the Coral Mortality Index, reef ecosystems of the outer GoK can be deemed healthy. The reef ecosystems of Okha and Mithapur are subjected to heavy anthropogenic pressure, resulting in reef degradation, still, Shivrajpur is fairly pristine, with no tourist and coastal development activities, resulting in higher biodiversity and scleractinian coral coverage.

CIFE/2017/FRM008/SR

A Study on Mangrove Status and Associated Crustacean Diversity of Dharamtar Estuarine Confluence, Maharashtra

Major Advisor: Chennuri Sathish

Major Advisor: Dr. Geetanjali Dheshmuke

Globally, mangroves are one of the highly threatened ecosystems, declining rapidly and thus, impacting associated fauna. Study on mangroves and associated crustaceans of the Dharamtar estuary was carried out to generate baseline information for future reference and use in conservation and management. The mangrove cover is estimated to occupy an area of 63.82 km² in 2020, which was estimated to be 24.9 km² in 1990. Very dense, moderate dense and open mangroves areas occupy 38.27, 13.49 and 12.06 km², respectively. A total of 7 true mangrove and 5 associate species were recorded during the study. On an average, 9542 trees per hectare were recorded during the study. The most dominantly distributed mangrove species was *Avicennia marina* (Forssk.) Vierh. The highest mean height was recorded for *Sonneratia apetala* Buch-Ham., followed by *A. marina.* The Margalef's species richness index, Shannon – Weiner diversity index, Pielou's evenness index and Simpson's diversity index values were estimated based on the distribution were 0.43-0.86, 0.688-1.364, 0.47-0.91 and 0.34-0.72, respectively.

Mangrove defoliation caused by insect *Hyblaea puera* (Cramer, 1777) was observed in the study area, and the high defoliated, moderately defoliated, low defoliated, very low defoliated, and un-defoliated mangrove areas were estimated as 6.6%, 9.9%, 8.3%, 50.1% and 25.0%, respectively. A total of 27 species of crustaceans were found to inhabit the mangroves, and the Shannon – Weiner index, Margalef species richness, Pielou's evenness and Simpson's diversity indices were estimated as 2.48–1.4, 3.2–1.08, 0.77–0.91 and 0.7–0.9, respectively. More density and species recorded during monsoon and fewer during post-monsoon, which may be attributed to the massive defoliation of mangroves during post-monsoon.

A total of 32 species of crustaceans were recorded from the estuarine water, and Margalef's species richness, Shannon-Weiner and Pielou's evenness and Simpson's diversity indices were estimated as 4.77–6.08, 1.2–1.7, 0.3–0.5 and 0.4–0.6, respectively. The higher number of individuals, species and Margalef's index, recorded during post-monsoon, which could be due to the movement of crustaceans, especially prawns, into the estuarine region due to the high availability of detritus (from insect frass) during post-monsoon, including other factors. The moderate diversity of mangroves and crustaceans indicates that this ecosystem is facing stressful conditions. Therefore, management measures are needed to conserve the mangroves and associated flora and fauna.

Diversity of *Artemia* along North Coastal Districts of Maharashtra

CIFE/2020/FRM002/SR

Meenatchi S

Major Advisor: Dr. B. B. Nayak

The sunrise sector, aquaculture depends on live feed for larval rearing in hatchery units, worldwide. *Artemia* spp. are considered as a potential live feed which can contribute to the better growth of larvae and maturation of brooders. This study tried to record the indigenous strains of *Artemia* from saltpans of north coastal districts of Maharashtra, if available using morphological and molecular methods. Sampling sites of this study include salt pans of north coastal districts of Maharashtra. Samples were collected using 40 µm mesh sized plankton net along with water samples for water quality analysis. A total of 23 samples from 3 coastal districts of Maharashtra, namely Mumbai, Thane and Palghar were sampled during this study. But the brine shrimp, *Artemia* spp. was absent in all the samples from the study area during the study period.

The other organisms from the study area which include the microalgae, filamentous algae, ciliates, zooplankton, crustaceans and fish larvae were reported and diversity indices were calculated. Reduced phosphorous content was noted, which can indirectly affect the primary productivity of saltpan ecosystem while comparing previous studies from the same sampling site. The over dominance of *Fabrea salina*, absence of favourite food of brine shrimp such as *Dunaliella salina* and presence of predators of Artemia such as mysids, copepods, mussel shrimp and fish larvae (*Oryzias dancena*) could be the possible reasons for the absence of *Artemia* in the study area. The outcome of this study suggested that the ecological and environmental factors can determine the presence of *Artemia* spp.

Characterization of Metazoan and Microbial Diversity from the Ballast Water Using Environmental DNA

CIFE/2020/FBT007/SR

S. Sangeetha

Major Advisor: Dr. A. Pavan Kumar

The native biodiversity of the ecosystem is often perturbated by anthropogenic factors such as introduction of non-native species through the ballast water. Identification of the metazoan and microbial diversity from the ballast water of international cargo ships could provide information on biodiversity carried by the ballast water. The present study is carried out with an aim to characterize the metazoan and microbial diversity from the ballast water of selected ports and to compare the species diversity of ballast and harbour waters of selected ports. The environmental DNA (eDNA) was isolated from the ballast water of ships arrived at V.O. Chidambaram Port, Thoothukudi, Tamil Nadu. Similarly, the harbour water also collected from the port for comparing the biodiversity with the ballast water. The V3-V4 region of the16S rDNA and V7 region of the 18S rDNA were amplified and sequenced using the illumine MiSeq NGS platform.

A total of 940 species-level OTUs (microbes) are identified including the ballast and harbour water. On average ~40% of the OTUs are shared among the ballast and harbour waters. At phylum level, the predominant bacterial communities include *Proteobacteria, Planctomycetes, Bacteroidetes* and *Actinobacteria*. Out of 940, 247 species level OTUs are exclusively present in the ballast water. Some of the species are pathogenic (Corynebacterium; Propionibacterium, Lewinella; Flavobacteriales) and antibiotic-resistant (species of *Brachybacterium*; Cyclobacteriaceae,

Cetobacterium) species. The bacterial families namely Xanthobacteraceae, Nocardiaceae, Geodermatophilaceae, Dermabacteraceae, Dermacoccaceae, Intrasporangiaceae, Dysgonomonadaceae and Spirosomaceae exclusively present in the ballast water. In case of metazoans, around total of 2025 OTUs are identified including both the harbour and ballast water. Of these, 767 OTUs are exclusively present in the ballast water, while ~1100 OTUs are shared between the ballast and harbour waters. Some of the species that are present exclusively in the ballast water are non-native to the Indian waters and have potential to establish in the non-native ecosystem. This study provides the baseline information on the biodiversity composition of the ballast water and harbour water from the Gulf of Mannar region.

Taxonomical, Biochemical Evaluation and Utilization of Order Dictyotales – Brown Algal Species

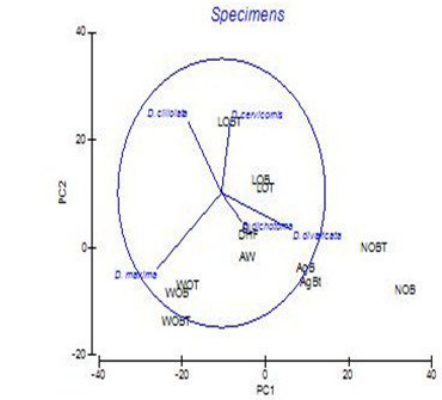
CIFE/2021/01/IF

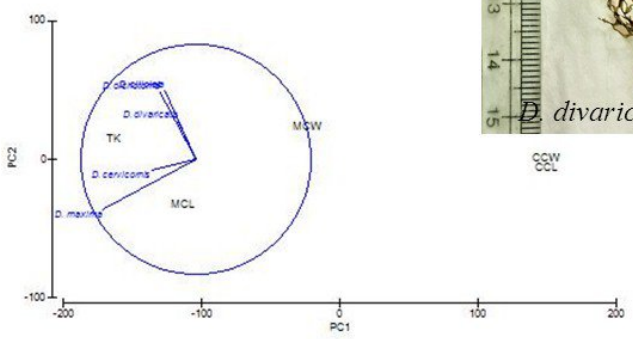
Project duration:2021- 2024

Principal Investigator
Dr. Geetanjali Deshmukhe

Co-Principal Investigators
Dr. A.K. Balange
Dr. Annam Pavan Kumar
Dr. Layana P
Mrs. Vidhya V.

The delination of species belonging to Dictyotales from Indian coast is carried out along with estimation of biochemical composition and utilization of brown seaweeds. Five species of Dictyota was carried out from the East and West coasts of India. The impact of culture conditions and media strength on survival and growth of *Padina tetrastromatica* was observed. 35 ppt salinity and full concentration of PESI media was found to be most suitable. The Impact of culture conditions and media strength on proximate composition and phenols of *Padina tetrastromatica* was observed. Under culture conditions, 40 ppt salinity seemed to have better results in term of phenol content. Proximate biochemical composition and mineral composition for 5 brown algal species viz P*adina spp., Dictyota spp., Stoechospermum marginatum, Spatoglossum asperum* and *Iyengaria stellata* were done.





D. maxima


0.2 mm


100 µm

CIFE/2020/04/IF

Identification and Characterization of Recruitment Ground of Commercially Important Small Pelagic Fishes along Maharashtra Coast

Project duration: 2020- 2023

Principal Investigator
Dr. B.B. Nayak

Co-Principal Investigators
Dr. A.K. Jaiswar
Dr. Annam Pavan Kumar
Dr. Sashi Bhushan
Dr. Karan Kumar Ramtake
Mrs. Vidhya V.
Mr. Abuthagir Iburahim S.
Mrs. Shobha Rawat
Mr. Dayal Devadas
Dr. Pawan Kumar

Monthly sampling in two estuaries covering 6 stations (two in Manori and four in Karanja) were carried out for estimation of water quality parameters, phytoplankton abundance, identification of eggs and larvae based on molecular and morphological tools. Study on the reproductive biology of 6 estuary associated fish species and feeding biology of 10 species were carried out. A total of 22 sampling trips were conducted and 1197 samples were collected including 546 eggs, 271 larvae, 235 juveniles and 235 adults between January 2022 and December 2022. Eggs of 9 species and larvae of 13 species were identified based on molecular and morphometric tools. Prominent among the identified species were *Rastrelliger kanagurta, Stolephorus indicus, Stolephorus insularis, Mugil cephalus, Johnius glaucus, Ilisha melastoma Chirocentrus dorab* and L*eiognathus brevirostris*. The early life forms were located towards the mouth of estuaries. *Mugil cephalus* early life forms was clearly located in only one of the few sampling stations and the availability was correlated with the seasonal distribution of the adult and juveniles and specific algal food.

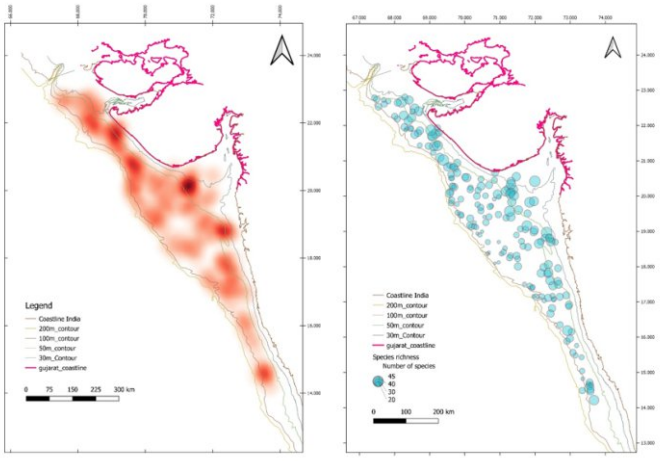
(CIFE/2014/FRM001/SR)

Assessment of Bottom Trawl Fisheries along Veraval Coast, Gujarat

Rajan Kumar

Major Advisor: Dr. A.P. Dineshbabu

The present study is based on the data collected from commercial trawlers operated from the Veraval fishing harbour of Gujarat. There were basically three types of trawling operation by the trawl operators of Veraval, namely pelagic, cephalopod and bottom trawling. The trawl nets used by the trawlers of Veraval have five specific designs based on target resource viz. ribbonfish, cephalopod, perch, shrimp, and Acetes trawl. The bottom trawling formed only a sub-component of the multi-day trawl operation and accounted for 33.17% of the total effort spent by them. The total landings of high value catch by multi-day bottom trawlers were 37636.7 and 41976.5 t in 2018 and 2019, respectively. During the same years, the landings of low value bycatch were 14648.1 and 12325 t. The amount of discards by multi-day bottom trawlers were 22102.4 and 16310.4 t in 2018 and 2019, respectively.



The economic valuation of low value bycatch landed by multi-day trawlers were 1632.11 and 1370.42 lakhs in 2018 and 2019, respectively. The percentages of juveniles landed for selected 15

species were in the range of 3.11 to 80.10%. The study period has witnessed the sudden rise and fall of Red-tooth trigger fish (*Odonus niger*) fishery along the west coast of India. The surface current anomalies might explain the phenomenon. There major demersal resources like threadfin breams, croakers and penaeid prawns were found to have a seasonal shift in their high abundance zones, with post-monsoon season being the most productive for the fishery. The study reported 380 species from the bottom trawl catches of Gujarat across 248 genera, 131 families, 37 order, and 10 class. The depths, latitudes and seasons showed significant difference in species richness, and other diversity indices. There were new distributional records for 22 finfishes and 10 crustaceans reported from trawl catches.

CIFE/2020/FRM008/SR

Biology of *Osteobrama vigorsii* (Sykes, 1839) from Bhima River basin, Maharashtra, India

Thanga Anusya S

Major Advisor: Dr. Karankumar K. Ramteke

Osteobrama vigorsii (Sykes, 1839) is a freshwater cyprinid which is endemic to the Krishna and Godavari River systems of India. It is one of the least studied species of the family Cyprinidae that belongs to the IUCN category Least Concern (LC). The present study aimed to report the morphometric and meristic characteristics, length-weight relationship, food and feeding habits along with reproductive biology of the species. A total of 323 specimens ranging from 9.8 to 26.9 cm length were collected from Veer dam, Bhima River basin, Maharashtra from January 2022 to June 2022. The length weight relationship can be written as W = 0.005921 L3.123614 and W = 0.12258 L1.988 for males and female, respectively. From the b values, it is observed that males show positive allometric growth whereas females show negative allometric growth.

Study on the food and feeding habits revealed that *Osteobrama vigorsii* is an omnivorous fish feeding mainly on aquatic insects, aquatic plants, phytoplankton, worms, fishes, and miscellaneous items. Aquatic vegetation formed the most dominant group (60.329%) followed by aquatic insects (26.362%). Phytoplankton formed the third most preferred group (9.12%). Gastro-somatic index values were highest during the month of March (Male: 3.183, Female: 3.081) and April (male: 3.585, female: 3.585). A diminishing trend in gastro somatic index was observed during May and June. The condition factor of the males fluctuated monthly between 0.7-1.21 and for females between 0.72-2.3 indicating that both sexes are in good condition throughout the study period. Month-wise observation of sex ratio showed the predominance of males over females in January, February, and March. Females dominated over males in April, May, and June. Month-wise analysis of Gonado-somatic index revealed that the prominent peak was observed in June for both males and females. Absolute fecundity ranged from 5555 to 11,007 numbers of ova while relative fecundity varied from 171-391 ova per gram of body weight. Length at first maturity for males was calculated as 151.177 mm and for females, length at first maturity was found to be 140.77 mm.

Life History Traits of *Abudefduf* sp. from the Southeast Coast of India

CIFE/2016/AQC011/SR

Rajesh N

Major Advisor: Dr. Imelda Joseph

Important life history traits of Indo-Pacific sergeant, *Abudefduf vaigiensis* collected from southeast coast of India, Gulf of Mannar was evaluated (n=360). Ambiguity regarding the identification was sought out through classical taxonomic approach along with molecular confirmation employing barcoding of 650 base pair (bp) region of the Cytochrome C oxidase 1 gene. Length weight equation and regression coefficient obtained for males, females, unsexed and overall fishes were W= 0.06 L 2.55 (R2= 0.82); W= 0.02 L 2.94 (R2=0.88); W= 0.04L 2.68 (R2=0.96) and W=0.04 L 2.67(R2=0.92) respectively. Relative condition factor (K) among overall fishes showed a value above 1, which indicates better condition of fish. Analysis of gut contents indicated that *A. vaigiensis* is an omnivorous, feeding on seaweeds, cladocerans, copepods and insects.

Gastro-somatic index (GaSI) for male had shown a regular pattern with an increasing trend after February and reached the highest value in July (1.20) and the lowest value (0.36) in November and that of female had shown an increasing trend followed by a decrease, with the highest value in July (0.95) and the lowest value (0.47) in January. Hepato-somatic index (HSI) of male had shown increase from November (0.85) to January (1.25) and decreased from February to September with the peak in December and that of female had increased from August (0.85) to December (1.25) and then decreased until July. Gonado-somatic index (GSI) in male had sustained at the maximum during September to March with the peak during February and was observed to be lower during April to July. GSI in female sustained at the maximum GSI from December to March with the peak during February and was observed to be lower during April to October.

The feeding was observed to be inversely correlated with reproductive development. Based on GSI and plasma reproductive hormone levels the breeding season has been defined to be from December to March with the peak in February. The histology of gonad has been revealed it of gonochoristic in nature with 6 maturation stages for ovary and 5 maturation stages for testes. Successful broodstock development could be achieved in captivity. The present information could form a strong baseline data for the seed production of *A. vaigiensis*, a commercially important marine ornamental fish.

Stock Structure Analysis of White Sardine *Escualosa thoracata* (Val., 1847) from Indian Waters

CIFE/2015/FRM004/SR

Prem Singh Prajapat

Major Advisor: Dr. Zeba Jaffer Abidi

Stock structure of the species of *Escualosa thoracata* (Val.1847) from 4 distinct locations along the Indian peninsula, two from each west coast (Mumbai and Kochi) and east coast (Kolkata and Chennai) has been analyzed for the holistic approach of stock identification. The morphometric variations of *Escualosa thoracata* (Val.1847) was studied to assess their phenotypic variations among four different stocks, viz., Mumbai (n = 82); Cochin (n = 85); Kolkata (n = 80) Chennai (n=87) in the Indian coast. The result indicated that a maximum co-efficient of variation is observed in snout length (13.55 %) followed by postorbital length (12.59%), body depth (11.81%). In the principal component analysis of the meristic traits of *E. thoracata*, 82.65% of total variations were explained by the first three principal components together. 51.23% of total variations contributed by PC 1, 22.15% by PC 2 and 09.27% contributed by

PC3. The truss distances were extracted from the digital images of specimens using software tpsDig2 and PAST.

The cross validation of truss analysis was recorded as 96.77 %, 62.50 %, 64.00 % and 73.33% of samples correctly classified to Kolkata, Chennai, Cochin and Mumbai population respectively. In this analysis, high percentage of the samples (74.58%) was well-classified. In the cross validation of the morphometrics by discriminants analysis the most well-defined stock belongs to Kolkata with only 3.23% of misclassified individual followed by Mumbai indicating the limited gene flow of Bay of Bengal population of white sardine. The fatty acid profile analysis of heart tissue comprised methanolysis, gas chromatography, and multivariate statistics. The relative area percentage was obtained for 25 fatty acids, comprising Eight saturated fatty acids (SAFA), Six mono unsaturated fatty acids (MUFA) and Eleven poly unsaturated fatty acids (PUFA): None of the SAFA showed significant difference between Kolkata and Mumbai populations, whereas six of the eight SAFA (except 17:0 and 19:0), showed significant variation between Chennai and Mumbai populations. Five SAFA (14:0, 17:0, 18:0 19:0 and 20:0) showed significant variation between Kolkata and Chennai populations and four SAFA (15:0, 16:0, 19:0 and 20:0) between Chennai and Cochin populations.

Among MUFA, highest percentage composition was showed by oleic acid followed by palmitoleic and gondoic acid. Among above three, only palmitoleic acid showed significant difference among the locations and it was highest in Mumbai samples, followed by Cochin. Among PUFA, Eicosatetraenoic acid (ETA) and DHA were found to be in significantly high in Kolkata and Mumbai population as compared to Chennai and Cochin. Mumbai population contained a significantly high concentration of linoleic acid compared to other three locations. Total variation together explained 72.45 percent in the first two principal component (PCs) with eigenvalues 132.23 and 6.11 respectively. PC1 contributed 77.30 percent of total variation whereas PC2 accounted 4.12 percent of the same.

CIFE/2014/AEM004/SR

Study on Habitat Ecology, Species Diversity and Biology of Snow Trouts in Kameng Drainage of Arunachal Pradesh, Eastern Himalaya

Kishor Kunal

Major Advisor: Dr. Debajit Sarma

The present study was conducted to assess habitat ecology, taxonomy, and biology of snow trouts in Kameng drainage, Arunachal Pradesh, Eastern Himalaya. Seasonal sampling was carried out from January 2018 to December 2019 at six sampling stations, namely Shergaon, Dirang, Sangti, Rupa, Munna Camp, and Tenga. Habitat assessment studies revealed optimal habitat conditions in the Kameng river for the proliferation of snow trouts. Water quality index and plankton diversity indices confirmed pristine, unpolluted water in the drainage. A total of 52 phytoplankton species belonging to 37 genera, 30 families, 21 orders, and 9 classes were identified, with density in the range of 142-1348 cell/liter and 19 periphyton genera belonging to 16 families, 13 orders, and 6 classes were identified with a density of 133-1365 individual /cm2. Zooplankton belonging

to 8 genera, 5 families, 4 orders, and 3 classes were also recorded with 68-286 individual/liter density. Total 23 species of fishes, including 5 species of snow trouts, namely *Schizothorax richardsonii, S. plagiostomus, S. molesworthi, S. progastus,* and *S. esocinus* were reported from the river.

Eighteen morphometric measurements were used to differentiate among 5 species of snow trouts. Species were described based on morphometric characters, and it was found that mouth patterns and lower lip structure were the most prominent morphological characters for visual differentiation of these five species. Meristic characters used were found to be inconsistent and overlapping and hence were not suitable for species differentiation. Reproductive and feeding biology studies were carried out for *S. richardsonii* and *S. plagiostomus*. Length-weight relationship analysis showed a negative allometric growth pattern in both species. The sex ratio was 1.3:1 in the case of S. richardsonii and 2.4:1 in *S. plagiostomus*.

The highest value of gonadosomatic index was observed in premonsoon and postmonsoon months in *S. richardsonii* and postmonsoon months in *S. plagiostomus.* In *S. richardsonii,* absolute fecundity was in the range 2875-18756 for 28-441 g fish, while in *S. plagiostomus,* the value was in the range 3982-21470 for 26-382 g fish. The maximum ova diameter of 2.6 mm and 2.8 mm was reported in *S. richardsonii* and *S. plagiostomus.* The length at first maturity was found to be 11.3 cm and 16.5 cm in male and female S. richardsonii and 11.2 cm and 17.1 cm in male and female S. plagiostomus, respectively. Gonadal histology data suggest two breeding peaks (pre and postmonsoon) in S. richardsonii while a single breeding peak (postmonsoon) in *S. plagiostomus.* Feeding behaviour suggests the herbivorous nature of both *S. richardsonii* and *S plagiostomus* during their adult stages.

Mapping Ecosystem Valuation and Modelling for Simulating Sustainable Fisheries Management Scenario in Selected Reservoir of India

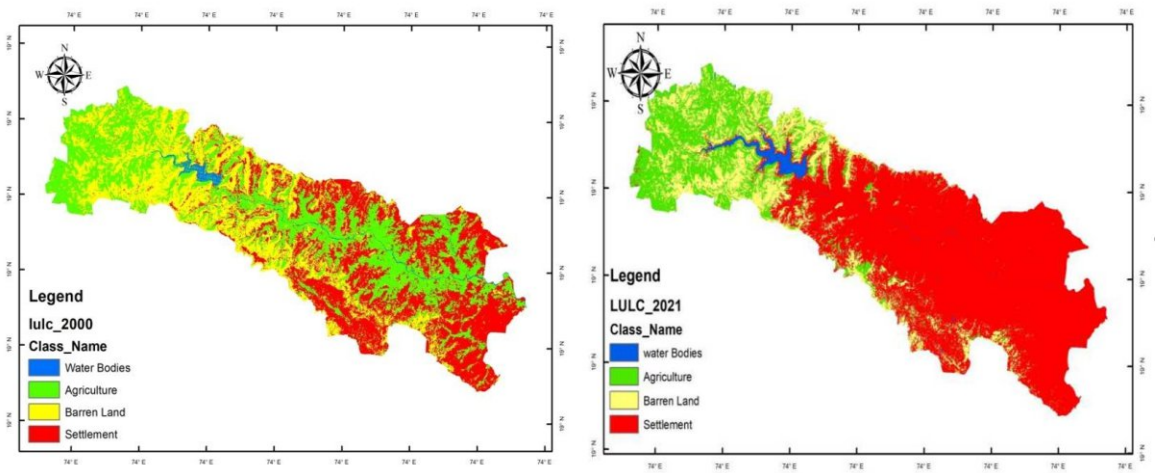
CIFE/2021/08/IF

Project duration: 2021- 2024

Principal Investigator
Dr. Vinod Kumar Yadav

Co-Principal Investigators
Dr. S.N. Ojha
Dr. Arpita Sharma
Dr. Karankumar K. Ramteke

Detailed assessment of the Dimbhe reservoir, Maharashtra including valuation of ecosystem services of reservoir in monetary terms, impacts of climate change and other environmental factors on ecosystem specifically fisheries, the status of reservoir ecosystem with its trophic interactions in a climate changing context and frame policies and management strategies are the parts of this research study. Primary data from 160 households from the 6 villages consisting of three clusters in the peripheries of Dimbhe



reservoir were collected and single and double bounded Contingent Valuation Method (CVM) was used to find the willingness to pay (WTP) for listed important provisioning services - water, fuelwood, and fodder. In CVM, the logistic model was used based on the dichotomous choice method to randomly estimate the WTP with three different bid values (first bid, low bid, and high bid, which were ₹250, ₹100, and more than ₹250, respectively).

Economic value of six provisional services *viz*. employment, water for irrigation, water for drinking, hydroelectric power generation, fuel wood, and fishing in the reservoir was estimated. Average total economic value of provisioning services in Dimbhe reservoir was estimated as ₹899.6 lakhs per year. Education, house type, and monthly household income were the significant potential factors for WTP for the provisioning services. Fisheries contribute about 2% of the total economic value of reservoir which indicates that there is a scope to increase the economic value of fisheries. The study showed significant change in the settlement area. The agriculture and barren land has decreased by 19.29% and 12.74% respectively and got converted into settlement area. This reflects spatio-temporal dynamics in land use and land cover changes in the study area, which must be considered in order to address future land use changes. Efforts have been initiated to develop a framework for Fish Culture Area Mapping, Efficient Ranching Assessment and Change Detection.

CIFE/2020/FEC004/SR

Ecosystem Valuation and Trophic Structure Dynamics for Sustainable Fisheries Management in Dimbhe Reservoir, Maharashtra

Waghmare Sneha Dadarao

Major Advisor: Dr. Vinod Kumar Yadav

Reservoirs provide a variety of ecologically and economically services. Understanding the forces that determine ecosystem valuation and trophic structure is important for policymakers responding to ecological dynamics and ecosystem services to future environmental changes. The study identified and assessed the major ecosystem services and trophic structure in Dimbhe reservoir. Primary data from 160 households were collected to find the Willingness to Pay (WTP) for provisioning services. The study estimated the economic value of six provisional services (employment, water for irrigation, water for drinking, hydroelectric power generation, fuel wood, and fishing) in the reservoir. Findings showed that the average total economic value of provisioning services in Dimbhe reservoir was ₹138.2 lakhs/ year.

The single and double bounded Contingent Valuation Method (CVM) were used to find the willingness to pay of respondents. In CVM, the logistic model was used based on the dichotomous choice method to randomly estimate the WTP with three different bid values (First bid, low bid and high bid, which were ₹250, ₹100, more than ₹250, respectively). Education, House type, Monthly household income were the significant potential factors for WTP for provisioning services. The CVM study showed that about 53.8% respondents were willing to pay for the provisioning of fuel wood, and 42% respondents were WTP for water and fodder. The study's findings showed that the respondents living in kaccha houses with a monthly household income of less than ₹5000 were more likely to pay for water, fuel, wood, and fodder provision. The trophic structure and energy flow were also analyzed in the selected reservoir ecosystem. The result found that, four trophic levels were identified in the Dimbhe reservoir. The highest trophic level was 3.33 for carnivorous fish, i.e., *Channa striata* indicated that the food chain was short, and the available food energy was large. The value of Total Primary Production/Total Respiration (TPP/TR) was estimated as 0.667, indicating the developing stage of the Dimbhe reservoir. Thus, the improved management of the reservoir ecosystem is necessary to ensure its sustainability. The study may be a revelation that conserving natural resources with the involvement of local people is essential.

Trophic State Monitoring of Selected Reservoir Using Remote Sensing and GIS

CIFE/2016/FRM008/SR

Adinath Tukaram Markad

Major Advisor: Dr. Asha T. Landge

Tiru reservoir is situated on the Tiru river (which further joins to Lendi river and then links to Manjara river which is one of the tributaries of Godavari river) in the Latur district was regularly monitored at five different sites from August 2017 to January 2019 for the estimation of 20 water quality parameters. Cluster Analysis (CA) extracted 3 clusters from the five sampling locations having similar water quality characters. Factor/ Principal Component Analysis (FA/ PCA) identified total 13 factors (out of 20) required to elucidate 74 % variation in the data. Discriminate Analysis (DA) extracted 16 parameters through 97.7% right assignations. The first group covers water quality parameters (T, DO, SDD, etc.) whereas, the second includes nutrients (Cl-, silicates, PP, TP, Chl-a, etc). Empirical relationship between Total Phosphorus (TP), Secchi depth (SDD), and chlorophyll-a (Chl-a) has been established. Nutrient saturation during summer due to low water level recorded poly-eutrophic condition in case of TSI (SDD) and TSI (TP) and eutrophic for TSI (Chl-a) estimates. Predominance of non-algal turbidity was observed throughout the study period.

Algal production is controlled by TP and non- algal turbidity. Three simple and effective empirical regression models were developed for the prediction of water parameters like Chl-a, TP and SDD with trophic state index values of TSI (Chl-a), TSI (TP) and TSI (SDD) by using Landsat 8 OLI Level 2 data sets. All the TSI prediction models have recorded very high performance. TSI (Chl-a) and TSI (TP) prediction models have recorded very strong correlation (R=0.999 each) followed by TSI (SDD) model (R=0.995). TSI (Chl-a), TSI (TP) and TSI (SDD) models have recorded very high coefficient of determination (R2=0.997, R2=0.999 and R2=0.989 respectively). The models developed during the present study were applied for historic imageries from 2013 to 2021 for checking it's applicability. The results revealed that Landsat Level II data sets can provide reliable and accurate predictions of water quality parameters as well as predicts trophic status by using multi-modeling approach.

Spatial Prediction of Fish Abundance in the Vembanad Lake Using Geostatistical Tools

CIFE/2020/FRM001/SR

Aiswarya S

Major Advisor: Dr. Asha T. Landge

An essential component of scientific management of fishery resources is a readily understood and accurately represented depiction of their abundance. Limited accessibility and constrained data points are no longer obstacles to reliable resource portrayal and assessment in the new era of wide-ranging spatial technologies. The concept known as geostatistics seeks to statistically study patterns of spatial variability, investigate the degree of their correlation, and ultimately estimate data for unmeasured points in space. The semivariogram model for kriging, of the fish abundance data in the northern reaches of Vembanad Lake, a Ramsar site, is optimised in the current study. In this study a total of ten different models were used to analyse data from majorly collected fish species *Nemapteryx caelata*, *Leiognathus brevirostris*, and *Metapenaeus monoceros*. The same method was employed to calculate the overall catch from the sample under study. Spatial interpolation maps using the methods of kriging and co kriging were used to generate the abundance maps for each case along with a prediction error map that quantifies the level of uncertainty associated. For fisheries experts, managers of aquatic resources, fishermen, and national policymakers, a precise forecast of the spatial distribution of the fish resources in Vembanad Lake might well be a promising decision support system.

Modification of dolnet for sustainable fisheries management along Mumbai Coast

CIFE/2022/04/IF

Project duration:2022- 2025

Principal Investigator
Dr. Karankumar K Ramteke

Co-Principal Investigators
Dr. Asha T. Langde
Mr. Abuthagir Iburahim S.

Experimental fishing was carried out in Madh island waters with modified dol net design. Dolnet site were selected and surveyed along the Marve coast. Total of 17 species recorded during observation. The average catch per haul for dolnet fishing operations was 18 kg/haul whereas in the upper and lower panel it was 12kg/haul and 13.15kg/haul, respectively.

Comparative Evaluation of Mesh Size Panel to Improve Fish Catch Composition of Dol Net

CIFE/2020/FRM001/SR

Zaheer Abass

Major Advisor: Dr. Karankumar K Ramteke

The study aimed at designing a mesh panel to improve the retained catch composition and to estimate the catch composition. A long conical-shaped bagnet (dolnet), locally called “Bokshi jal” with a wide rectangular mouth and narrow cod-end having a length of 45 m was used in experimental fishing. The mesh size of dol nets varied between 10 - 60 mm across its different sections. square mesh panel was installed in the conventional net having a 35 mm mesh size. Experimental fishing trials were conducted between March 2022 to May 2022. The average catch per haul for conventional and modified dol net fishing operations was 21.5 kg/haul whereas in the upper and lower panel it was 8.42 kg/haul and 13.15kg/haul, respectively. A total of 48 species belonging to 25 families were recorded from both conventional and modified experimental gear during experimental fishing. The fishery comprised 31 species of finfishes,15 Species of Crustaceans, and two species of Molluscan. Major catch composition of dol nets recorded during the study from both the net included *Coilia dussumieri*, *Acetes indicus*, *Trichiurus lepturus*, and *Harpadon nehereus*. On average, plastics formed 4.09% of the total catch from experimental fishing. It was also observed that square mesh panels reduce the sorting time which consumes less time and labor to sort the catch onboard. Findings of this study could be used as baseline information on the design specifications, parts, and operation of dol nets, which would help for technological innovations of the nets and their operation in a sustainable manner and suggest measures to ensure the sustainability of dolnet fishery resources.

3.9 Climate Change and Vulnerability

Assessing Carbon Sequestration Capacity and GHG Emission Potential and its Mitigation under Different Aquaculture Systems

CIFE/2019/14(A)/IF

Project duration:2019- 2022

Principal Investigator
Dr. Vidya Shree Bharti

Co-Principal Investigators
Dr. Gayatri Tripathi
Dr. Rathi Bhuvaneswari
Mr. V. Harikrishna
Dr. Sunil Kumar Naik

Biochar kiln and gas collection chamber was designed and fabricated at CIFE for the production of biochar and collection of greenhouse gas from the pond. It was observed that the potassium enriched biochar significantly rectifies the deficiency of potassium in shrimp in inland saline water. Potassium enriched biochar coated feed meets the potassium requirement of the shrimp in an inland saline system deficient in potassium for optimum growth of the shrimp and fish. Biochar amendment to the soil reduces the emission of nitrous oxide in the pond condition and improves the growth and production of fish and shrimp in aquaculture. Carbon sequestration potential is higher in cultured ponds compared to the newly opened pond. Higher stocking density reduces the sequestration due to emission of carbon dioxide during aeration. Stocking density of 45 Nos/m² is significantly enhancing the carbon sequestration potential than 60 Nos/m².

Some significant Achievements are

- Biochar amendment in the sediment significantly improve the sediment health and water quality parameter and productivity of the system
- It was observed that emissions of Nitrous oxide were significantly less in biochar treated ponds compared to control.
- The average fluxes of N2O in shrimp culture ponds of SD-30, SD-45, SD-60 were 122±38, 425±85, 440±84 ppb/m²/day, respectively
- Biochar ensures a lower environmental footprint by reducing greenhouse gas emissions. Hence, the application of biochar in the aquaculture field is a future approach for better productivity and sustainability.

Carbon accumulation rates in sediments from different shrimp farming ponds

Pond	Age	Sediment depth (cm)	Sediment accumulation rate (cm year^{-1})	Sediment dry bulk density (g cm^{-3})	Sediment oxidizable organic carbon (%)	Carbon accumulation rate in sediment (kg ha^{-1} year^{-1})
P1	8	12.9±1.2*	1.62±0.02	1.07	0.62^{b}±0.04	1073^{b}±75
P2	8	13.6±1.4	1.71±0.01	0.97	0.64^{b}±0.01	1054^{b}±30
P3	7	11.6±1.2	1.66±0.02	1.01	0.80^{c}±0.01	1346^{c}±28
P4	7	10.8±1.4	1.57±0.03	1.14	0.50^{a}±0.02	902^{a}±28
P5	5	9.05±0.8	1.81±0.03	1.13	0.48^{a}±0.015	987^{ab}±52
P6	5	9.35±0.5	1.87±0.05	1.09	0.52^{a}±0.01	1055^{a}±54

*Values within a column followed by different letters are significantly different at $p < 0.05$, as obtained from the Duncan multiple range test

Documentation, Inventorization and Bioprospecting of Micro-algae of Freshwater, Habitats of Maharashtra for Atmospheric Carbon Sequestration

CIFE/2019/14(B)/IF

Project duration: 2019-2022

Principal Investigator
Dr. S.P. Shukla

Co-Principal Investigators
Dr. Rathi Bhuvaneswari
Dr. Saurav Kumar
Dr. Kundan Kumar

Three new prototypes of bioreactors (two tubular and one open raceway) were developed for the biomass production of a commercially important cyanobacterium Spirulina (Arthrospira) platensis. The trials were completed and the design of the tubular photobioreactor was transferred to Phoenix Agrotech LLP in a non-exclusive mode. MoU was also signed with the industry for follow-up. A low-cost medium for biomass production was formulated that reduced the cost almost ten times. The medium was further amended for a higher yield of a value-added pigment phycocyanin. The prototypes developed and tested can facilitate biomass production throughout the year without any interruption which is not possible in open raceway ponds during the rainy season. A single step process was developed for purification of a valuable pigment phycocyanin (colorant grade).

Enhancing Physiological and Metabolic Adaptive Mechanism of GIFT to Hyper-thermal Stress through Dietary Interventions and Environmental Manipulation

CIFE/2022/13/IF

Project duration:2022- 2025

Principal Investigator
Dr. Tincy Varghese

Co-Principal Investigator
Dr. Subodh Gupta
Dr.Sikendra Kumar
Dr.Rathi Bhuvaneswari

All male seeds of GIFT tilapia were procured from RGCA, Chennai and acclimatized for a week in ambient temperature. They were acclimated to three temperatures namely, 26.2, 27.5, 28.4 for 15 days with basal feed containing 30 % crude protein and 6% Crude lipid. Critical thermal maxima (CTmax) were estimated by following a reduction of 0.5°C in every 30 minutes using the water bath and an additional aquarium thermostat. CTmax obtained for the acclimation temperatures 26.2°C, 27.5°C and 28.4°C were 41.8°C, 42.2°C and 42.4°C, respectively. Based on the critical maximum temperatures, a high temperature of 33.3°C and ambient normal temperature of 28.3°C were selected for the second experiment to determine the preferred energy source during the thermal stress in GIFT.

Bioprospecting of Thermotolerant Freshwater Microalgae in Climate Change Scenario

CIFE/2022/12/IF

Project duration: 2022- 2025

Principal Investigator
Dr. Rathi Bhuvaneswari G.

Co-Principal Investigator
Dr. S.P. Shukla
Dr.Tincy Varghese

Study on the effect of higher temperature on the mesophilic algae was initiated using sample from Powai Lake and Rajgir (Nalanda Bihar). Isolation of pure cultures initiated for the screening of microalgae from culture collections for thermal tolerance. Specific growth rate and doubling times of Chlorella vulgaris and Spirulina platensis were calculated. Elemental analysis of Carbon, nitrogen, hydrogen, and sulfur contents in the biomass of Chlorella vulgaris and Spirulina platensis using a CHNS analyzer (Elementary, VarioMICRO). Carbon content in the biomass ranged from 44-48 % in outdoor culture units. Nitrogen content recorded was in the range of 9-10% in the biomass produced in outdoor units. The downstream processing of the Spirulina biomass yielded 10-12% phycocyanin. The samples collected from the hot water streams were analysed and the algal species present were recorded.

Effects of Biotic and Abiotic Factors on the Responses of Selected Bivalves to Ocean Acidification

CIFE/2016/FRM607/SR

Chitra Soman

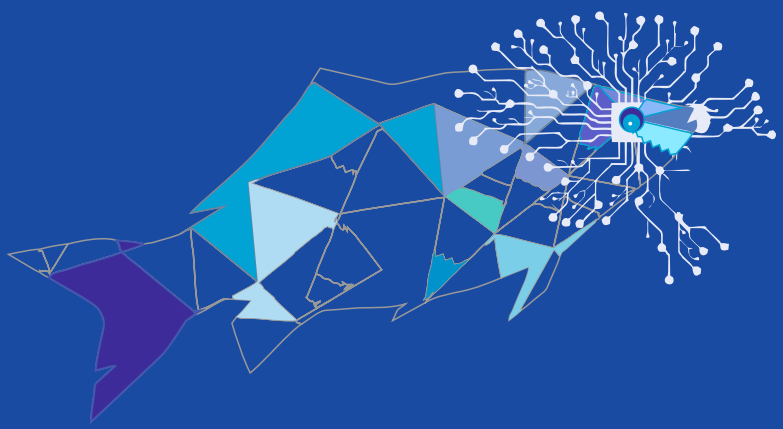
Major Advisor: Dr. B.B. Nayak

Coastal and marine ecosystems are under extreme stress due to the changing climatic factors. The increasing CO_2 levels in the atmosphere are reduced by the oceans, which have absorbed about 29 per cent of global CO_2 emissions. In this study, the present conditions of the coastal waters of the north Mumbai coast were evaluated based on which the experimental studies on ocean acidification were planned. The experimental studies covered present and future CO_2 levels affecting the pH of the seawater, varying salinity levels, temperatures. Animals were exposed to varying conditions, and their survivability with respect to feeding and their growth was measured. The primary field study aims to appraise the spatial and temporal dynamics of the physicochemical conditions of the coastal waters of the north Mumbai coast in India. Four sampling stations were monitored in the coastal area, where two stations were fixed near the coast (Off Aksa and Juhu beach) while the other two were away from the coast.

Overall, SST, pH, alkalinity, and phosphorus showed significant variation when the data across seasons were analyzed, whereas chlorophyll a and phosphorus showed significant variation across stations in the two way univariate ANOVA model. We investigated that the present environmental pCO_2 level varied between 207 to 1844 µatm. A laboratory experiment was conducted to study the effect of food availability on the response of clam species, Gafrarium divaricatum in different seawater pH conditions manipulated by bubbling of

CO_2. The clams were exposed to the combined effect of two factors, such as two variations of feeding density of Isochrysis algal cells (low: 2500 cells/ml and high: 10000 cells/ ml) and four different seawater pH levels (8, 7.7, 7.4 and 7.1) for 60 days. In low feeding levels, the survival rate was reduced with mortality increased at 7.4 and 7.1 pH conditions, whereas mortality was less evident in the high feeding level. Most ocean acidification studies reveal the potential of organisms to physiologically acclimatize to ocean acidification conditions where food availability may play a crucial part in counterbalancing the decreased seawater pH effect on bivalves. In another experimental setup, the multifactorial exposure effect of *Meretrix meretrix* to different levels of CO2 corresponding to pH of 7.9, 7.5, 7.1; the salinity of 30 ppt & 35 ppt and water temperature of 25 and 30 °C were elevated for 90 days. This study determined the combined effects of predicted near-future levels of ocean acidification on the response of *M. meretrix,* specifically on the growth, mortality and structure of the shell. The survival rate was highest (70%) in the combination of 25° C*30 ppt*7.9 pH and lowest (20%) in the 7.1 pH combined with a salinity of 35 ppt in both temperature levels. Salinity and pH were found to affect the shell growth significantly, with growth at the 25° C × 30 ppt × 7.9 pH combination yielding higher growth than all other treatment groups in *M. meretrix*. Stereomicroscopic and SEM imaging reveal that ocean acidification impairs the calcification process at low pH (7.1), causing evidence of inner shell surface dissolution.

3.10 Seafood Quality & Value Addition



Microbial Remediation of Fish Scale Bio-waste and its Potential Application in the Production of Biologically Active Compounds

(CIFE/2021/1/IF)

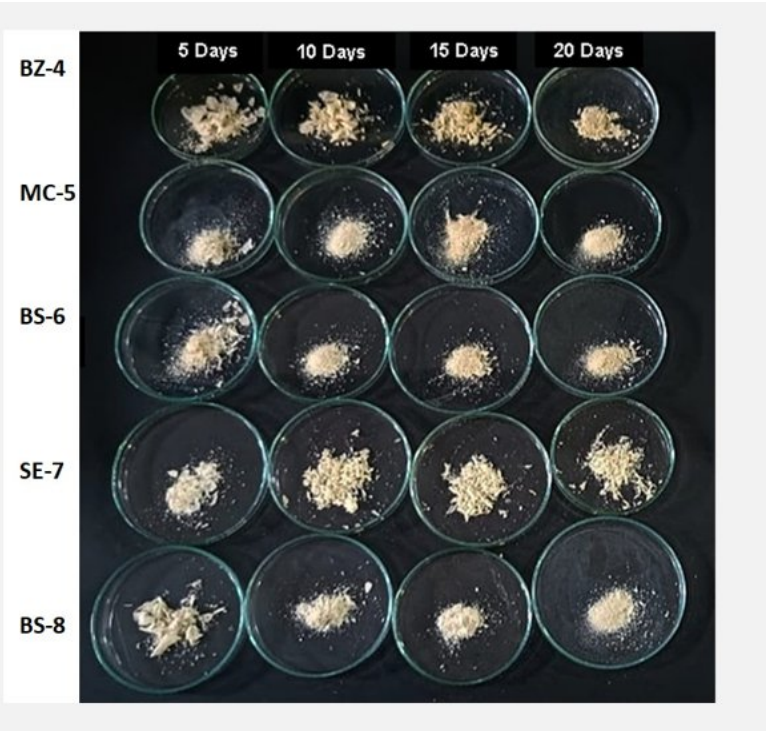
Project duration: 2021-2024

Principal Investigator
Dr. Sanath Kumar H.

Co-Principal Investigators: ,

Dr. Binaya Bhusan Nayak
Dr. Amjad K. Balange
Dr. Manjusha Lekshmi

Fish scales, which weigh typically between 1-2% of the body weight of fish, are an important component of fish waste generated post-processing. Due to their slow degradation and negative environmental impact, fish scales offer a formidable challenge for their disposal. The biological method of degrading the scales is an effective and environment-friendly method of remediating fish waste. This project aims to identify and characterize fish scale degrading bacteria from the marine environment and employ them to hydrolyze fish scales in a laboratory scale. Fifteen isolates used in this study were identified by sequencing of partial 16SrRNA gene. Preliminary experiments using Rohu and mixed carp scales revealed that all 15 isolates could degrade the scales at varying levels in Luria Bertani (LB) broth and in simple nutrient broth containing peptone or tryptone and salt. Following this, the degradation experiments were carried out for 5, 10, 15, and 20 days using different media prepared in seawater. The moisture, protein, ash, and fat contents of degraded scale products were 15.4%, 6.02%, 44.1%, and 1.02%, respectively. Of all the bacterial strains tested in this study, PF-A9 showed the highest scale degradation efficiency of 68% in LB broth prepared in seawater after five days of incubation. Other isolates also exhibited scale degrading abilities in the range of 40-60% over varying incubation periods. Some isolates such as MC-A5, SE-A7, BS-A8. BS-A12, SM-A13, VS-KT02, and LF exhibited efficient scale degrading abilities in all the media tested in this study. Physical observation of scales at the end of experiments revealed complete disintegration into a fine powder suggesting efficient degradation of scales by bacteria of marine origin (Fig. 1).



- Bacteria of marine origin are valuable in remediating fish scale and reducing environmental impact.
- The degradation of scales can be achieved using simple seawater growth medium containing peptone derived from animal/plant wastes
- The process is economical and ensures a circular and bio-economy towards utilizing all forms of fish waste generated in fish processing industries.

(CIFE/2020/PHT002/SR)

Physiological Characterization of Fish Scale Degrading Bacteria from the Marine Environment

Pragati Shetty

Major Advisor: Dr. Sanath Kumar

The biological method of degrading the scales is an effective and environment-friendly method of remediating fish waste. The study aimed to identify and characterize fish scale degrading bacteria from the marine environment and employ them to hydrolyze fish scales in a laboratory scale. Fifteen isolates used in this study were identified by sequencing of partial 16S rRNA gene. Of all the bacterial isolates tested in this study, *Priestia flexa* (A9) showed the highest scale degradation efficiency of 68% in LB broth prepared in seawater after five days of incubation. Other isolates also exhibited scale degrading abilities in the range of 40-60% over varying incubation periods. Some isolates such as *Macrococcus caseolyticus* (A5), *Staphylococcus epidermidis* (A7), *Bacillus stratosphericus* (A8). *Bacillus subtilis* (A12), *Stenotrophomonas maltophilia* (A13), *Virgibacillus salaries* (KT02), and *Lysinibacillus fusiformis* exhibited efficient scale degrading abilities in all the media tested in this study. This study also employed peptone derived from fish waste as the media for scale degradation. The degradation experiment was scaled up to 1 L. Three selected bacteria viz. *Staphylococcus epidermidis* (A7), *Bacillus subtilis* (A12,) and *Stenotrophomonas maltophilia* (A13) were used individually as well as in mixed cultures. Fish waste-derived peptone was used in this experiment at 0.1% (w/v) level. The mixed cultures showed the highest (70.02%) degradation after 20 days of incubation. This study shows that bacteria of marine origin can be potentially valuable for remediating fish scale and reducing environmental impact. Further, the degradation of scales can be achieved using peptone derived from fish waste which would make the process economical and ensure a circular economy towards utilizing all forms of fish waste generated in fish processing industries.

(CIFE/2020/PHT006/SR)

Feasibility of Using Fish Waste-derived Peptone as a Growth Media Component for Laboratory Cultivation of Bacteria

Sousruti Kar

Major Advisor: Dr. Sanath Kumar

Peptone is the primary element in bacteriological media. Fish peptone can be prepared by acid hydrolysis, alkali hydrolysis, and enzymatic hydrolysis of fish waste. The present study aimed to explore the feasibility of using fish waste-derived peptone as a bacterial growth media component. The optimum degree of hydrolysis was determined by using Response Surface Methodology (RSM). The mackerel fish waste and mixed fish waste were used for the preparation of peptone using papain enzyme and the hydrolysate was spray dried. The peptone powder was used to replace the commercial peptone in culture media at 0.25%, 0.5%, 1%, and 2% levels. Fish peptone incorporated broth and agar media were used for growing Gram-positive and negative bacteria namely *Escherichia coli, Staphylococcus aureus, Klebsiella pneumoniae* and *Lysinibacillus fusiformis.* All bacterial species grew well at

different concentrations of fish peptone. Growth curve analysis indicated a higher rate of growth of bacteria on fish peptone compared to the commercial peptone. Fish peptone incorporated alkaline peptone water (APW) enrichment broth and thiosulphate citrate bile salts sucrose (TCBS) agar were used for the selective enrichment and isolation of *Vibrio* spp. Isolation rates of *Vibrio* spp. on fish peptone containing media was similar and comparable with commercial peptone containing media. The results suggest the potential application of peptone derived from fish waste as a microbiological media component. The method of fish peptone utilization described in this study will help valorize fish processing waste and reduce the environmental impact of fish waste.

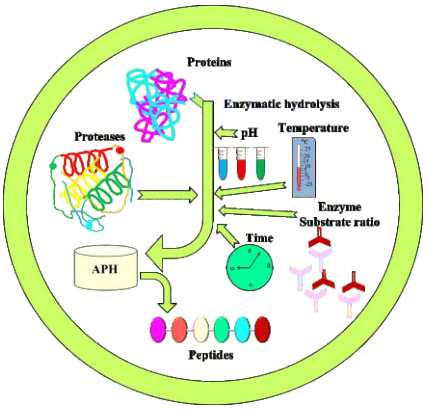
Valorization of *Acetes* spp. for the Bioactive Peptides and Biopolymers

(CIFE/2016/PHT603/SR)

Vignaesh D

Major Advisor: Dr. Martin Xavier K. A.

Acetes spp are unexploited tiny shrimps that are mostly caught as bycatch and are an excellent source of protein and chitin. In the present study, *Acetes* protein hydrolysates were prepared with four commercial proteolytic enzymes (alcalase, papain, trypsin and pepsin) independently and the process conditions were optimized with Response Surface Methodology using Box Behnken design. To obtain the desired DH (between 5 to 30 %), the influence of duration on the degree of hydrolysis (DH) was evaluated using a linear regression plot. The structural and functional characterization of optimized spray dried protein hydrolysates were investigated. The shell residue that remained after enzymatic hydrolysis was utilized for the chitin extraction following the removal of traces of protein and minerals with modest chemical treatments. The optimum hydrolysis conditions for alcalase, trypsin, papain and pepsin were found to be 8.00, 8.04, 7.04 and 3.08 for pH and 1.53, 1.24, 2.10 and 1.84 for E/S and 53.5, 37.8, 52.9 and 37.6 °C for temperature respectively. The time required to achieve 5 to 30% DH at different enzymatic treatments ranged from 21.33 to 197.95 min. The DH and pH regulated the functional properties of the optimized spray dried protein. The influence of DH on bioactive properties such as 2,2-Diphenyl-1-picrylhydrazyl (DPPH) radical scavenging activity, 2,2'-azinobis 3-ethylbenzothiazoline sulfonic acid (ABTS) radical scavenging activity, metal chelating activity and Angiotensin Converting Enzyme (ACE) inhibition activity was investigated. The consequences of DH on Peptide Chain Length (PCL) ratio and secondary derivative structure of *Acetes* protein hydrolysate at different enzymatic treatments was analysed. Chitin prepared from shell residue using alcalase showed higher degree of deproteinization (DDP) and degree of N-acetylation (DA) values. Therefore, DH-5, DH-15 and DH-30 were selected for the evaluation of quality parameters such as X-ray Diffraction and Scanning Electron Microscope. The current study suggested that DH influenced the functional characteristics of protein hydrolysates, and that chitin recovery through enzymatic deproteinization might be a potential technique for enhancing chitin quality. Adopting this technology for valorization of *Acetes* shrimp through production of protein hydrolysates and chitin could enhance the sustainable utilization of *Acetes* that land on the Indian coast.



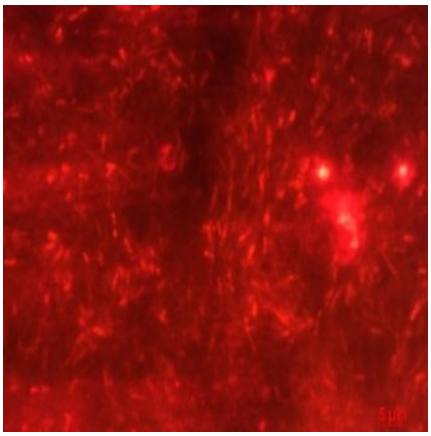
Distribution of Pathogenic Microaerophilic *Arcobacter* sp. in Seafood and Development of a Rapid Method for its Detection

(CIFE/2021/1001/EF)

Project duration: 2021-2024

Principal Investigator
Dr. B.B. Nayak

Co-Principal Investigators
Dr. Sanath Kumar H.
Dr. Manjusha L.



Sixteen samples of fish and shellfish were analyzed for *Arcobacter* isolation using selective enrichment broths and isolation agar media. A total of 99 isolates presumptively identified as *Arcobacter* spp. based on Gram staining catalase, oxidase, and urease tests, growth on Mac Conkey agar, in 2% and 4% NaCl, Nitrate reduction and Indoxyl acetate reduction. The isolates were subjected to PCR targeting the 16SrRNA gene. Of these, 25 were identified as *Arcobacter* spp. by PCR. Seventeen isolates retrieved from the laboratory and corresponding to a previous work were also subjected to PCR, followed by sequencing of PCR products. Of these, 13 were confirmed as *Arcobacter butzleri* and two as *Arcobacter skirrowii*. Flourescent in-situ hybridization was carried out using fluorescent dye-labeled genus-specific and species-specific probes for Arcobacter identification .

Enumeration of *Arcobacter butzleri* from Seafood by Using Fluorescent *in-situ* Hybridization.

(CIFE/2020/PHT009/SR)

Veeranki Sai Krishna

Major Advisor: Dr. B.B Nayak

Arcobacter spp. are emerging foodborne and waterborne pathogens known to cause human infections. Among *Arcobacters, A. butzleri* is the most important and potential pathogenic species. The present study reports using fluorescent in-situ hybridization to detect and enumerate *Arcobacter butzleri* from seafood. For this study, *Arcobacters* were isolated from various seafood samples and previous isolates in glycerol stock stored in CIFE repository were also revived. From a total of 89 isolates, 20 isolates showed typical positive results in biochemical tests and confirmed in PCR by using *Arcobacter butzleri* specific primers, Butz-F and Arco-R. They were sent for 16s rRNA sequencing for further confirmation. *Arcobacter butzleri* whole and partial genome sequences were collected from NCBI database to select the target sites. Whole cell hybridization experiments were performed for the pure cultures by using EUB 338 (Universal Eubacterial target), ARC94 (*Arcobacter* specific probe) and Arcobu (*Arcobacter butzleri* specific target) probes on black poly carbonate filters, charged slides and normal glass slides. When the cells were hybridized by using universal probe, all the bacterial cells present in the sample got fluoresced, whereas when specific probe ARC94 was used, only the target bacteria with the complementary sequence from the probe got fluoresced. Hybridization was performed by using Arcobu probe and those filters could not examined due to some technical problems. With the specialized microscope *E. coli* as negative control did not elicit any fluorescence. The sensitivity of the probes was as low as 1/32 dilution. On artificial seeding experiment, the muscle layers were seen to be attached to *Arcobacter* cells. This method serves as a rapid detection technique for enumerating and detecting pathogenic bacteria from seafood, thus may help in preventing outbreaks by early detection.

Development of Molecular Methods for Detection and Quantification of *Cronobacter* spp. of Human Health Significance in Seafood

(CIFE/2022/18/IF)

Project duration: 2021-2024

Principal Investigator
Dr. Manjusha L.

Co-Principal Investigators
Dr. Binaya Bhusan Nayak
Dr. Rajendran K. V.
Dr. Sanath Kumar H.

Seafood samples comprising of finfish, shellfish and dry fish samples were collected from retail fish markets. A total of 15 samples were analyzed that included 5 samples each of finfish, shellfish and dry fish. Indian mackerel, Bombay duck, black pomfret, golden anchovy and sin croaker constituted the finfish samples, whereas kiddi shrimp, crab, paste shrimp, clam and cuttlefish constituted the shellfish samples. Dried samples were comprised of paste shrimp, kiddi shrimp, golden anchovy, Bombay duck and ribbon fish. The collected samples were screened for the presence of *Cronobacter* sp. by using different combinations of screening broth, enrichment broth and selective media. Out of 15 samples, 620 presumptive isolates of *Cronobacter* sp. were obtained from 13 samples by selective plating using the different media combinations, with and without the addition of vancomycin supplement. These isolates were screened for important biochemical confirmatory tests for *Cronobacter* sp. such as IMViC, malonate, glucose, lactose, nitrate, lysine, ornithine and phenyl alanine tests. Based on the results obtained, few isolates were subjected to PCR using different genus and species-specific primers such as SG, SI, Saka, ES and Csak primers. Of these, 8 isolates showed positive amplification for *Cronobacter* sp.

Incidence and Characterization of Non-lactose Fermenting Enterobacterales in Fresh Seafood

(CIFE/2020/PHT004/SR)

Santosh Kumar Panda

Major Guide: Dr. Manjusha L.

This study investigated the presence of non-lactose fermenting Enterobacterales (NLFE) in seafood collected from fish landing centres and markets from Mumbai, India. A total of 18 samples were screened, which included 9 samples each of fresh finfish and shellfish. Among these, 11 samples (61%), constituting 6 finfish and 5 shellfish samples were shown to be positive for NLFE by plating on Mac Conkey agar. Presumptive white colonies of NLFE (156 no.) were subjected to Gram's staining, oxidase, catalase and glucose tests. All isolates were Gram negative and catalase positive. Eighty-nine oxidase negative isolates were obtained, out of which 42 turned out to be glucose positive NLFE, which were used further for biochemical and virulence characterization. Identification of 14 NLFE isolates was carried out using Hi25TM Enterobacteriaceae Identification Kit. The NLFE identified included 1 isolate each of *Proteus mirabilis, Enterobacter amnigenus* (Biogroup 1), *Enterobacter gergoviae, Citrobacter amalonaticus, Enterobacter cloacae, Serratia marcescens, Enterobacter agglomerans, Pragia fontium* and *Morganella morganii*, 2 isolates of *Escherichia fergusonii*, and 3 isolates of

Proteus vulgaris. The results of uidA PCR showed 3 of the isolates to be positive, indicating the presence of beta-glucuronidase enzyme. The NLFE isolates of the study were also screened for the presence of virulence traits such as shiga toxin and labile toxin, the results of which showed a faint amplification of shiga toxin gene by one of the isolates, which needs further confirmation. The study of antibiotic susceptibility pattern of NLFE was done by testing them against 14 commonly used antibiotics using disc diffusion method. Resistance to ceftazidime was exhibited by all isolates, followed by tetracycline (90.47%). All the isolates tested (100%) showed sensitivity to ertapenem and gentamicin, followed by ciprofloxacin (97.61%), whereas none of the isolates were resistant to imipenem. Resistance to two or more antibiotics was detected in 32.5% of the isolates showing resistance to seven antibiotics. Overall, incidence of NLFE was generally found more in shellfish which can be attributed to their filter feeding habit leading to accumulation of pathogens. Multidrug resistance was also predominantly found in shellfish samples. Incidence of NLFE (61%) in seafood in this study is its first report from India. Moreover, the plausible presence of a potential virulence gene and multidrug resistance of NLFE add to their significance from public health and food safety perspectives, as they often pose a diagnostic challenge by way of misidentification with other closely related bacterial species.

(CIFE/2016/PHT605/SR)

Development and Quality Improvement of Fish Sausage from Indian Major Carps

Sandeep Bhaskar Gore
Major Advisor: Dr. A. K. Balange

This study was aimed to explore the possibilities of better utilization of the carps by development of value-added fish products in the form of fortified fish sausages and to study its storage stability at low temperature. The investigation was carried out through three experiments. In the first experiment, the Indian major carps (*Catla catla, Labeo rohita and Cirrhinus mrigala*) were employed to study the quality of sausage prepared from unwashed and single washed mince. The gel forming ability of fish muscle is very important for the development of sausage like products. The gel strength of sausage from unwashed mince was found more than the single washed mince, however, colour parameters of sausages from single washed mince were significantly better than its counterpart. Among Indian major carps, rohu was selected for further study based on cost, availability and preference of fish among consumer. In the second experiment, the concentrations of additives (starch, MTGase and tea extract), cod liver oil and oat fiber were optimized to improve textural and nutritional quality of sausages from mince. Among additives, starch (8%) was found to be potential additive to improve the mechanical properties of sausage. The cod liver (8%) and oat fiber (2.5%) were optimized to offer multiple health benefits to the consumer. In the third experiment, the shelf-life stability of sausages from mince of rohu were studied at refrigerated (4±1ºC) and frozen (-18±2ºC) storage temperature. The gel strength of prepared sausages was found to have increased during low temperature due to the effect of storage temperature and time. However, biochemical and microbiological quality characteristics of sausages from mince were significantly increased and sensory scores were gradually decreased during low temperature preservation. Nonetheless, sausages prepared from mince of rohu could be stored for 49 days at refrigerated temperature without affecting sensory quality. The sausages from mince were found to be best up to three months during frozen temperature which can be seen through formation of large pores due to inability of mince to retain starch, fiber and oil intact. The fortified sausages from mince were rated as “like very much” at the beginning to “like slightly” at the end of frozen storage.

Microplastic Contamination in Fishery Products

(CIFE/2021/9/IF)

Project duration: 2021-2024

Principal Investigator
Dr. K. A. Martin Xavier

Co-Principal Investigators
Dr. Binay Bhusan Nayak
Dr. Amjad Khansaheb Balange
Dr. Layana Porayil
Dr. S. Monalisha Devi

During this study period, cured fish samples from five stations along the eastern parts of India were studied. Station 1 and 2, 3 are from the south east, 4 and 5 are form the central east coast of India. These stations along the east coast of India known to have major fish curing yards and salt cured fish and sea salt samples were selected for sampling. Based on local availability and consumer preference, 150 cured fish samples (30 from each) were collected from five stations during the study. All the samples were collected from the site with the help of local fishers who were employed in traditional fish curing business. Microplastics were found in all the collected salt cured fish and the salt samples with the average abundance of 45.99 ± 11.24 MPs items/g and 171.3 ± 52.4 items/100g across all the stations. Kolmogorov - Smirnov test of the data proved that it is normally distributed (D = 0.08). Among the five stations, the abundance of microplastics in salt cured fish and salt was highest at station 2, with an average abundance of 54.06 ± 14.48 MPs/g and 235 ± 42 MPs/ 100 g respectively. There was no significant difference ($p > 0.05$) in MPs abundance of cured fish samples of various studied locations. Whereas, the average abundance of MPs in salt samples in various studied stations was significantly different from each other ($p < 0.00$) and was highest in station 2 and lowest in station 5. Overall, *Sardinella longiceps* of station 2 found to have more abundance of MPs (73.5 MPs items/g) and *Rastrelliger kanagurta* of station 1 was found to have lowest abundance of MPs (26.67 MPs items/g). Pearson correlation test indicates, there was a weak positive correlation ($r = 0.3$, $R^2 = 0.1$) between MPs abundance in salt samples and salt cured fish samples. Whereas there was negligible positive correlation ($r = 0.1$, $R^2 = 0.006$) between fat content of fish and it's microplastics abundance. Moreover, with an average of 45.94 ± 9.86 MPs/g the salt cured fatty fish samples (> 5% fat by weight) were found to similar MPs abundance as lean fish (< 5% fat by weight) containing 46.01 ± 12.01 and further interpretation revealed that, dried demersal fish observed to have significantly higher ($p < 0.05$) MPs/g than pelagic dried fish.

Abundance and Characteristics of Microplastics in *Sardinella longiceps* (Valenciennes, 1847) and Cynoglossus *macrostomus* (Norman, 1928) along the West Coast of India.

(CIFE/2020/FRM004/SR)

Sagar Ronad

Major Guide: Dr. Shashi Bhushan

Microplastics (MPs) are anthropogenic pollutants, which are being detected in the water, sediments, and guts of many aquatic organisms which is an alarming issue. This study was undertaken to assess the abundance and characterize microplastic pollution in selected fishes landed along the West Coast of India. Two of the commercially important species landed along the west coast, Indian Oil Sardine. *Sardinella longiceps* Valenciennes, 1847 and Malabar sole, *Cynoglossus macrostomus* Norman, 1928 were selected for the study.

Fishes were collected from four landing centers (Versova Fish Landing Centre- Mumbai, Dhakke Fish Landing Centre- Mangalore, Thoppumpady Fish Landing Centre, and Marmagao Fish Landing Centre-Goa). A total of 1637 microplastics were observed among 240 samples studied along the west coast. The mean number of MPs per individual in gastrointestinal tracts (GI) tracts varied from 5.57±0.85 to 13.13±1.49 in *S. longiceps* and 2.10±0.49 to 8.07±0.98 in *C. macrostomus* along the west coast. There was no significant correlation between abundance of MPs and total length, body and gut weight of Oil Sardine along west coast, while there was a significant correlation between abundance of MPs and total length, body and gut weight in Malabar Sole along the West Coast. According to shape, MPs were classified into five types, in which fragments were the most abundant shape of MPs along the West Coast, followed by fiber, microbead, film and irregularly shaped MPs. Six different colors MPs were recorded in the present study and transparent color was the most abundant color found followed by black color, red color, blue color, brown color and yellow color. Based on size,100-250µm size range was the most dominant MPs size range from all along the coast. Eight different polymers were detected in the present study, in which polypropylene and polyethylene were the most dominant polymer. The other polymers like High Density Polyethylene (HDPE), PET, Polyester, Polyvinylidene fluoride (PVDF), and polyoxymethylene were also identified from the samples. The study shows the accumulation of microplastics in the gut of commercially important fishes landed along the West Coast of India and poses a risk to consumers and organisms sharing the food chain.

Effect of Salt on the Microplastics Abundance in Different forms of Salt Dried Fish

(CIFE/2020/PHT003/SR)

Sandhiya V.

Major Guide: Dr. K.A. Martin Xavier

Drying is one of the traditional methods of preservation widely practiced all along the Indian coast for the preservation of fish. Salt is added to the fish to speed up the drying process, to add flavor, and to inhibit bacterial spoilage. The presence of microplastics in salt is evident from the research works by several authors around the globe. The curing salt collected from the Versova drying yard has a mean microplastic abundance of 41.5 MPs/g of salt. Indian Mackerel, *Rastrelliger kanagurta* salted at different fish to salt ratios as 1:1, 3:1, 5:1, 7:1, and 10:1, followed by a mechanical drying process revealed that, as the salt concentration increases the microplastics count also increases which is evident from the results as it decreases from 65.7 ± 6 MPs/g to 3.36 ±1.5 MPs/g in 1:1 to 10:1 (fish: salt) salted mackerel. In order to figure out the impact of different processing styles on the microplastics abundance of salt-dried fish, Indian Mackerel was processed into three processing styles- eviscerated, butterfly and steaks then, salted in 3:1 fish-to-salt ratio followed by a mechanical drying process which revealed that the mean microplastic abundance in the edible tissue was 32.67 ± 5 MPs/g, 75.34 ± 6 MPs/g, and 8.6 ± 2 MPs/g in eviscerated, butterfly and steak processing styles. Among the three styles butterfly style has a greater number of microplastics owing to its larger surface area. The major size, color, and morphology of the isolated microplastics in both the studies were <100 µm, brown color, and fragments. In the study of effect of different drying locations in the microplastic abundance of salt-dried mackerel, it has been found that sun-dried mackerel had more number of microplastics than mechanical dried and beach dried mackerel. This study revealed that the environmental microplastic contamination also adds up microplastics in the salt-dried fish. In the study of effect of brining on the microplastic contamination in mackerel, 5%,15% and 26% brine solutions were prepared and the fish was subjected to salting, it has been found that there is a significant difference between the microplastic content in 5% and 26% brine salted mackerel ($p<0.05$) at time intervals of 4hr, 8hr, 12hr, 16hr, 20hr and 24hr salting period.

Abundance of Microplastics in Cured Fishes along the Eastern States of India

(CIFE/2017/PHT703/SR)

Suguna P.

Major Guide: Dr. K.A. Martin Xavier

The incidence of microplastics (MPs) and their negative consequences on natural ecosystems have sparked alarm in the scientific community worldwide. In this study, the prevalence of microplastics in cured fish samples and salt, which is used for the curing process in different locations in the eastern states of India, was assessed. A total of 38 cured fish samples were collected and subjected to digestion, filtration, density separation, and the extracted polymers were characterized by size, shape, and color under a stereomicroscope. Polymer confirmation was done by using Fourier Transform Infrared Spectroscopy. Among the cured fish sampling sites, the Tuticorin sampling site was identified with the highest microplastics number of 54 items/ g of cured fish sample. The Visakhapatnam sampling site was found with the lowest abundance of 36 items/ g of cured fish sample. Among the salt samples from curing yards, Tuticorin sampling sites were reported with the highest microplastic abundance of 235.33 ± 20.98 items/ 10 g of salt sample, and the Agartala sampling site was reported with the lowest abundance of 89.00 ± 11 items/ 10 g of salt sample. Microplastic abundance in cured fish and salts were decreased in the order of TNT > ODG > TPA > TNM > APN >APV and TNT > APN > TNM > APV > ODG > TPA, respectively. The dominant MPs size in cured fish and salt samples was observed as less than 250 µm category. The dominant morphotype of MPs was observed as the fibres and fragments category. Translucent, Blue, and Black coloured MPs plastics are dominant among the different colours. Nevertheless, there was a significant reduction in numbers observed after washing. This study forms the first baseline research on microplastics in cured fish in India. There must be more studies that have to be done to establish the remedy for reducing the microplastic-associated risk in cured fish.

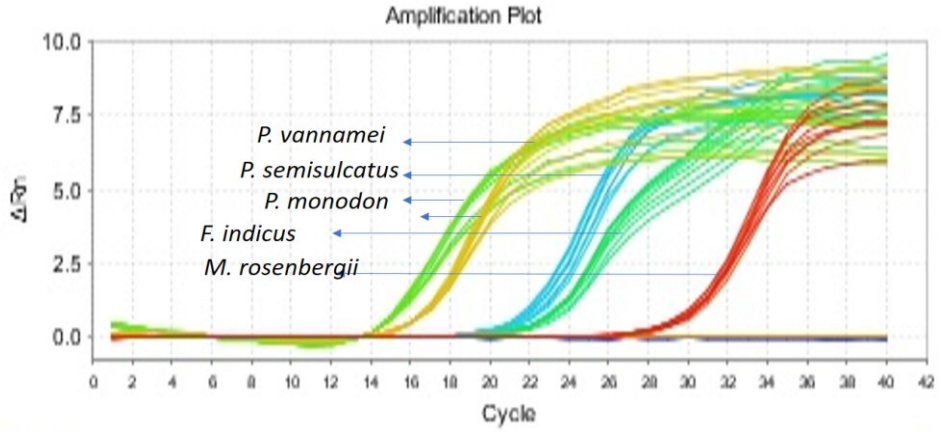
Development of DNA Based Methods for Rapid Species Identification of Raw and Processed Shrimps

(CIFE/2020/PHT007/SR)

Lidiya Wilwet

Major Guide: Dr. G. Jeyasakaran

Food authenticity is an issue of great concern for food regulatory authorities, as mislabelling is one of the biggest commercial frauds in the food industry. In this study, different PCR based methods such as species-specific PCR, multiplex PCR and Realtime PCR protocols were developed to authenticate shrimp products of commercial significance viz. *Penaeus monodon, Penaeus semisulcatus, Fenneropenaeus indicus, P. vannamei, Macrobrachium rosenbergii, Metapenaeus affinis,* and *Heterocarpus gibbosus.* Mitochondrial 16S rRNA and nuclear ITS1 genome regions were chosen as the molecular targets for authentication. Species-specific primers (PM-F2/PM-R3, PsIT-F1/ PsIT-R1, FI-F2/FI-R3for



LVF1/LVR1, Mar-F2/Mar-R3, MA-F1/MA-R1, and HeG-F1/HeG-R1) were designed using bioinformatics tools such as NCBI GenBank database, CLUSTAL OMEGA and BioEdit. The PCR amplified the respective targets successfully and the amplicons were sequenced, analysed using BLAST tool in NCBI and sequences of different species of South Indian coast were deposited in GenBank database. PCR amplification was performed targeting 16S rRNA and ITS1 regions using the specific primers for shrimps. The specificity and the limit for detection of shrimp species were confirmed with targeted shrimp and fishes. The designed primers successfully amplified the targeted species and no cross amplification was observed. The limit for detection of shrimp species was 1- 0.1 ng/ml. Raw, frozen, cooked, fried and canned shrimp products processed by standard procedures were authenticated with developed PCR arrays. Unique positive amplifications were also obtained in processed shrimp products without any degradation or alteration in the major fragments. The methods were also validated with commercial shrimp products. As the developed PCR assays possess specificity, sensitivity, and applicability, they can be used by food regulatory authorities for authentication of shrimp species in seafood processing industries.

Effect of Drying on The Quality and Stability of Small Fish "Bhat Masali"

(CIFE/2020/PHT010/SR)

Tanushree Sardar

Major Guide: Dr. A.K. Balange

Small indigenous fish provides crucial nutrients required in human diet as it is eaten along with bone, skull, and eyes. A small native fish locally known as "Bhat Masali" is typically found in the Narmada basin in Gujarat, Madhya Pradesh, and Maharashtra. The present study was conducted to select the ideal drying conditions and to evaluate the biochemical composition and storage stability for "Bhat Masali" in terms of quality and shelf life. In this study, "Bhat Masali" was dried in a mechanical dryer at temperatures of 45, 50 and 60 °C and by improved sun drying on a raised platform. Traditionally sun-dried (control) "Bhat Masali" from Nandurbar was brought for comparing with the results of improved sun-dried and mechanically dried "Bhat Masali". Based on moisture content, time taken for drying and sensory analysis, the drying technique was standardized. Among the 3 mechanical drying temperatures (45 °C, 50 °C and 60°C) drying at 50 °C was selected. According to sensory scores, the control, mechanically dried at 50 °C and improved sun-dried "Bhat Masali" were more acceptable as

compared with other mechanical drying conditions. There was an increase in fat, protein and ash with the decrease in moisture of "Bhat Masali" during mechanical drying at 45 °C, 50 °C and 60 °C and improved sun drying. The quality parameters of "Bhat Masali" dried under different conditions (mechanical drying at 50 °C, improved sun-drying and control) were within the acceptable limit. The biochemical and microbiological parameters were within the acceptable limits at the end of 2 months storage at room temperature. From the above findings, it was observed that as the raw material of control sample was of good quality, it gave overall good performance.

Functional Characterization of Mudskipper Muscle Proteins and it's Processing Waste Utilization

(CIFE/2020/PHT005/SR)

Sharath S. P.

Major Advisor: Dr. Layana P.

Mudskippers are intertidal hardy fishes which are underutilized and are relatively untapped as a food source. The present study aimed to understand the scope for utilization of Mudskipper by evaluating the physico-functional properties of mudskipper muscle protein and the bioactivity of its waste protein hydrolysate. Boleopthalmus dussumieri was selected for this study. The muscle protein fractions were found to be constituted by myofibrillar protein (63.95%), sarcoplasmic protein (27.19%), alkali-soluble and stroma protein (6.27%). Myosin heavy chains (195-202 kDa) and actin (44 kDa) bands were visible in the SDS profile, further confirming the presence of the myofibrillar proteins. Gels were prepared from mudskipper mince after different washing steps to study the gel-forming ability of mudskipper protein. Gels prepared from both unwashed mince of big-sized fishes and conventionally washed mince of small-sized fishes exhibited good gel strength and scored 5 in the folding test. Unwashed mince gel of big fishes exhibited higher gel strength (323.99 g.cm) compared to the reported gel strength of unwashed mince of Nemipterus japonicus (304 g.cm), a candidate species for 'surimi'. The muscle proteins were extracted by the pH shift method with the aid of acid (ACPI) and alkali (ALPI). ACPI and ALPI manifested good gels at lower concentrations of 3% in the least concentration endpoint method. ALPI exhibited an appreciable level of solubility, emulsion activity, water and oil-holding capacity, foaming activity, and whiteness, whereas ACPI had good emulsion stability. Fish protein hydrolysates (FPHs) were prepared from mudskipper waste using enzymatic hydrolysis using four different enzymes, i.e., Alcalase, papain, pepsin, and trypsin. The degree of hydrolysis was highest in Alcalase (67.71%) treatment after 5 h of hydrolysis. All four FPHs exhibited excellent scavenging activity in a dose-dependent manner on DPPH and ABTS. In conclusion, these results suggest that the functionality of mudskipper muscle protein and its bioactive waste protein hydrolysate could be useful in the food industry for various applications.

Biochemical Composition and Bioactive Properties of Selected Brown Seaweeds

(CIFE/2020/PHT008/SR)

Itishree Das

Major Advisor: Dr. A. K. Balange

Seaweeds have been employed in human and animal diets for centuries. There are many underutilized seaweeds from the west coast with good nutrients and bioactive properties. In this study, the brown seaweeds *Spatoglossum asperum, Stoechospermum marginatum,* and *Iyengaria stellata* were collected from the west coast of India, and their biochemical composition and nutrient profiles were evaluated. The moisture and fat content of the seaweed sample had an inverse relationship, whereas the ash content had a direct relationship with the mineral content of the samples. Heavy metals concentrations were crossing the acceptable limit in the samples, but cadmium was absent. Brown seaweed has comparatively more elevated amounts of polyphenolic compounds, which are a rich source of natural antioxidants and shows good antimicrobial activity. The higher the phenolic content the higher will be the bioactive properties. In the present study, I. stellata had higher antioxidant properties than *S. asperum*. The antimicrobial activities of both seaweeds were comparable. In the present study, 50% ethanolic extract of *I. stellata* was used by redissolving with distilled water for 24 days of chilled storage study of mackerel, and the ratio of fish to ice was maintained throughout the study. Total of four treatments were given at four different concentrations i.e., 0%, 1%, 1.5% and 2% (v/v). The changes in different parameters were checked with an increase in storage period on every 4th day. Moisture, protein, fat, and ash, the four key constituents of fish, were observed to decrease as the storage time advanced, whereas the values of biochemical parameters like pH, TVB-N, TMA, PV, FFA, and TBARS increased with an increase in storage period. The total plate count increased with the increase in the storage period but had a drop on the 4th day. The sensory attribute also had a decreased score as the storage period increased. The control (without any seaweed extract) was sensorially rejected on 20th day, whereas other treatment samples were accepted on 24th day. In the study, the shelf life of mackerel was extended for 4 days when compared to the control. Overall, it can be concluded from the present investigation that selected brown seaweeds can be a good source of nutrients with good bioactive properties and can be used as a natural preservative in the chilled storage of fish.

Bioactive Properties of *Fucoidan hydrolysate* Obtained from Brown Seaweeds along the West Coast of India

(CIFE/2020/PHT001/SR)

Payel Debbarma

Major Advisor: Dr. Layana P.

Fucoidan is a sulphated polysaccharide present in various brown seaweed species and possess many bioactive properties such as anti-microbial, anti-oxidant, anti-diabetic and anti-browning properties. In the present study, five brown seaweeds found along the west coast of India (*Sargassum cinereum, S. Johnstonii, S. swartzii, Padina tetrastromatica* and *Dictyota dichotoma*) were evaluated for their fucoidan content. Two methods were employed for the extraction of fucoidan, i.e; alcohol water extraction (AWE) and hot water extraction method (HWE). Fucoidan content was found to be highest (97.78mg/g) in S. cinereum, which was extracted using AWE method. The HWE method produced less fucoidan than the AWE method for all seaweeds examined. During compositional analysis of Fucoidan rich extract (FRE) prepared from the seaweeds, fucose was found as the main sugar form present in it. The maximum fucose (55.88 mg/g) has been extracted from S. cinereum through AWE and *S. johnstonii* contained the least amount of fucose (11.20 mg/g). However, the amount of sulfate was highest in *D. dichotoma* than *S. cinereum*. FRE of seaweed also contained phenolic compounds that are coextracted with fucoidan., The highest Total Phenolic Content was

observed in FRE of S. cinereum (16.94 mg Gallic Acid Equivalent /g) extracted via HWE and the lowest TPC was recorded in AWE among all the seaweed species examined. Further, the antioxidant capacity of FREs was evaluated using DPPH and ABTS free radical scavenging assays. FRE of *S. cinereum* exhibited the highest scavenging activity in both the DPPH and ABTS assays. Due to its high fucoidan content and antioxidant activity, S. cinereum was selected for the further study. Fucoidan hydrolysate was prepared by chemical hydrolysis method using mild hydrochloric acid. To study its bioactivity, antioxidant and antimicrobial assays were carried out. Hydrolyzed fucoidan exhibited better DPPH and ABTS radical scavenging action than native fucoidan at all the concentrations examined. However, fucoidan did not show any antimicrobial activity either in its native form or hydrolyzed form against the selected bacteria in disc diffusion assay. S. cinereum was identified as the best source of fucoidan among the seaweeds evaluated, and the fucoidan hydrolysate made from it has increased antioxidant activity, which can be further examined for their application component.

Lipid Enhancement in *Ulva* species through Media Intervention for Biodiesel Production

(CIFE/2020/FRM007/SR)

Swagatika Sahoo

Major Advisor: Dr. Geetanjali Deshmukhe

Seaweeds play a key role in the ecology of intertidal and subtidal ecosystems. Abiotic factors such as sunlight, temperature, salinity, mineral availability and salinity can influence their growth, chemical composition and distribution. Green seaweeds, *Ulva propenguinensis, Ulva lactuca, Ulva lobata* along West Coast of India were cultured at 25 ppt, 30 ppt and 40 ppt salinity at PES Media in two different concentrations (20 ml L-1 SW, 10 ml L-1 SW) in an indoor culture experiment for 21 days to study the effect of salinity and media concentration on the growth and lipid content Ulva spp. The findings showed that there is a significant difference in the Daily growth rate (DGR) of *U. propenguinensis, U. lactuca* and also in the DGR of *U. lobata* between the treatments. *U. propenguinensis, U. lactuca, U. lobata* showed a maximum DGR of 1.84%d-1, 0.81% d-1, 3.09% d-1 in treatments subjected to 25 ppt, 40 ppt and 40 ppt in media concentration of 20 ml L-1 SW. Total crude lipid content in wild samples of *U. propenguinensis* was 0.4% dry weight which showed enhancement up to 0.83% when cultured under 25ppt with 20ml L-1 SW media concentration. For *U. lactuca* and *U. lobata* crude lipid content increased 0.96% to 1.57% DW and 0.35% to 0.85% DW respectively under the treatment of 40 ppt with 20ml L-1 SW media concentration. Study showed that in all Ulva spp., in all samples Saturated FA fraction (SFA) was dominant with highest content of C16:0 followed by Monounsaturated FA (MUFA) with C18:1n-9 and Polyunsaturated FA (PUFA) with C18:2n-6. These FA compositions used to estimate biodiesel properties and it was found that all biodiesel properties are falling within the range provided by Indian and international standards (BIS Standard/ ASTM D6751 and EN 14214) except the cold filter plugging point. Biodiesel yield was found to be 71.99-85.71% of algal oil and 2-3% dry weight of seaweed used. Results of the study indicated that *Ulva* spp. occurring in the west coast of India contained very less lipids which can be enhanced by changing the salinity of the culture medium along with high concentration of culture media. The genus *Ulva* is an appropriate biomass target for the production of biodiesel due to its fatty acid profile, which is high in saturated fatty acids and has C18:1 as the second most abundant fatty acid.

3.11 Extension, Gender and Livelihood

Percolation Tank Based Aquaculture for Tribals in Nashik District, Maharashtra by Convergence of Corporate Social Responsibility Model

(CIFE/2019/13/IF)

Project duration: 2019-2022

Principal Investigator
Dr. Arpita Sharma

Co-Principal Investigators
Dr. K.K. Krishnani
Dr. K. Pani Prasad
Dr. Ajit K. Verma

Freshwater aquaculture has vast untapped potential for expansion in Indian context as large number of water bodies are still underutilized. One such underutilized water body which has not caught the attention of many is percolation tanks. Percolation tanks are found in state like Tamil Nadu, Maharashtra, Andhra Pradesh, Karnataka and Gujarat. Utilization of percolation tanks for fish culture has not yet been popularized in India even though these water bodies are large in numbers. These can serve as an entrepreneurship opportunity for rural tribal youth and contributor in livelihood security of people. There are no reports of usage of percolation tanks for aquaculture in Maharashtra.

Under a research project undertaken by ICAR-CIFE, Mumbai, aquaculture was initiated in percolation tank for livelihood generation for tribal youth in Nashik district, Maharashtra with convergence of Corporate Social Responsibility (CSR). This percolation tank is situated in Laxmanpada hamlet, Pahine Village (Gram Panchayat), Taluka Trambakeshwar, District Nashik and CSR of BOSCH company is in place in this village. Water analysis, primary productivity of the tank was studied and it was found to be suitable for aquaculture. Thereafter livelihood study was conducted and trainings were imparted to the tribal youth. Tribal youth group of 'Laksh Yuva Purush Bachat Gat' was formed along with opening of bank account. As this water body comes under the Provisions of The Panchayats (Extension to The Scheduled Areas) (PESA Act) permissions to undertake aquaculture was taken from Gram Pradhan. Stocking was done and regular advisories were provided. Corporate Social Responsibility (CSR) of BOSCH provided supervision and inputs.

Based on this research project, an innovative Model of Convergence of CSR in Aquaculture (CCSRA) was developed. Water bodies like percolation tanks which are not under the purview of DoF but under the PESA act, have a potential of entrepreneurship, livelihood generation and providing food and nutritional security to the rural/tribal youth. Convergence and integration of aquaculture while construction and engineering design of the percolation tanks is recommended. Through this model of CCSRA i.e., convergence of GO (ICAR-CIFE, Mumbai)-Community (Lakshmanpada tribal youth, Nashik)-Private (CSR-BOSCH, Nashik) rural youth can take up aquaculture in underutilized/untapped water bodies like percolation tanks.

Enhancing Fish Productivity through Farmer Participatory Research in Selected Districts of Manipur (Chandel) and Madhya Pradesh (Barwani)

CIFE/2020/09/IF

Project duration: 2020-2023

Principal Investigator
Dr. Munil Kumar Sukham

Co-Principal Investigators
Dr. Shrinivas Jahageerdar
Dr. Ashutosh D. Deo
Dr. Dhalong Saih Reang
Dr. Sunil Kumar Naik
Dr. G.H. Pailan
Dr. Dilip Kumar Singh

Magur culture along with IMC has been initiated, 3 stream water fed earthen ponds in Komlathabi, Chandel were stocked with 600 fry of Magur/pond, during the month of October 2022. Dimensions of the ponds were (30x40 ft, 80x10 ft, 60x50 ft) with depths of 2.5, 4.0, 4.0 ft respectively and treated with cow dung manuring and liming initially. In Kaziphung, composite culture with Grass Carp:300 fingerlings, Rohu:4000 fry, Common carp: 300 fingerlings fed with Rice bran and Oil cakes was done. As farmers were applying lime at

regular intervals, pH levels in ponds were within the desirable range of 6.5 -7.8 and DO level was recorded 4-7 mg/l.

Grass carp from these ponds were reported to have good keeping quality and taste. The grasses used to feed were Water-thyme (*Hydrilla verticillate)*, Creeping water primrose (*Ludwigia grandiflora*), Giant salvinia (*Salvinia molesta*), Para grass (*Brachiaria mutica).*The major feed -Para grass known as Napi Tuchombi (*Brachiaria mutica* (Forssk)) was used as feed upto 40 kg/pond per day. It contains around 22.3% crude protein with 16.05% while rest of the grass contains around 13% protein. Polyculture of IMCs and common carp with 4000/Acre stocking density, fed with pelleted feed including local made feed is being continued in Barwani, MP

KVKs and Fisheries: Extension Strategies for Strengthening Linkages and Fisheries

(CIFE/2021/6/IF)

Project duration:2021-2024

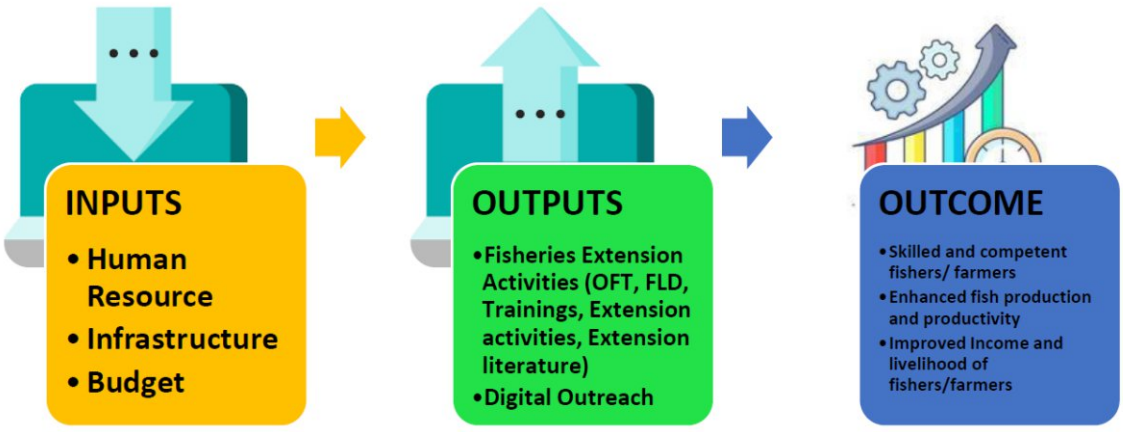
Principal Investigator
Dr. Ananthan P. S.

Co-Principal Investigators
Dr. S. N. Ojha
Dr. Ankush Kamble
Dr. Shivaji Argade
Dr. Neha Qureshi
Dr. Munil Kumar S
Dr. Hari Krishna
Dr. Shyamala K.
Dr. Sreedharan K.

The Project assesses the status of KVK-led fisheries extension activities as well as the potential for fisheries development in states to strengthen the science-extension-development interface. The information and capacity building requirements of KVK-SMS were also being captured to help design appropriate extension strategies, conduct capacity building programs & strengthen linkages.

A detailed assessment of different KVKs' fisheries activities in the states of West Bengal, Bihar, Andhra Pradesh, Tamil Nadu and Andhra Pradesh were done during 2022. A novel methodology called Fisheries Extension Intensity Index (KVK-FEII) was developed and validated using data from four states under the Project to quantify the depth of extension effort of each KVK at the district level. The logical Inputs-Outputs-Outcome framework contextualised for KVK, as illustrated in the figure below, informed this methodology.

The FEII of the majority of the KVKs in all the four study states (Andhra Pradesh, Maharashtra, West Bengal and Bihar) were found to be less than 50%. The mean value was highest for West Bengal (48%) and lowest for Maharashtra (27%) with Bihar (36%) and Andhra Pradesh (34%) scoring in-between. The critical factor determining the extension intensity in a KVK was found to be the presence or absence of the Fisheries SMS, and the availability of the fisheries related infrastructure in a KVK. As activities like conduct of field demonstrations, on-farm trials, training programs, and literature development are target-oriented for each SMS, fisheries activities are found wherever fisheries SMS are available. For instance, only two KVKs (Ratnagiri and Raigad) have fisheries SMS in Maharashtra while 11 KVKs have them in West Bengal. Preliminary findings show that there is no



correspondence between the potential available for fisheries in a particular district and the presence of SMS in the corresponding KVK in most states. The study proposes to identify the districts with fisheries potential and where fisheries SMS would be required.

The info and training need assessment showed the gaps in the existing linkages between the research system and the KVKs. While the priority of training areas differed somewhat across the study states, there was no significant difference. Irrespective of the specialisation, general skills such as “ICT/ Social media for Development'', “Entrepreneurship Development / Incubating Start-ups”, and “success story documentation” topped the charts in most states, while among the fisheries related programs, the sought after areas were “recent aquaculture technologies', 'feed management', and 'disease management'. Most SMS preferred to attend the residential or in-person training programme with a preferred duration of 5- 7 days. About 35-48% (in different states) felt that the travel allowance and budget were less than adequate to perform the mandated extension activities. Interestingly, the majority of SMS prefer co-development of fisheries extension materials with ICAR institutions.

KVK-led Fisheries Extension in West Bengal and Bihar: Assessment and Action Plan

(CIFE/2020/FEX001/SR)

Debosmita Dey

Major Advisor: Dr. Ananthan P.S

As KVKs can play a catalytic role in tapping the fisheries potential for development, this study attempted to assess the fisheries extension activities being undertaken by KVKs as well as the information and capacity development needs of KVK Subject Matter Specialists (SMS) in the states of West Bengal and Bihar. A novel KVK Fisheries Extension Intensity Index was also employed. The assessment revealed 65% of the KVKs in West Bengal and 48% of the KVKs in Bihar have the infrastructure to conduct fisheries programs, whereas fisheries SMSs are in position in 52% and 18% of the KVKs, respectively.

A major share (53%) of KVKs budget went to salaries, making 40% available as operational cost and 7% as non-recurring fund. SMSs wished to be trained in entrepreneurship development (WSM score 48.67), success story documentation (WSM score 45.5), and BMPs in aquaculture (WSM score 44.83) and training needs of SMS are not related to their age, gender, service length, organisational climate, perceived adequacy of fisheries infrastructure and budget availability. SMS spend 65 % of their time on extension service, but most are unsatisfied with their workspace (76%) and partially satisfied with working conditions (68%). Most respondents (66%) preferred in-person rather than online programs, of 5-7 days duration and a fee structure of Rs.5000/-. KVKs in west Bengal conducted 50 OFTS, 655 FLDS, 725 trainings for 19761 beneficiaries during 2017-19 and the corresponding values for Bihar are 30, 284, 417 and 10964, respectively. Only 7 KVKs in West Bengal, namely Cooch Behar, South 24-Parganas (Narendrapur), Uttar Dinajpur, South 24-Parganas (Nimpith), Malda, Murshidabad, North 24 Parganas, and 4 KVKs in Bihar Supaul, Darbhanga, Muzaffarpur II, Madhubani I have high FEII score (>66%) indicating significant gaps.

Suggested actions points are: posting of fisheries SMS in KVKs located in the identified potential districts (Bankura, Purulia, West Midnapore, Burdwan in West Bengal and West Champaran, Saharsa, Purnia, Nalanda, Lakhisarai in Bihar); immediate filling up of 33% and 27% vacant SMS positions in West Bengal and Bihar, respectively; creating fisheries demonstration units in the identified KVKs, development of fisheries extension materials in English, Hindi and Bengali; building the capacities of SMS for improved digital outreach and identified training areas.

KVK-led Fisheries Extension in Andhra Pradesh and Tamil Nadu: Assessment and Action Plan

(CIFE/2020/FEX004/SR)

Geetha M.

Major Advisor: Dr. Ananthan P.S

Krishi Vigyan Kendras (KVK) provide a basket of extension and advisory services and act as a bridge between the research and extension systems at the district level. The present study assessed the status of fisheries extension activities by KVKs as well as the information and capacity development needs of KVK Subject Matter Specialists (SMS) in Andhra Pradesh and Tamil Nadu.

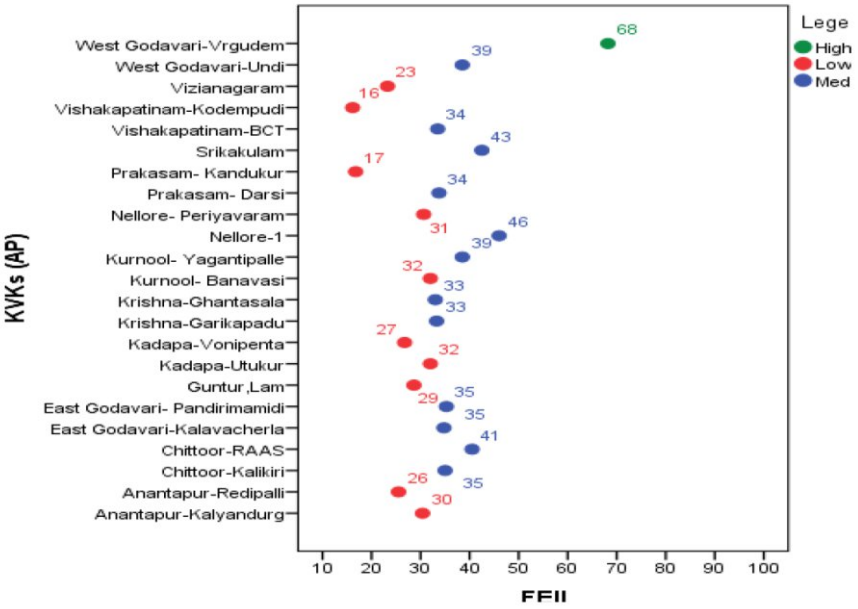


Fig 4.30 Fisheries Extension Intensity Index scores of KVKs in AP

A novel KVK Fisheries Extension Intensity Index was employed. The assessment revealed that fisheries SMS were present only in 8 of the 53 KVKs functional (4 in each state) during 2018-20 and only these KVKs have conducted fisheries related extension activities with an average of 1 OFTs, 2 FLDs, and 13 trainings per KVK per year. Majority of the respondents perceived that they have adequate workspace (58%) and time (67%). Most (60%) of the respondents preferred to attend training in offline mode with a preferred duration of 5-7 days. Spearman's rank correlation has shown that the training needs of SMS is not related to their age, gender, perceived adequacy of fisheries infrastructure and budget availability. However, it differed significantly between states. Demand for training in success story documentation, entrepreneurship development and PRA was high for Andhra Pradesh SMS while the priority areas in Tamil Nadu were for recent aquaculture technologies, feed management, and project/extension management. The mean KVK Fisheries Extension Intensity index (FEEI) score of KVKs in Tamil Nadu (39.2) is higher than that of KVKs in Andhra Pradesh (33.7). One KVK in Andhra Pradesh (West Godavari- Vrgudem) and one KVK in Tamil Nadu (Namakkal) have high FEII Score (>66%) indicating the need for strengthening KVKs for fisheries development.

Suggested actions points are: posting of fisheries SMS in KVKs located in the identified potential districts (Guntur, Vishakaptnam, Prakasam, Krishna, Pudukottai, Villupuram, Thiruvannamalai, Ramanathapuram, Tirunelveli, Thiruvallur, Madurai, Virudhunagar, Thoothukkudi); immediate filling up of 44% vacant SMS positions; creating fisheries demonstration units in identified KVKs; development of fisheries extension materials in English, Telugu and Tamil; building the capacities of SMS for improved digital outreach and competencies in identified training areas.

Assessing the Impacts of Skill Development Programmes Imparted by ICAR- Central Institute of Fisheries Education

(CIFE/2020/08/IF)

Project duration: 2020-2023

Principal Investigator
Dr. Shivaji Argade

Co-Principal Investigators
Dr. S. N. Ojha
Dr. Ananthan P.S.
Dr. Neha Qureshi
Dr. G. H. Pailan
Dr. Murlidhar P. Ande
Mr. Hari Krishna
Dr. Sunil Kumar Nayak
Dr. Md. Akalakur
Dr. Dasari Bhoomaiah

The training effectiveness and differential impacts of ICAR-CIFE's skill development programmes SciCom-2020 (Science Communication for smart researchers) (n=200), One Year Post Graduate Diploma in Inland Fisheries & Aquaculture Management (PGDIF&AM) (n=75), One Year Certificate Course on Aquaculture and Hatchery Management (n=34) and Skill Development Training on Aquaculture for professionals (n=123) and farmers (n=118) in Telangana and Andhra Pradesh were assessed using developed training effectiveness index methodology at four levels of effectiveness i.e. reaction, learning, results and behaviour.

The mean index score of SciCom-2020 was found 0.80 which demonstrates that it was perceived highly effective by the trainees. Two success stories of Miss Naushin Raheema (Impassioned Scicommer) and Mr. Ranjan Mohanta (SciCom Enthusiasts) who became SciCom trainers were documented.

About 48% of PGDIF&AM trainees expressed a highly favourable attitude towards the subject matter of PGDIF&AM. Mean unit scores of trainee's and trainer's attitude were 0.67 and 0.77, respectively which indicates significant (p=0.030) difference in their attitude towards PGDIF&AM. The mean unit score of knowledge (0.64) and skills (0.59) of trainees clearly demonstrated the medium level of gain in knowledge and skills after attending the course. It was satisfactory to note that about 40% of trainees had expressed a high level of improvement in their job performance after completion of PGDIF&AM.

In case of One-year Certificate Course 'Fish Farming and Hatchery Operation', the majority (67.65%) of trainees perceived that the training program was very highly effective. The overall mean effectiveness unit score of one-year certificate course was found 0.79. As a result of attending One-year Certificate Course, almost all the trainees (93%) got employment in private companies, commercial farms, etc. There is high demand for this certificate course among tenth/twelfth pass students who are looking for job opportunities in fisheries and aquaculture.

In case of Skill Development Training on 'Fish Culture and Its Management Methods', about 71.80% of farmer trainees perceived that training program was highly effective. The overall mean effectiveness unit score was found 0.84. In case of Skill Development Training on Aquaculture for Professionals, about 77.24% of trainees perceived that training programs were highly effective. It was found that almost all the programmes were highly effective at first three levels i.e. reaction (0.92), learning (0.85), behaviour (0.79) but when it comes to results level (0.65), it was found medium effective. To document the socio-economic impacts of skill development training, about 33 innovative success stories of trainees are compiled.

Evaluation of Post-Graduation Diploma in Inland Fisheries and Aquaculture Management

(CIFE/2020/FEX006/SR)

B. Bhavana

Major Advisor: Dr . Shivaji Argade

The evaluation of skill development programs helps to improve the effectiveness of training programs for its wider adaptability and the present study was conducted to evaluate Post-Graduate Diploma in Inland Fisheries and Aquaculture Management course which is offered for updating knowledge and skill of State Fisheries Department Officials. The robust methodology was developed for measuring the effectiveness and impact of PGDIF&AM course with selected sample of 75 trainees, 8 trainers and 90 non-trainees.

The results demonstrate that majority of trainees (77.33%) had medium to high favourable attitude towards PGDIF&AM whereas the majority of trainers (87.50%) had high favourable attitude. There was no significant difference in attitude of trainees and trainers towards PGDIF&AM except attitude towards teaching methods (p=0.030). The majority of trainees had low to medium gain in knowledge (64%) whereas majority of trainees (66.67%) had low to medium skill gain after attending PGDIF&AM. The trainees and non-trainees mean unit scores of job performance level were 0.65 and 0.54, respectively. There was a significant difference in the job performance level of trainees and non-trainees (p=0.032).

The major suggestions given by trainees were teaching must be more interactive and practical oriented (0.73), course content needs to be revised considering trainees needs, course duration and latest development in the sector (0.69), classroom and labs must be equipped with latest technologies (0.61), facilities for extracurricular activities of trainees must be strengthened (0.61), boarding and loading facilities need to be improved (0.61) and course eligibility criteria needs be to be revised for the wider adaptability of PGDIF&AM (0.57) whereas course eligibility criteria needs be to be revised for the wider adaptability of PGDIF&AM (0.94), course evaluation procedure needs to be easy and flexible (0.81), make PGDIF&AM course open for all rather than only for in-service trainees (0.75), age limit for participating PGDIF&AM must be fixed for making teaching and learning more effective (0.56) were suggested by the trainers to make PGDIF&AM more vibrant.

Evaluation of CIFE's Skill Development Trainings on Aquaculture in Telangana and Andhra Pradesh

(CIFE/2020/FEX003/SR)

Bheemala Samantha

Major Advisor: Dr. Shivaji Argade

The present study is an earnest effort to evaluate the effectiveness of CIFE's skill development training on aquaculture for farmers and professionals in Telangana and Andhra Pradesh using four level Kirkpatrick model consisting of reaction, learning, behavior and results with a selected sample of 118 farmers/fishers, 123 professionals, 34 one-year certificate course trainees and 34 State Fisheries Department Officials. The overall effectiveness mean unit scores for skill development training for farmers/fishers, professionals and one-year certificate course were 0.81, 0.84 and 0.79, respectively which indicates the high level of training effectiveness.

The mean unit score of trainee's job performance after attending refresher course for DoF officials was 0.33 which indicates the low level job performance. The majority of farmer/fisher trainees

perceived information needs were about improved technologies in fish culture (100), disease and health management (97), source of healthy brooder and fish seed (97) whereas the perceived training needs were disease and health management (100) followed by best management practices in fish culture (99) and resource and input needs were credit facilities (100) followed by subsidies on pond construction and gear and craft assistance (99). The majority of information needs perceived by the professional trainees were improved techniques in aquaculture and best management practices whereas the perceived training needs were need more training, more field visits and practical sessions.

The major suggestions from fishers/farmers were follow up training must be conducted with suitable intervals to take the learning forward (0.94) whereas the professional trainees suggested keeping required knowledge and skills up-to-date (0.94) and more interactive hands-on training sessions (0.91) and trainees of one-year certificate course suggested course duration should be increased to 1 to 2 years and made equivalent to a diploma for improving applicability and wider adaptability of it. Among four levels of training evaluation, all the SDTs were found highly effective at reaction and learning levels whereas at behaviour and results levels found less effective. This implies that the host institution needs to develop strategies for improving the effectiveness of SDTs at behaviour and results levels so that the transfer of learnt knowledge and skills and outputs of the SDTs may be improved in a sustainable manner.

Impact Analysis of NEH, TSP and SCSP Programs Conducted by ICAR-CIFE during the Last Ten Years

CIFE/2022/20/IF

Project duration: 2022-2025

Principal Investigator
Dr. Swadesh Prakash

Co-Principal Investigators
Dr. Arpita Sharma
Dr. Paramita Banerjee Sawant
Dr. Vinod Kumar Yadav
Dr. Ankush L. Kamble

Secondary information has been collected from NEH Training coordinator. On Farm trials (OFTs) or Front Line Demonstrations (FLDs) conducted by KVKs indicated that fish farming is a highly profitable enterprise with benefit-cost ratios varying from 1.5 to 4.0 and have the potential to address issues like livelihood insecurity, unemployment, etc in NEH states. More than 26.3 lakh people of the region are associated with the sector for livelihood. The demand for fish is very high in NE India as more than 95% of the population are active fish consumers.

Tripura is nutritionally self-sufficient in fish production but in an estimate, it was recorded that the state annually spends about Rs. 400 Crores for importing fish from outside to meet the local demand. Though a high yield potential has been realized in fisheries, many challenges to sustain the production and productivity level and reduce the cost of production persists. The marginal and small farmers, landless farmers, peasants, etc can seek livelihood opportunities in these common property resources with promotion of culture-based fisheries such as cage culture, pen culture, etc. Further data collection is in progress.

Attitude of Professional Fisheries Students Towards Entrepreneurship in Tamilnadu

(CIFE/2020/FEX007/SR)

U.Sangeetha

Major Advisor: Dr. S.N Ojha

Fisheries is the sunrise sector with diverse resources and potential, playing a vital role in the country's socio-economic development. Due to constant change and intricate nature of modern technological systems, fishers and fish farmers often lack technical expertise and competence. As students are future

entrepreneurs, their attitude is critical in determining their success. The present study was undertaken to assess the attitude of fisheries students towards entrepreneurship and its determinants in Tamil Nadu. Data was collected from two fisheries colleges covering 447 students using a structured online survey, telephonic interviews, and personal discussion with faculty, alumni, and entrepreneurs.

Data were analysed using descriptive statistics, Weighted Sum Method (WSM), tests of significance, and factor analysis using SPSS 22 and NVivo 12 software. Girls constituted 54% of the students, while 77% belonged to the OBC category. The study indicated a highly favourable attitude towards entrepreneurship, with a mean score of 0.73. While one-third of students (34.78%) had a highly favourable attitude, another 31% had a very high favourable attitude. It was found that the education and income of parents (14.3%) contributed most to the total variance (65.25%). Boys exhibited a relatively more favourable attitude towards entrepreneurship as compared to girls.

The significant factors influencing the fisheries students' attitude towards entrepreneurship were their own interest/passion, followed by the level of education, academic performance and salary/income from different careers. Financial limitations, inadequate guidance, and technical assistance for start-ups were the significant barriers encountered by the students in starting their entrepreneurial ventures. The Student READY (SR) program implemented by the colleges was perceived to have only a moderate effect with regard to inculcating entrepreneurial characteristics such as self-confidence (36.25%), achievement motivation (36.25%), and risk orientation (42.50%). Structural and operational changes are required in SR alongside an organic partnership with the industry to create more job-creators.

Gender Analysis of Fisheries Sector in Telangana

(CIFE/2020/FEX005/SR)

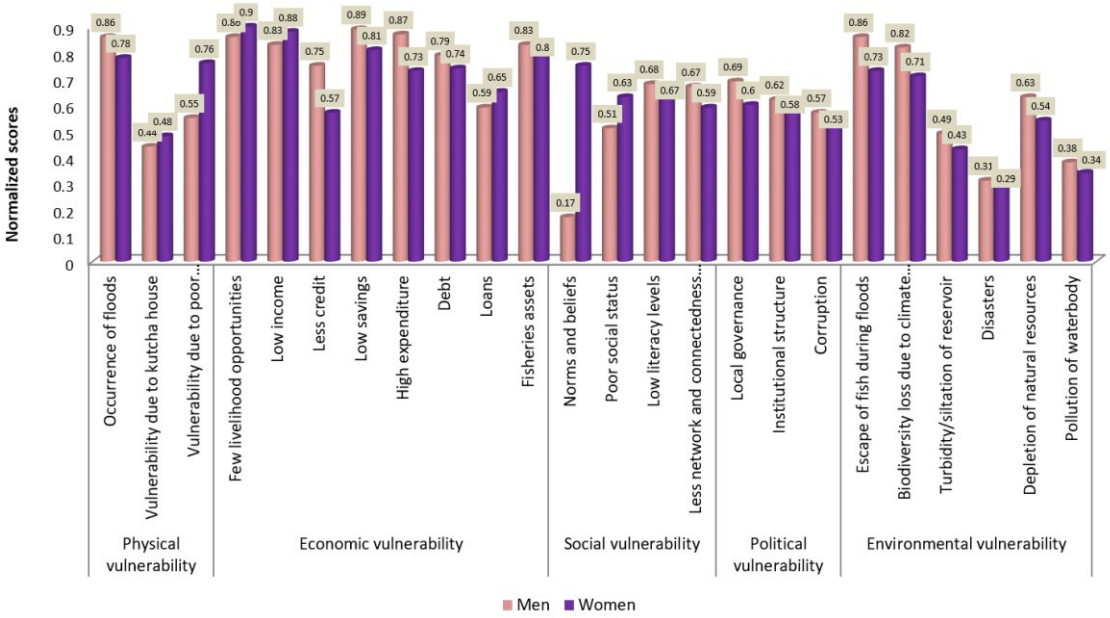
Priyanka Mushkam

Major Advisor: Dr. Arpita Sharma

A study entitled 'Gender Analysis of Fisheries Sector in Telangana' was carried out with the objectives to assess profile, capacities, constraints and vulnerability contexts, to evaluate gender roles, time use pattern, workload, needs, to evaluate access, control and decision making over resources of inland fishermen and fisherwomen. Nagarjunsagar reservoir in Nalgonda, Kothapalli, Ooracheruvu tank in Karimnagar and Musheerabad fish market in Hyderabad district were selected. Information was collected from 154 men and women respondentsusing Gender Analysis Tool for Fisheries and Aquaculture (GATFA©) tool.

It was found that average family size was 4.27 with 86.6% having nuclear family. Majority (55.8 %) of the households had land holding between 0.02 to 0.04 acres and about. Fish sellers had highest income, savings and expenditure followed by fishers of tank and reservoir. There was no significant difference in involvement of men and women in case of reservoir fisheries but women's competencies were higher in post-harvest sector. In case of tank fisheries involvement of men and women was compartmentalized and there was a significant difference. In case of fish markets there was no significant difference between men and women. In reservoir fisheries, for fisherwomen marketing constraints were ranked first, whereas, for fishermen economic constraints ranked first. In case of tank-based fisheries and markets, for fisherwomen economic constraints ranked first for both men and women. Economic vulnerability was high for both fisherwomen and fishermen of reservoir, tank and market.

With reference to productive roles, there was significant difference between them with respect to time use and work load. There was a significant difference between the needs of fisherwomen and fishermen. In case of tank-based fisheries, statistical significant difference was found between



fisherwomen and fishermen with regard to access, control and decision making over all the resources. In case of fish market, significant difference was found in terms of control and decision making. Findings of the study bring into focus that many works are performed by both and it is better to consider gender a fluid rather than taking them as two binaries. It can be concluded from the study that in Telangana, fisheries is an important livelihood activity not just for men but very important for women too. Therefore, while designing policy interventions, these issues need to be taken into consideration.

(CIFE/2020/FEX002/SR)

Gender Analysis of Aquaculture Based Livelihoods in Mizoram

B. Lalmuansangi

Major Advisor: Dr. Arpita Sharma

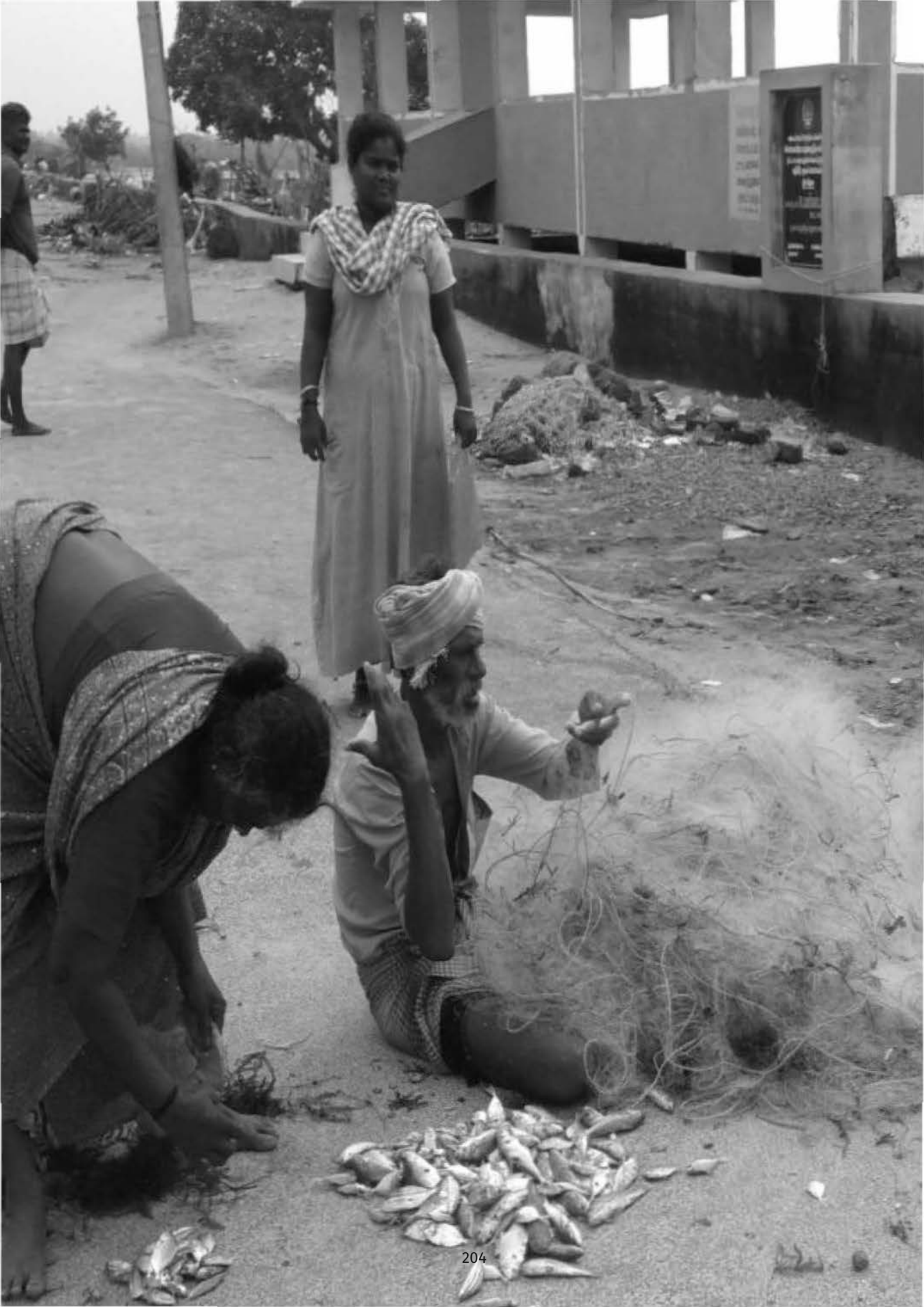
The study was conducted on gender analysis of aquaculture based livelihoods in Mizoram was conducted for different aquaculture-based livelihoods like 'unitary and integrated farming system', 'paddy-cum fish culture' and 'pig-cum-fish culture' in Kolasib, Mamit, Champhai district and fish market in Aizawal. Information was collected from 180 men and women fish farmers/ fish sellers using a copyrighted tool 'Gender Analysis Tool for Fisheries and Aquaculture' (GATFA ©).

It was found that in most cases head of household was a man and ownership of land was in name of man. Households with paddy cum fish farming system had highest income, savings and expenditure followed by pig cum fish farming system and unitary farming system. In unitary farming there was significant difference between capacities of men and women for pre harvest, harvest and post harvest activities. Significant difference was found between men and women with reference to capacities, time use pattern and workload for reproductive roles in all livelihood systems and women's participation was significantly higher. But for productive and community roles no statistically significant difference existed in time use and workload. From these results it is implied that men and women both are actively involved in all aquaculture based livelihoods.

For practical gender needs there was a significant difference between men and women in case of unitary farming system. There was no difference between men and women for access to resources but significant difference was found with reference to control over resources and participation in decision making. Both men and women were found to contribute significantly to the family's income, savings, expenditure, and loan repayments. The GATFA © tool was able to highlight that

women's participation is not just limited to post harvest as it is often assumed and they are involved in pre-harvest, harvest and post-harvest activities. In addition, it has also indicated that men play active role in post-harvest activities. It can be concluded from the study that aquaculture is an important livelihood not just for men but very important for women too. Therefore, while designing policy interventions, selection of beneficiaries should not be just head of the household (who is usually a man) but all who are involved in that livelihood system.

3.12 Economics, Institutions and Policy



Assessing Economic Feasibility of Farm Ponds for Aquaculture in Maharashtra

CIFE/2021/05/IF

Project duration: 2021-2024

Principal Investigator
Dr. Ankush L. Kamble

Co-Principal Investigators
Dr. P.S. Ananthan
Dr. S.N. Ojha
Dr. Kishore Kumar Krishnani
Dr. Neha W. Qureshi
Dr. Sukhdane Kapil

Farm ponds with plastic lining are privately owned ponds that are dug out in the fields and are filled using surface run off or ground water through water pump and are used mainly for irrigating field crops. The present study examines the feasibility of these farm pond water resources for fish farming and investigates its various dimensions. The investigation of present report is mainly based on primary data collected from Pune, Ahmednagar and Satara districts of Maharashtra. This report is prepared with inputs from 81 farmers who owned farm ponds. Among them there are 42 farmers who have tried fish farming in farm pond at least once.

Initial estimates shows that about 1.29 lakh acre private farm pond water is available for fish farming in Maharashtra which are owned by 2.46 lakh farmers. The socio-economic status of farm pond owners (Average age – 48.4 years, average education - secondary standard, 5.6 members per family, 6.3 acre farm holding per family and annual average income Rs. 4.67 lakh), shows that it is very favorable for fish farming. Adding to this, farmers have water in their farm ponds for almost 11 months, so they can grow one fish crop comfortably.

The dimension of reported farm ponds especially depth (average 9.2m) is biggest limitations observed for fish farming in the farm pond, which is not matching the recommended depth (1.5-2.0m) for aquaculture in ponds. Further, the average water holding capacity of these farm ponds are 1.02 crore liters and it takes months to fill the pond or draw water from the pond. In fish pond total water exchange is necessary to reduce the concentration of ammonia, maintain pH and oxygen level and reduce toxicity level to avoid disease contaminations. In farm ponds only 2-3 per cent water exchange is possible. Moreover, before stocking the fish ponds need to sterile. However, the possibility of sterilization of farm pond is very less due to various constraints. All these farm ponds are lined with plastic which inhibit the growth of natural phytoplankton. As natural food does not grow in these ponds, one has to depend on artificial company made feed. As a result, artificial feed costs are very high in these ponds. Therefore, we need sincere efforts at all level to grab the huge potential of available private water resources for aquaculture in Maharashtra.

(CIFE/2020/FEC005/SR)

Farm Ponds for Aquaculture: Assessing Economic Feasibility in Ahmednagar District of Maharashtra

Rathod Sagar Sitaram

Major Advisor: Dr. Ankush Kamble

Aquaculture plays a vital role in livelihood security by increasing incomes and providing employment opportunities along with food and nutritional security to the billions of people worldwide. Largely constructed plastic lined farm pond in Ahmednagar district (19,060 no.) of Maharashtra is a new area which offers opportunity to rear fish and other aquatic organisms. Therefore, to examine various dimensions of aquaculture in plastic lined farm pond, the present study was conducted to assess the status, potential, socioeconomics as well as factors and constraints in farm-ponds aquaculture in Ahmednagar district of Maharashtra. The primary data of 73 farm pond farmers were collected using semi-structured interview schedule during first half of 2022.

Data analysis was performed using simple statistical and economical tools like descriptive statistics, percentage analysis, cost and benefit analysis. It is estimated that around 9,339-acre water is privately available in Ahmednagar district which is owned by 19,060 individual farmers. Further average length, width and depth of these farm ponds respectively reported 176.9, 129.5 and 31.0 feet, represents these dimensions are not as per recommendation of fish ponds. The present status of aquaculture in plastic lined farm pond shows that they are stocking mainly Catla, Rohu, Tilapia, Mrigal, Common Carp, Pangasius and Cyprinus with average stocking density of 22,921 fry seed per acre.

Economics of aquaculture in plastic lined farm pond shows that farmers are losing their income. On an average farmer earn Rs. 4,169.75/- gross income per acre while total cost of production reported Rs. 89,742/- per acre. This represents that farmer lose rupees 85,572/- per acre from farm pond with B:C ratio 0.05. The unregulated seed suppliers, high feeding cost, non-availability of scientific literature on package of practices on aquaculture in plastic lined farm pond along with others are limiting the production and profit of aquaculture farmers. In brief, presently aquaculture in plastic lined farm pond is non profitable with large number of constraints. To grab the huge potential of available water resources we need sincere integrated efforts at all level i.e., farmers, researchers, government, agriculture and fishery departments, private enterprise and policy makers.

Accounting and Valuation of Professional Human Capital in Indian Fisheries Higher Education

(CIFE/2021/4/IF)

Project duration: 2021- 2024

Principal Investigator
Dr. Neha Wajahat Qureshi

Co-Principal Investigators
Dr. Ananthan P.S.
Dr. Shivaji D. Argade
Dr. Ankush Kamble
Dr. Dasari Bhoomaiah

Human capital alters the productive capacity of the economy by changing the size or productivity of the workforce thus structurally impacting the economy. This project proposes to quantify the investment/expenditure being made by Fisheries Universities / Colleges of India for generating human capital and their subsequent benefits or impacts in the form of economic value to fisheries sector. Under this project a novel methodology for valuing the human capital produced by Universities has been developed and copyright for the same has been filed (HCVaF). In this reporting period, 3 colleges under Tamil Nadu Dr. J. Jayalalithaa Fisheries University (TNJFU) and College of Fisheries, Kerala University of Fisheries and Ocean Science (KUFOS) were selected for the study.

Accounting and Valuation of Professional Human Capital in Indian Fisheries Higher Education has shown that the net investment / expenditure made by KUFOS on each B.F.Sc. student for 4 years, M.F.Sc student for 2 years and Ph.D. student for 3 years were ₹ 1,90,019 ₹. 6,69,840 and ₹ 12,13,689 respectively. Similarly for 3 colleges under TNJFU, the net expenditure incurred by TNJFU on each BFSc, MFSc and PhD are; Thhothukudi (₹ 1,09,735 for BFSc, ₹ 10,10,94 for MFSc and ₹ 22,06,541 lakhs for PhD); FCRI Ponneri (₹ 85,237 lakhs for BFSc, ₹ 11,10,753 lakhs for MFSC and ₹ 18,14,372 lakhs for PhD); FCRI Thalainayaru (₹ 23 lakhs for BFSc). Mapping the career paths of all the alumni who have passed out from the colleges post 2010, it was found that maximum students from KUFOS have chosen to pursue career with Department of Fisheries (30%), followed by Industry (16.9%). In case of FC&RI Thoothukudi, it was seen that 50% of graduates have landed jobs in private sector followed by permanent teaching/faculty positions in SAUs (18%). In case of FC&RI Ponneri, 68% graduates have got into private sector followed by banking sector (9%) and DoF (7%). For FC&RI Thalainayaru, only one B.F.Sc batch has passed out in 2021 and out of 21 graduates, 4 got placed in DoFs,and private sector. Although only few students have got into choosing entrepreneurship as their major career path, however it was seen that in value terms, entrepreneurship has the highest net worth i.e., ₹3,96,578 followed by Private sector/ Industry (₹3,45,901) indicating greater scope for entrepreneurship in near future for KUFOS and TNJFU both (₹ 5,26,087 and ₹4,52,508).

The accounting of expenditure revealed that total expenditure made by KUFOS on its human capital (all B.F.Sc, M.F.sc and Ph.D) in between 2010-2020 was estimated at ₹ 41 Cr. while the total value of students using discounting method was found to be ₹ 689 Cr. In this way, contribution of KUFOS to the nation was found to be ₹360Cr (2010-2020), which is almost 16.8 times the investment made. The total expenditure on human capital made by FC&RI Thoothukudi in between 2010-20 is ₹ 39.5 Cr. while the total value of students was found to be ₹ 351 Cr. In this way, contribution of FC&RI Thoothukudi to the nation is almost 8.8 times the investment made. Similarly, contribution of FC&RI Ponneri to the nation was found to be 19.6 times investment and FC&RI Thalainayaru was 20.6 times investment.

For valuating the human capital using TFP model, it can be surmised that the share of KUFOS in fisheries HRD was 6.29% and hence in TFP growth rate becomes 0.05%. Similarly for FCRI Thoothukudi, Ponneri and Thalainayaru contribution to fisheries HRD is 4.45%, 3% and 1.7% respectively. Taking the above analysis further, and converting the percentage share of fisheries HRD in monetary terms it was evident that KUFOS contributed ₹ 212 crores during 2020-21 in case if it was assumed that only 50% of the fisheries sector were actually manned by professional graduates (B.F.Sc, M.F.Sc and Ph.Ds).

Similarly, breaking down TNJFU's contribution, it was evident that FC&RI, Thoothukudi contributed ₹ 149.698 crores during 2020-21 in case if it was assumed that only 50% of the fisheries sector were actually staffed by professional graduates. FC&RI, Ponneri contribution was ₹ 100.92 crores during 2020-21 (if it was assumed 50%) and FC&RI, Thalainayaru contribution was ₹ 57.19 crores during 2020-21 (if it was assumed 50%). However, the realistic scenario would be somewhere between 50% and 100%.

India's Patented Technological Innovations in Fisheries and Aquaculture

CIFE/2022/19/IF

Project duration: 2021- 2024

Principal Investigator
Dr. Arpita Sharma

Co-Principal Investigators
Dr. Swadesh Prakash
Dr. Vinod Kumar Yadav
Dr. D. Bhoomaiah

IPRs have an important role in raising the economies of countries all over the world by stimulating innovation. IPRs protect the rights of an inventor in his/her invention, and at the same time facilitates social and economic growth. Without protection of ideas, businesses and individuals would not secure the complete benefits of their inventions and would emphasis less on research and development.

The Indian Patent Office (IPO) received 4,05,324 applications for various IPRs in 2018-19. But how many and which were the patents applications related to fisheries and aquaculture have not been studied after year 2000 and this is the objective of this project. To extract the patents in fisheries and aquaculture sector attempt was made to make a list of keywords relevant to the domain. However, that the selection of key words is exhaustive. Nevertheless, an attempt was made to search patents with some keyword at a time along with use of Boolean operators in the search parameters using different database. But the results were not accurate. Another attempt was done by using the patent classification and the search was refined with additional key words in title and abstract. But it was observed that there were not one but many relevant classification terms in the field of fisheries and aquaculture like biotechnology, bio-chemistry, chemical, pharmaceuticals, physics, etc. This method was also not found to be up to date. Many database were reviewed and it was seen that none provides complete coverage of the entire set of published patent documents. So method of mining the patents from the weekly official journal of the Indian patent office was adopted.

Using this methodology, information has been collected and analysis has been done on last five year patents in fisheries and aquaculture sector which includes nationality of the applicant, discipline (aquaculture/fish processing technology), organization of the applicant, patents by ICAR/non-ICAR institutes, field of invention, time taken from patent application to its grant, classification of patents as per IPC. Patents from the 262 weekly official journal of the Indian patent from 2016 to 2020 have been searched and patents related to fisheries and aquaculture were extracted. In the period of from 2016 to 2020 a total of 71.87% of the applicants who were granted patents were Indians whereas 28.13% were of other nationalities and the difference was statistically significant. Further analysis with reference to the technology domains is being done. A Skill Development Programme (SDP) on 'Intellectual Property Rights (IPR) in Fisheries Sector' was organised by ICAR-CIFE, Mumbai, from 2 to 8 August, 2022 in hybrid mode and 13 female and 13 male trainees participated in this SDP.

Value Chain Analysis of Wild Harvested Seaweed in the Gulf of Mannar and Palk Bay, Tamil Nadu

(CIFE/2020/FEC001/SR)

Ahila M.S

Major Advisor: Dr. Neha W. Qureshi

The Indian coast sustains the flourishing growth of economically significant seaweed populations and is regarded as 'Wonder Plants of the Sea'. The study on the value chain of these resources remains unexplored and seaweed collection, marketing, and processing are unorganized activities. Thus, the present study attempted to analyse the trends of wild seaweed production, socio-economic profile of harvesters, value chain of major wild harvested species, and suggest strategies to institutionalise

the value chain. The study focused on the value chain of four major wild-harvested species (*Sargassum, Turbinaria, Gracilaria* and *Gelidiella*). Six villages were selected based on the maximum landings of these species, in which three villages fall under the Gulf of Mannar and rest under the Palk Bay. A total sample size of 185 were taken, and data was collected through interview schedule and focused group discussions. Descriptive analysis, trend analysis, cost-benefit analysis, marketing efficiency tools, and rank-based quotient were used for the data analysis.

Trend analysis revealed that wild seaweed production is diminishing, so it is imperative to cultivate these native species. Most fisherfolk engaged in seaweed collection were women (58 %). About 63 % of seaweed harvesters were literate, more than half (60 %) belongs to middle age group (36-55 years) and 60 percent had seaweed collection as their main occupation. The average annual income of a seaweed harvester is ₹ 88,870. The price spread is found to be high (> 75 %) for the selected species, irrespective of fewer intermediaries. Marketing efficiency is estimated to be 0.04, 0.36, and 0.13 for the *Sargassum* & *Turbinaria, Gelidiella,* and *Gracilaria spp,* respectively; this is reflected by the low price obtained by the harvesters, high marketing margin, and high consumer price. Even though the products fetch a high price in the domestic and global market, the harvesters have received a paltry sum and are exploited advertently. Government intervention is required to fix a minimum assured price. Also, analysing the institutional arrangements, it is suggested that the formation of Farmer Producer Organisation (FPO) will help to organize and institutionalize the sector, providing financial support, improving bargaining power, and streamlining the value chain.

Assessing the Performance, Economics and Energy Efficiency of Various Fishing Systems in Pulicat Region of Tamil Nadu

(CIFE/2020/FEC004/SR)

Mani Selvam J

Major Advisor: Dr. Swadesh Prakash

Fishing provides high-quality seafood and creates employment and income for coastal communities worldwide. The Pulicat region is located in Thiruvallur district of Tamil Nadu. Around 52 villages are distributed in the Pulicat region. The present study was conducted to assess the trends and performance of fisheries and to compare the socio-economic profile of fishers, and economic benefit of various fishing systems in


the Pulicat region of Tamil Nadu. Level of non-renewable energy utilization by different fishing systems along the Pulicat coast was also worked out. The primary data collected based on the fishing gears operated in this regions by adopting proportionate random sampling method through pre-tested interview schedule. Trend line analysis results indicated that there was declining trend in marine fish production that evidenced from the CAGR of -1.42.

The socio-economic profile of the collected respondents showed that majority of them were Hindu, belonged to the middle age group (36-59 years), and educated up to primary school. Most of the respondents were resided in pucca houses as a nuclear family. Kruskal Wallis test revealed that there was a significant ($P<0.05$) difference between House area, total expenditure, total credit, and crew members among different fishing systems. An average annual income of Rs. 1,73,205/- was obtained from the primary occupation of fishing, however there was a significant difference ($P<0.05$) observed among different fishing systems studied in this region. Fuel cost was one of the major components of the annual variable cost for all the fishing systems. The benefit cost ratio in all the fishing systems was found to be more than one which indicates that all the five types of fishing systems were economically viable; however, the highest of 3.08 was observed in SDL. The CO_2 emission and fuel consumption per tons fish was found to be better for SDL after PRS. Therefore, the data of the present study suggest that economic benefit and energy efficiency was accomplished in SDL compared to all other studied fishing system in Pulicat region which may pave the way to exploit the marine fishery resources sustainably.

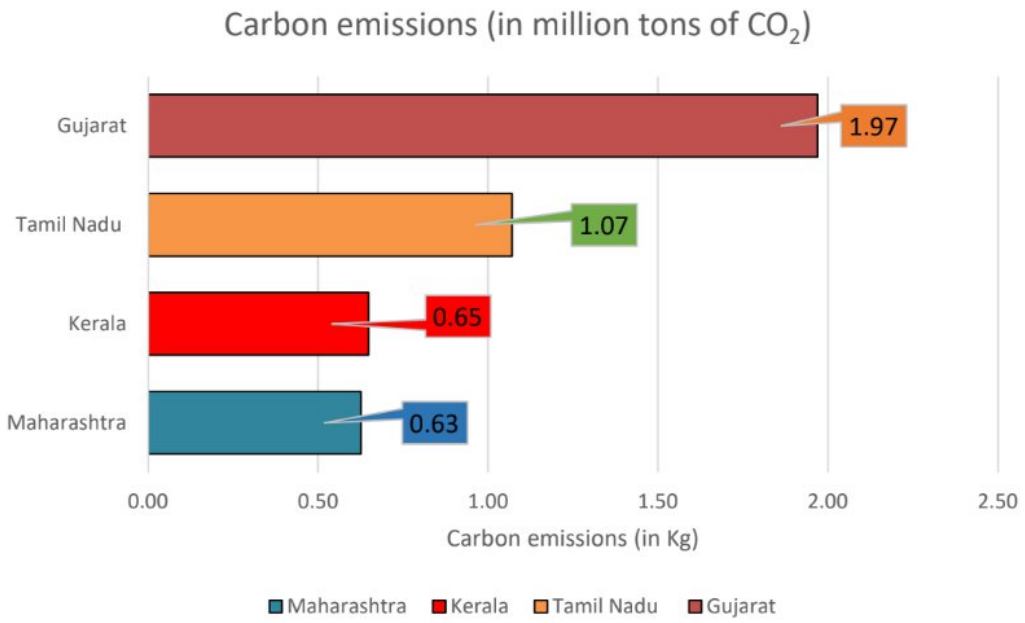
Macroeconomic Assessment of Carbon Footprints in Marine Capture Fisheries of India

(CIFE/2020/FEC002/SR)

Aparna Anil

Major Advisor: Dr. Neha W. Qureshi

In this study, an attempt has been made to quantify carbon emissions from marine capture fisheries of India. The four principle maritime states (Gujarat, Tamil Nadu, Kerala and Maharashtra) in terms of the largest fleet size in marine capture fisheries have been selected for analysis. The assessment revealed that the carbon footprints of marine capture fisheries increased to 4.42 million ton CO_2 in 2016, an increase of 22% from emission levels in 2010. The highest emissions were from multi-day trawlers of Gujarat (1.6 million ton CO_2) while lowest is from mechanised purse seiners of Kerala. State wise, highest carbon emissions were from Gujarat (1.9 million ton), followed by Tamil Nadu (1.02 million ton) while Maharashtra and Kerala had comparable total emissions (0.64 and 0.62 million ton respectively).



The carbon emission intensity rose to 1.2 kg CO_2 / kg of fish landed, indicating more emissions being released from landing a unit quantity of fish. It was highest in Gujarat (2.54 kg CO_2 /kg fish), followed by Maharashtra (1.34 kg CO_2 /kg fish) and Tamil Nadu (1.33 kg CO_2 /kg fish). In Kerala, it was the lowest at 0.8 kg CO_2 / kg fish landed. A comparison of craft systems points to mechanised trawlers being the most carbon-intensive system in India, while mechanised dol netters and purse seiners being the least carbon-intensive. The analysis revealed that 1636 million litres of fuel were burnt, resulting in fuel intensity of 0.36 kg of diesel per kg of fish landed. It was found that technological changes can achieve emission reductions up to 15% with fuel cost savings of 25%. Alternative fuel options considered reveal that hybrid vessels can result in emission reductions of 0.5 million tons with cost savings of 21 billion. Reduction in revenue at various levels of effort owing to subsidy reduction has been estimated for each state.

A revenue loss of 13 million is created in Maharashtra with emission reduction of 0.4 million ton, while in Gujarat, the revenue loss is at higher levels at 151 million with emission reduction of 1.2 million tons. In Tamil Nadu, the emission reduction is 0.68 million ton with revenue loss of 5.8 million. The effect of subsidy reduction in Kerala is much lower since fuel subsidies in the state are solely for motorised crafts. It is deduced that the motorised sector will be the most affected in case of any diminution in subsidies. Based on this evaluation, a reduction in subsidy or streamlining is recommended over complete dissolution due to significant economic implications. It has also been estimated that excess fleet size results in 1.72 million ton CO_2 , and a reduction from current fleet size to optimal creates a revenue decrease of 40% annually. It is surmised that Optimal fishing fleet size may be maintained in each state.

(CIFE/2020/FEC006/SR)

Supply Chain Analysis of Mud Crab (*Scylla* spp.) in Krishna District of Andhra Pradesh

Palsam Karthik Kumar Goud

Major Advisor: Dr. Swadesh Prakash

The mud crab, also known as the mangrove crab, is a portunid crab species that are economically significant and is regarded as a source of food and income generation through its fishery in many tropical countries in the Indo-Pacific region. Mangrove forests are generally regarded as the best natural habitat for mud crabs, and the state of Andhra Pradesh is endowed with 404 sq. km of mangrove area. So, the

present study was undertaken to identify existing marketing channels, examine price spread and supply chain efficiency and recognize the constraints in the mud crab supply chain in the Krishna district of Andhra Pradesh. Krishna district was selected purposively based on the prevalence of high mud crab harvesting and marketing activities. Proportionate random sampling and snowball sampling technique was carried out to select respondents. Data was collected with the help of a pre-tested interview schedule from 152 fishers, 11 middlemen, 7 wholesalers, 3 retailers. The data obtained by the study was analyzed (descriptive statistics, price spread, marketing efficiency, and rank-based quotient (RBQ)). Among the 5 identified marketing channels, major (56%) quantity is disposed of through channel-1 (Fishers-Middlemen-Wholesaler-Exporter). The green crab had 4 grading sizes (XL, Big, M, GL), whereas the orange crab was graded into 2 sizes (RB, RL) in the study area.

The marketing cost of fisher includes the cost of packing used for tying crabs. The major share of marketing costs incurred was transportation costs for both middlemen and wholesalers, and market fees for retailers. Among both the export marketing channels, channel-4 (Fishers-Wholesaler-Exporter) was more efficient than channel-1 (Fisher-Middlemen-Wholesaler-Exporter), with high marketing efficiency (4.24) and less price spread (₹143.21 per kg). Among the domestic channels, channel-5 (Fisher-Wholesaler- Consumer) is more efficient, with the highest marketing efficiency (2.29) and low-price spread (₹63.78 per kg). Low harvest/ Less catch, Quantity handled decreased, Quantity and value handled decreased, and Decreased demand are the major constraints faced by fishers and marketing intermediaries. Department of fisheries, Krishna district, must take initiatives to reassure crab fishers and support their socioeconomic development by providing micro credit facilities and working capital requirements of fishers.

Impact of Cage Culture on Fishers' Livelihood in Chandil Reservoir, Jharkhand.

(CIFE/2015/FEX503/SR)

Shweta Kumari

Major Advisor: Dr. Arpita Sharma

This study was done with the objective of assessing fisheries management system, fish production patterns, cage culture practices and its impact on fishers' livelihood in Chandil reservoir. Interviews were done with 200 (49.87%) members of 5 cooperative societies working in this reservoir. The results of the study indicated that cage culture started in this reservoir in 2011 and by 2019, 933 cages were installed. This is 21% of the total cages installed in state. Leasing of the cages for fish culture is done by district fisheries officer for 10 years and priority is given to cooperative societies at a fixed token amount of ₹ 100 per hectare annually. Cages are stocked with Pangasius seeds @ 7,000 fry/cage. Cost of seed was ₹ 1.5 per fingerling and feed was ₹ 16 per kg. Culture period was 10 month and survival rate was 80%. Feed was given at rate of 1-5% of body weight. Small feed mill has also been established in 2016 which has 2 tonnes/day production capacity.

Fish production from cages have increased from 110 tonne in year 2011-12 to 250 tonne in year 2018-19 but average production per cage did not show increasing trend. Input cost especially for seed was a constraint. The benefit cost ratio was found to be 1.46. Fisheries management system was found to be effective with active participation of state and central government and fisher members of the cooperatives. Results revealed that 66.67% of the NFDB guidelines were being followed. However, guidelines for water quality, fish health monitoring, and use of safety measures were followed partly. With reference to the livelihood study, there was positive impact on all capitals in the range of 20% to 35%. Highest impact was on human capital (34.66%) followed by social (30.99%), financial (28.90%), physical (25.95%) and natural capital (20.85%). Wilcoxon signed rank test revealed a statistically significant difference between the before and after scores at 5% level of significance. It was reported that fisher members' average income was ₹3.5 lakh. It was found that all cooperative society had average or above average performance and there was

no significant difference in the performance scores. However, market linkages and relationships had lower scores and there was no value addition reported.

It is clear from the study that adoption of fish culture in cages in Chandil reservoir has increased the production and productivity of fishery resources as well as livelihoods of people. Responses for hypothetical counterfactual revealed that the livelihood impacts were due to cage culture intervention. Sole causal attribution could be established with ruling out alternatives as no other major development programmes were reported. Additional causal inference was established with process tracing. Based on perceptions and fish production information it can thus be concluded that cage culture in Chandil reservoir has emerged as a viable livelihood option with positive impacts especially for people who were displaced due to reservoir construction due to the effective participation of cooperative societies, community, Non-Government Organizations and Government.

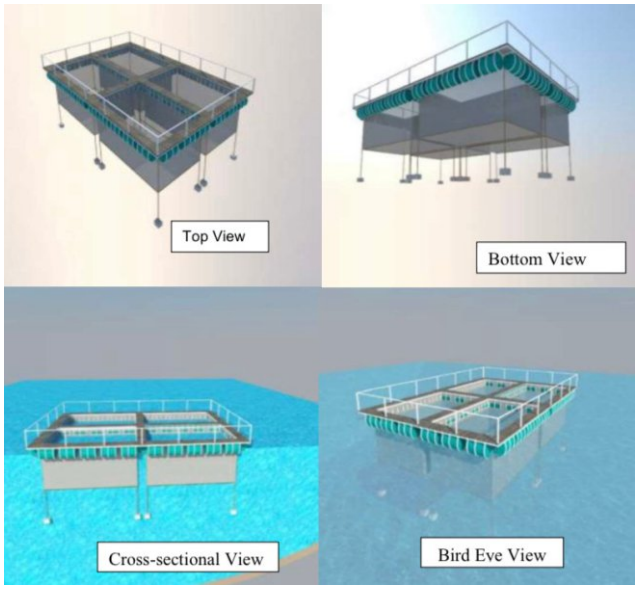
An Economic Evaluation of Cage Culture in Reservoirs of Jharkhand

(CIFE/2015/FEC501/SR)

Stanzin Gawa

Major Advisor: Dr. Nalini Ranjan Kumar

Cage culture technology has immense potential to augment enhanced fish productivity in open water bodies, especially in reservoirs. This study is an attempt to empirically investigate the economic performance of cage culture in reservoirs of Jharkhand. The data from three selected reservoirs that is Chandil, Massanjor and Hatia were collected. The study revealed negligible representation of women in cage culture both as individual cage farmers and participation in fisheries cooperatives. The cage farmers were more educationally empowered and their economic conditions were better off as compared to fishers and 51 % of them were having pucca houses while none of the fishers of Chandil reservoirs was having a pucca house. However, in the case of Massanjor and Hatia reservoirs 13.3 and 3.33 % of fishers were having a pucca house. Cage culture for both cage farmers and fisheries cooperative at Chandil reservoir was economically viable indicated by a BC ratio of 1.22 and 2.11. Cage culture by the fish cooperative in Hatia reservoir was also economically viable with a BC ratio of 1.88.



The result showed that feed contributes only 34.45 % of the total cost of production deviating from the general intensive culture system where feed contributes at least 50 per cent of the total cost. While feed contributed 72.61, 66.36 and 54.80 % of the total cost of production for cage farmers, and cooperatives of Chandil and Hatia reservoirs respectively. Income inequality was observed to be higher among cage farmers compared to fishers, however, per capita income was sevenfold higher for cage farmers as compared to fishers. The economic viability and sensitivity analysis showed cage farmers of Chandil reservoir had IRR higher than the opportunity cost of investment at only 12% at original cost and benefit. The estimates of economic viability indicated that the Chandil reservoir cooperative had better performance than others which may be due to factors like good site selection, strong organizational management and availability of a feed mill. However, there is a need to improve quality and reduce the price of fish feed which was found to be a major factor in deciding the profitability margin and ultimately contribute to the reduction of the overall cost of production.

(CIFE/2015/FEC504/SR)

Floods and Fisheries in Assam: An Economic Evaluation of Losses, Current Coping Strategies and Way Forward

Hoilenting

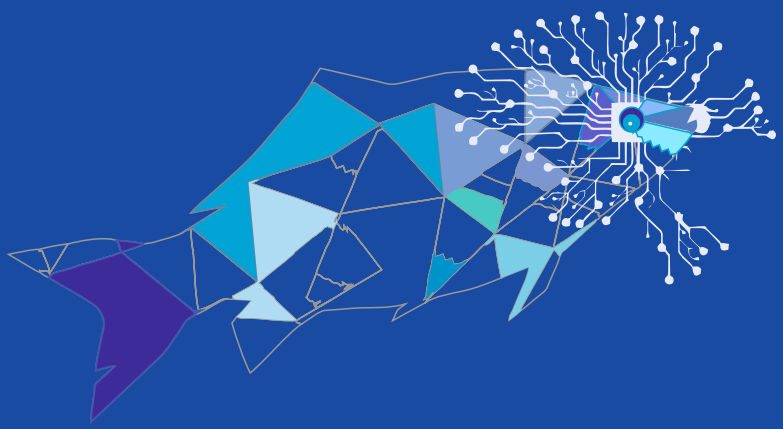
Major Advisor: Dr. Rama Sharma

Natural disasters have been recurrent phenomena in many parts of India. In north-east, Assam is one of the flood prone states and suffers enormous losses due to recurrent and extensive flooding in the low lying regions. Current study have evaluated economic losses in fisheries sector among the four selected districts of Assam due to 2017 flood, effectiveness of flood coping strategies adopted by fishers and government intervention in mitigating the floods with suitable suggestions. Dhemaji, Jorhat, Morigaon and Dhubri districts were purposively selected by using multistage sampling method. Field survey was conducted after the flood occurrence from September 2017 to February 2018. By using structured interview schedule, primary data was collected from 240 respondents.

Results reveals that majority of fish farmers and fishers were males, educated up to primary/high school, belongs to early/middle age group, residing in kachha house in joint family, low/middle income groups and are involved in agriculture also. Nearly 2,941 respondents got affected with flash and riverine floods and an average pond area of 327.59 ha. was inundated for two or more weeks. In culture fishery, average annual loss of ₹ 97,552/ acre- per person was found with share of 56.84% in loss of fish. While in capture fishery, it was of ₹ 23,044.95/-per person due to 2017 floods. Significant effect of days of inundation, rainfall and area of the pond on loss of fish was found at 1%, while depth of floodwater was at 5%. Income inequality had worsened after flood among the fishers and lower income group fishers had suffered maximum losses of their average annual income (79.42 %) as compared to higher income groups (55.74 %).

Different flood coping strategies were adopted by fishers' and raising pond dyke was found as the most effective FCS with 1st rank. Cost-benefit analysis indicated that investment on raising pond dyke would be beneficial with B-C ratio 4.96. Fish farmers had reported damage assessment in culture fishery only but none of them had received any relief funds and were striving hard to rehabilitate themselves after floods. Proper and strong linkages among governments/non-government organisations, insurance company along with local communities are necessary for mitigation of flood as they are aware of actual scenario, resources, facilities, support systems and alternative options to carry out disaster operation. Damage/loss assessment related to climate change and remote sensing methods in fishery sector still have scope and it can further be strengthened by studying the positive impact of floods also.

04 Extension Achievements



4.1 Programs under Tribal Sub Plan (TSP)

Nodal Officer: Dr. K.A. Martin Xavier

Under the TSP component, ICAR-CIFE conducts several tribal community development programs and activities throughout the year. During 2022, a total of 17 training programmes were conducted in Maharashtra, Madhya Pradesh, Jharkhand, Tripura, Manipur, Sikkim and West Bengal benefiting as many as 616 participants. A descriptive summary of these programs is given below.

Utilization of locally available ingredients for fish feed preparation for better income generation and livelihood improvement

Coordinators: Dr. S.K Nayak and Mr. Dhalongsaih Reang

One day awareness-cum-inputs distribution program was conducted by the CIFE Powerkheda Centre in Barwani district, Madhya Pradesh on 27 January 2022. Shri N. P Raiwar, Asst. Director of Fisheries, Barwani was the Chief Guest and Barwani Member of Parliament's representative was also present. Lectures on scientific fish farming and preparation of fish feed using local ingredients were given by Dr. Sunil Kumar Nayak and Mr. Dhalongsaih Reang. Fifty participants belonging to the scheduled tribe community participated. Hand-held feed makers were distributed among the participants. The program was covered in the newspaper "Dainik Bhaskar" and the local TV channel.

Cage farming in reservoirs as a potential livelihood option for tribal communities

Coordinator: Dr. Kapil Sukhdhane

Division of Aquaculture, ICAR-CIFE organised a one-day awareness-cum-training programme for the tribal society of Zanzorli village in Palghar district on 8th February 2022. It was attended by 21 tribal participants (20 men and 1 woman) from "*Shree Zanzroli Adivasi Macchimar Sahkari Sanstha*". The sessions covered types of cages used in reservoirs, fish culture, feed management in cages, disease management, the economics of cage farming, and sharing of success stories of farmers. Mr. Amol Sonone, Asst. FDO, Palghar delivered a talk about different schemes and subsidies available under *Pradhan Mantri Matsya Sampada Yojana*. The fishers here depend on wild fish catch from reservoirs and the river streams where income is uncertain and it is hoped that adoption of cage farming in reservoirs, additional income can be earned. The training was highly appreciated with good feedback from the trainees.

Enhancing fish productivity through farmer participatory research (Barwani, M. P.)

Coordinators: Dr. S.K Nayak and Mr. Dhalongsaih Reang

One day training and inputs distribution program was conducted on 28th Jan, 2022 in Thikri Block, Barwani, Madhya Pradesh. Sri Jagdish Mujaldi, Janpat Panchayat Secretary was the Chief Guest. Lectures covered scientific fresh water fish culture in rural ponds, feed management in aquaculture systems, importance of soil and water quality management, and disease management. Fish seed, floating fish feed and fertilizers were distributed among the 10 selected beneficiaries including members of the two fishery cooperative societies. The program was covered by several local newspapers.

Enhancing fish productivity through farmers participatory research (Chandel, Manipur)

Coordinator: Dr. S. Munilkumar

A three-day on-farm skill development programme for fish farmers of Chandel district was organized by CIFE Kolkata in collaboration with DoF, Manipur during 17-19 March, 2022. The programme was a part of a research project which aims to develop sustainable farming models for the district and enhance fish productivity through farmers' participatory research. During the programme, farming techniques relevant to local conditions were demonstrated. Farm-made feeds with locally available leaves, fish health management, water quality testing, plankton estimation etc. were discussed. A total of 50 (men: 42 and women: 8) tribal fish farmers attended and received critical inputs like quality fish feed, lime, fish fingerlings, water testing kits for pH and dissolved oxygen.

Culture of improved fish varieties for livelihood development

Coordinator: Dr. Martin Xavier and Mr. Dhalongsaih Reang

One day awareness cum inputs distribution program was organized at Longtharai valley, Dhalai, Tripura on 3rd March, 2022. The program was organized in collaboration with the State Fisheries Department, Tripura. Dhalai district of Tripura is identified as an aspirational district by NITI Aayog, from where 50 fish farmers were identified with the help of the state DoF. Participants were briefed on the feasibility of introduction of genetically improved fish variety for increasing productivity and improving livelihoods. One aluminium hundi and a cast net each was distributed to the 50 farmers as support to their fish farming activity.

Cage aquaculture: a potential livelihood option

Coordinator: Dr. Shivaji Argade

Training-cum-demonstration programme was organised during 3-6th March, 2022 at Junnar (Pune, Maharashtra) benefitting 50 tribal fishers (men-40, women-10) from Shivechiwadi village residing near Manikdoh Reservoir in Junnar block. Field exposure visit to cage aquaculture unit at Dimbhe reservoir provided hands-on

training on various activities and preparation of value added fish products. Mr. Santosh Khamkar, a successful entrepreneur doing cage farming at Dimbhe reservoir acted as a resource person as well demonstrating the preparation of fish fillet and fish vada from fresh harvested fish for fisher women self-help group. Dr. Kiran Rasal, Scientist highlighted the potential fish species and their culture practices in cage aquaculture. On this occasion, 150 kg of fishing nets were distributed to selected 30 needy men fishers (5 Kg each) from Manikdoh reservoir in order to get a good fish harvest.

Feed and feeding methods in freshwater aquaculture

Coordinator: Dr. D. K. Singh

CIFE Kolkata in collaboration with the NGO, Sundarban Dreams organized a skill development program during 5-7 March, 2022 at Gidang, Kalimpong-I, Darjeeling, West Bengal. Farmers got trained on composite fish culture, feed and feeding management, water quality management and fish disease management in aquaculture. Moreover, farm-made feed preparation using locally available feed ingredients was also practically demonstrated. Farmers had hands-on experience on water testing kits (pH kit and DO kit). A total of 50 tribal farmers received various inputs, such as lime: 50 kg, Fish feed: 30 kg, pH and DO kits, and technical materials. The beneficiary farmers appreciated the efforts of CIFE for conducting this training with support through input distribution which would surely assist to enhance fish production and improve their livelihood.

Ornamental fish breeding and culture

Coordinator: Dr. Suman Manna

CIFE organised a three-day skill development training programme in Bengali medium for 25 (Men - 20, Women - 5) fish farmers of South Tripura district, Tripura was organized during 10-12 March in collaboration with CoF, Tripura in its premises. Prof. Ratan Kumar Saha, Dean, CoF, was the Chief Guest. Sessions covering basic aquarium setup, live food in ornamental fish, ornamental fish breeding and culture for species relevant to North East India, etc. were held by experts from ICAR-CIFE Kolkata and College of Fisheries, Lembucherra. Practical demonstration of water quality parameters, field visits to the commercial ornamental fish farms, farmers-scientist interaction were integral part of the program. At the end, critical inputs for ornamental fish farming namely fish feed, water testing kit (pH, DO, nitrate & nitrite, ammonia), plankton net, aerator and ornamental fishes were distributed to the farmers. The training was highly appreciated with positive feedback from the trainees.

Monitoring of water and soil parameters for sustainable aquaculture

Coordinator: Dr. Suman Manna

A three-day skill development training programme for 50 fish farmers of East Singhbhum, Jharkhand was organized during 14-16 March, 2022 by CIFE Kolkata in collaboration with KVK, East Singhbhum, Jharkhand at the KVK. Lectures related to composite fish farming, feed and feeding management, fish disease management, integrated fish farming, importance of soil and water quality for sustainable aquaculture were covered. Practical demonstration of water quality parameters was also covered. A farmers scientist interaction was organized where all the questions of farmers were addressed. At the end, critical inputs for ornamental fish farming like, lime, fish feed, water testing kit (pH, DO) were distributed among the farmers. Trainees appreciated and provided positive feedback.

Integrated fish farming

Coordinator: Dr. Sujata Sahoo

CIFE Kolkata, in collaboration with KVK, Jalpaiguri organized a three-day skill development training during 12-14 March, 2022 at Alipurduar, West Bengal. The training was inaugurated by Dr. Biplab Das, Head, KVK, Jalpaiguri. Farmers were trained on composite fish culture, feed and feeding management and integrated fish farming. Farm-made feed preparation using locally available feed ingredients and water testing kits (pH kit and DO kit) were practically demonstrated. A total of 50 tribal farmers participated and received various inputs, such as lime: 50 kg, fish feed: 30 kg, water testing pH and DO kits, and study materials. The beneficiary farmers appreciated the training program and the input support.

Biofloc technology in aquaculture

Coordinator: Dr. Babitha Rani. A.M

Division of Aquaculture organized a demonstration - cum - training program on biofloc technology in aquaculture for 15 participants (including two TERI staff) from Mokhada village of Palghar district, Maharashtra on 25th March 2022. It was conducted in association with The Energy research Institute (TERI), Maharashtra. The biofloc technology is one of the promising technologies in aquaculture which can lead to higher production from areas where there is scarce land and water resources. The demonstration was given at the commercial scale unit at CIFE, Mumbai and the session covered tank design and construction, inoculum formation, candidate species selection, water quality management, routine management of system and feed management, merits and demerits of biofloc based fish farming, and market demand. Besides the coordinator, Dr. T. I. Chanu, Dr. Kapil Sukhdhane and Dr. Madhuri Pathak elaborated on various measures to be taken care of while farming fish in the biofloc system.

Advances in freshwater aquaculture for fish farmers

Coordinator: Dr. S. Dasgupta

CIFE Kolkata along with ICAR Research Complex for NEH Region, Sikkim Centre, Tadong, ICAR-KVK, East Sikkim, Ranipool and Directorate of Fisheries, Govt. of Sikkim, Gangtok jointly organized the three-day skill development programme at ICAR Sikkim Centre, Tadong during March 25-27, 2022. Fifty farmers from East district and North district participated. Shri. N. Jaswant Singh, IFS, Director of Fisheries, Sikkim was the Chief Guest. The farmers had training on diversified aquaculture, feeding management and RAS. Water testing kits developed by ICAR-CIFE and the methods of fish feed preparation were demonstrated. Amur Carp, fish feed, tarpaulin, and lime were distributed to the trainees on completion.

Best aquaculture practices with special reference to nutrition and health

Coordinators: Dr. Gayatri Tripathi, Dr. Vidyashree Bharti, Dr. Kiran Rasal and Dr. Manish Jayant

One day training programme was held at Nandurbar on 28th September 2022. The session covered importance of aquaculture as a livelihood option for the tribal community, good aquaculture practices and disease management, water quality management in ponds, feed requirements of IMC and *Pangasius* at various stages, understanding the right ingredients in feed, management of diseases, and hands-on preparation of fish feed. The fish samples, water and soil samples were also collected for documenting status of health and environmental parameters. A total of 50 participants from various villages of Navapur Tahsil, Nandurbar benefitted from this training programme.

Zero-waste utilisation of fish

Coordinator: Dr. H. Mandakini Devi

CIFE Kolkata organized a three-day training-cum-demonstration programme at Khukthar Village, Chandel District, Manipur during 24-26 November, 2022. Demonstrating that all parts of fish can be effectively utilised, the farmers were trained on extraction techniques of fish feed ingredients from fish waste, preparation of fish cutlet, fish ball, fish pickle and fish powder, packaging techniques of different value-added fish products. A demonstration session on fish silage preparation from the fish processing waste was also covered. A trainees-resource persons interface was also conducted to address the queries. A total of 25 trainees who were mainly members of Idung Ipaar SHG benefited from the training programme.

Modern methods of freshwater aquaculture

Coordinators: Dr. Sujata Sahoo; Dr. Suman Manna

CIFE Kolkata conducted three programs on modern methods of freshwater aquaculture for tribal fish farmers at different locations in West Bengal Jharkhand. They were held during 11-13 December in Mirik, Darjeeling (W.B.)for 25 people, and during 19-21 December in Madarihat, Falakata, Alipurduar (W.B.) for 25 people, and during 21-23 December in East Singhbhum (Jharkhand) for 20 farmers. The participants were trained on feeding management, modern methods of fish culture, soil and water quality management, air breathing fish breeding and culture, freshwater aquaculture, basic pond management practices, integrated farming system (pig cum fish culture), carp poly-culture and fish health management. Practical demonstration, distribution of CIFE's pH kit & DO kit and supply of inputs such as aluminum hundies, fishing nets and caps for their aquaculture activities formed an integral part. A farmer-scientist interaction was also held. All the farmers were actively involved in the discussion and expressed satisfaction. The programs were covered by popular newspapers. While the first program was coordinated by Dr. Suman Manna, the other two were coordinated by Dr. Sujata Sahoo.

4.2 Scheduled Caste Sub Plan (SCSP) Component

Nodal Officer: Dr. Parimal Sardar

Under the SCSP component, ICAR-CIFE has conducted several training programmes to develop the marginalised community. During 2022, a total of 23 training programmes were conducted in Kerala, West Bengal, Andhra Pradesh, Jharkhand, Bihar, Haryana, Rajasthan and Punjab benefiting as many as 1191 participants. A descriptive summary of these programs is given below.

Feed based fish farming

Coordinators: Dr. Shamna N and Dr. Babitha Rani A.M

The training program was conducted in Parakode Block, Kerala on 10-12 January 2022 wherein 30 farmers (18 women and 12 men) participated. The Block Panchayat President did the inauguration in the presence of ADF, Pathanamthitta. Farmers were exposed to hands-on feed preparations using locally available ingredients like leafmeal with a small pelletizer. The interaction with farmers revealed that the major problems faced were the cost of production and finding a suitable market for the produce. Hence, the ADF, Pathanamthitta suggested having a collaborative project on low-cost feed production using locally available ingredients by installing a small-scale feed mill. DoF was also interested and asked for technical guidance from the institute. A technical bulletin was distributed to all the beneficiaries.

Ornamental fish breeding and culture

Coordinator: Ms. Husne Banu

The training programme was conducted at ICAR-CIFE, Kolkata Centre during 9-10 Feb 2022 for 50 fish farmers from Bishnupur block, South 24 Parganas. The programme was inaugurated by Dr. G.H. Pailan, OIC, CIFE Kolkata Centre in presence of Mr. S. Banerjee, ADF, South 24 Parganas. The farmers were trained on ornamental fish breeding and rearing, water and soil quality management, live feed production and health management aspects. Inputs like ornamental fish, feed, plankton nets, aerator and CIFE-developed water testing kits were distributed among the participants.

Demonstration of leaf meal based farm-made aquafeed preparation and on-farm feeding management

Coordinator: Dr. Sikendra Kumar and Dr. Dilip Kumar Singh

Training were conducted at Kunda Block (8-11 Feb 2022) and Lawaloung Block (14-16 Feb 2022) in collaboration with DoF, Jharkhand benefiting 45 and 50 farmers respectively. Several lectures on composite fish culture, pre-& post stocking pond management, and feed-based aquaculture were given in addition to a demonstration of leaf meal based pelleted, ball and mash feed preparation. *Eichhornia* leaf meal, mustard oil cake, maize, wheat flour, DORB (deoiled rice bran) and vitamin minerals mixture were used for feed preparation. Different methods of feeding such as bag feeding, tray feeding and broadcasting were demonstrated. Farmers were also taught about water quality testing, fish health management and harvesting process. Each farmer was provided with 500 IMC seeds (5 to 8 g/fish) and one ice box. Overall, the training programmes were highly successful with positive feedback from farmers and wider media coverage.

Basic aquaculture practices for livelihood improvement

Coordinators: Dr. Muralidhar P Ande and Dr. Karthireddy Syamala

A training programme was organised by ICAR-CIFE, Kakinada centre during 18-19 March 2022 at Kuchipudi village, Guntur District, Andhra Pradesh benefitting 50 farmers. Dr. Muralidhar P. Ande, in his inaugural address, emphasised the importance of basic aquaculture practices, feed and feeding management and the SCSP scheme. Dr. Karthireddy Syamala briefed about soil and water quality management, seed transportation and fish diseases and their control measures. Aquaculture inputs (starter floating pellet feed- 4500 kg, grower floating pellet feed- 8000 kg, lime-7500 kg) were distributed coupled with farm visits and farm advisory services. The programme was covered by the local newspaper and highly successful with good feedback from the participants and fisheries officials.

Modern methods of freshwater aquaculture

Coordinator: Mrs. Husne Banu

CIFE Kolkata organised a training programme for 100 (84 men, 16 women) fish farmers of Sonarpur, South 24 Parganas (W.B.) during March 26-27 2022 in collaboration with Integrated Rural Development & Management (IRDM) Faculty Centre, RKMVERI, Narendrapur and Sasya Shyamala KVK. The farmers were trained on homemade feed preparation, advanced methods of aquaculture practices, fish diseases management and pH and DO kits were demonstrated for the water quality management. Critical inputs for ornamental fish farming like lime (100 kg), fish feed (90 kg), cast net, aluminium handi and water testing kit (pH, DO) were also distributed to the farmers.

Feed based aquaculture and on-farm feeding management

Coordinators: Dr. Sikendra Kumar and Dr. Tincy Varghese

The training programme was conducted in collaboration with KVK, Manpur Gaya and the DoF Gaya office at KVK Manpur, Gaya (Bihar) during 22-24 August 2022. A total of 26 farmers were taught the basics of aquaculture, composite fish culture, pre and post stocking management, pelleted feed preparation using the local ingredients and water quality management. Locally available ingredients like MOC (mustard oil cake), maize, wheat flour, DORB (de-oiled rice bran) and vitamin-minerals mixture were used for pelleted feed preparation. Hands-on demonstration was given on mash, ball and pelleted feed preparation and different feeding methods (bag feeding, tray feeding and broadcasting). The training including a total of six theory and three practical classes have received a positive response and excellent feedback from the farmers with coverage in three local newspapers.

Fish processing and value-added fish products for fish farmers

Coordinators: Dr. S. Dasgupta and Dr. H. Mandakini Devi

CIFE Kolkata conducted the three days training programme during 14-16 Dec 2022 for the rural folks from North and South 24-Parganas districts of West Bengal. The programme was inaugurated by Dr. C.N. Ravishankar, Director, CIFE at Kolkata Centre. The programme was attended by 40 fish farmers. Deliberations on the benefits of fish for health, post-harvest preservation and demonstration on fish filleting, pickles, sausages, cutlets, nuggets and prawn spicy powder preparation techniques were given to the farmers.

Aquaculture technologies as livelihood options

Coordinators: Dr. G.H. Pailan, Dr. P. Sardar, Dr. G. Biswas, Dr. Suman Manna, Dr. Sujata Sahoo, Dr. S. Datta, Dr. D.K. Singh, Dr. H. Mandakini Devi, Dr. Harikrishna V , Dr. Pankaj Kumar, Dr. Sreedharan K, Dr. Ashok Kumar

CIFE Kolkata and Rohtak Centers conducted 15 training programmes for 808 marginalised fish farmers at different locations in West Bengal, Haryana, Punjab and Rajasthan. The participants were trained on feeding management, soil and water quality management, basic pond management practices, modern methods of fish culture, air-breathing fish breeding and culture, freshwater aquaculture, integrated farming system, integrated fish farming particularly pig cum fish culture, poly-culture of carps, and fish health management and shrimp farming in inland saline areas. Practical demonstration was followed by the distribution of pH kit & DO kit developed by ICAR-CIFE and other inputs such as aluminium hundies, fishing nets and caps and the Farmer-Scientist interaction.

4.3 Programmes under North-Eastern Hill States

Nodal Officer: Dr. A. K. Verma

Under the NEH programmes, ICAR-CIFE conducted several training programmes. During 2022 a total of 10 training programmes were conducted at Arunachal Pradesh, Tripura, Manipur, Assam, Nagaland, Mizoram and Nagaland including a launch workshop. A total of 419 participants benefitted. A descriptive summary of these programs is given below.

Market networking for value added fish products

Coordinator: Dr. Sujata Sahoo

A two days training programme was organized by ICAR-CIFE, Mumbai during 2-3 Feb 2022 at the pilot plant facility of Guijan, Tinsukia, Assam for the promotion of value-added fish products and establishing market linkages. The products like Puthi fish pickle, Boriola fish pickle, Ari fish pickle, Pangas fish pickle, Rohu fish cutlet, fish paneer and fish papad were displayed to a total of 40 participants including product manufacturing women and product buyers. Dr. R. K. Majumdar, Retired Professor & Head, FPT, College of Fisheries, Tripura demonstrated value-added products: Fish shidol and fish paneer preparation and the potential buyers tested all the products. Dr Amjad Balange, Principal Scientist, ICAR-CIFE, Mumbai delivered a talk on marketing strategies for value-added fish products. All the fish products were prepared under the guidance and supervision of Mr. Avinash Sable, Technical Officer, ICAR-CIFE, Mumbai. To date, almost 150 women were trained in making value-added fish products and among those, a group of 12 women have started marketing their product with a brand name SPINAC. The team working at the pilot plant has expressed their gratitude to Dr Ravishankar C N, Director & VC, ICAR-CIFE, Mumbai for taking this project to the next level.

Advances in sustainable aquaculture practices

Coordinator: Dr. Suman Manna

A four-day skill development programme for 100 fish farmers (87 men, 13 women) of Assam was organized by CIFE Kolkata in collaboration with offices of DoF, Dibrugarh & Dhemaji (Assam). Mr. Tirthanath Hazarika, DFDO, Dibrugarh inaugurated the programme at Dibrugarh (8-9 March 2022) and Mr. Lakhiram Lagachu, DFDO, Dhemaji inaugurated the programme at Dhemaji (10-11 March 2022). Lectures on different aspects of composite fish farming, feed and feeding management, fish disease management, and the importance of soil and water quality for sustainable aquaculture etc. were covered. Practical demonstration and field visits were organized to better understand the management practices and water quality parameters of the farmer's fish pond. Critical inputs for farming like lime, fish feed, water testing kit (pH, DO) were distributed to the farmers.

Upscaling and fish health management in the fish-based integrated farming system

Coordinators: Mr. Dhalongsaih Reang and Dr. Arun Sharma

ICIFE Mumbai organized a training-cum input distribution program in collaboration with KVK Birchandra Manu, South Tripura during 25-27 March 2022 benefiting 34 farmers including 2 tribal women SHGs and a Farmers' Club. Under this program, a vermicomposting unit and five units of integrated fish farming model were developed in the farmers' field comprising poultry, duck, pig, and horticulture. Dr. Ravishankar C. N., Director, CIFE and Dr. A .K Verma, Nodal Officer, NEH scheme emphasized the convergence of CIFE and KVK in improving farmers' livelihood in the North-East

region. The training coordinators visited all the demonstration sites and selected the beneficiaries and further discussed with farmers and assessed the scope of up-scaling in collaboration with KVK South Tripura. Several lectures took place on the scope of doubling farmers' income through integrated fish farming, production management of fish and livestock, and fish health management. The initial inputs delivered to the farmers include fish seed: 10240 fingerlings, piglets: 3, poultry: 98, ducklings: 60, and horticulture planting materials like banana, lemon, papaya etc. Other inputs including poultry feed: 470 kg, pig feed: 650 kg, duck feed: 470 kg, and lime: 300 kg were also distributed to the participants and the training was highly appreciated.

Modern methods of sustainable aquaculture

Coordinators: Dr. H. Mandakini Devi and Dr. G. Biswas

CIFE Kolkata conducted two training programmes at Thoubal, Manipur (14-16, March 2022) and Dimapur, Nagaland (21-23 March 2022) to train the farmers on feeding management, fish health management, soil and water quality management, basic pond management practices, modern methods of fish culture, air-breathing fish breeding and culture, freshwater aquaculture, integrated farming systems, poly-culture of carps and integrated fish farming systems particularly pig cum fish culture. The training program also included a practical demonstration and distribution of pH kit & DO kit developed by ICAR-CIFE and other inputs such as aluminium hundies, fishing nets and caps for aquaculture activities while benefitting a total of 100 farmers.

Preparation and packaging of value-added fish products

Coordinator: Dr. H. Mandakini Devi

Training cum demonstration programme was conducted at the District Fishery Office, Churachandpur, Manipur during 21-23 November 2022. The participants were trained on preparation of fish cutlets, fish balls, fish pickle and fish powder. Technical sessions took place on the nutritional and health benefits and packaging techniques of ethnic value-added fish products of Manipur. A trainees and experts interface session was also conducted to address the query/feedback from the trainees. 20 farmers (16:M and 4:F) from aspirational backward blocks of Churachandpur such as Lamka, Henglep, Sangaikot, Santanding, Bongbal benefitted from the training.

Integrated fish farming

Coordinators: Dr. Suman Manna and Dr. G.H. Pailan

CIFE Kolkata organized a training-cum-awareness programme on 22-24 November 2022 for the tribal fisher folks of West Khasi Hills, Meghalaya at Porsohsat Fish Farm. The programme was inaugurated by Shri J. Suchiang, DDF, Shillong. Dr. G.H. Pailan, OIC, CIFE Kolkata briefed the

participants about the importance of integrated fish farming and Dr. Suman Manna, Scientist gave deliberations on soil and water quality management in integrated fish farming and demonstrated CIFE-developed pH, DO and ammonia test kit for water quality parameters. 20 tribal fish farmers participated in the training and the same was appreciated by Govt. of Meghalaya.

Sustainable freshwater aquaculture practices

Coordinators

CIFE Kolkata has conducted two such training programmes at Papum Pare District, Arunachal Pradesh (22-24 Nov 2022) and Aizwal, Mizoram (28-30 Nov 2022) to train the fish farmers on basic pond management practices, feeding management, fish health management, soil and water quality management, modern methods of fish culture, air breathing fish breeding and culture, freshwater aquaculture, different integrated farming systems, poly-culture of carps, and integrated fish farming particularly pig cum fish culture. Practical demonstration and distribution of pH kit & DO kit developed by CIFE and other inputs, benefited a total of 70 fish farmers.

Project launch workshop and training program at Dhalai district Tripura

Coordinators: Mr. Dhalongsaih Reang and Dr. Arun Sharma

The project "Improvement of water quality and fish health in integrated freshwater aquaculture system through treatment of animal manure" was launched by CIFE Mumbai in collaboration with the State DoF, Tripura during 21-23 October 2022. A total of 30 participants (23 men and 7 women) attended the program. The training program included release of an extension bulletin on the "Aqua-based integrated farming system" (Volume-1), demonstration of the polyculture of fish releasing 10,000 fish fingerlings including species like Singi, Koi, IMC, and minor carps and exposure visits to farms of progressive farmers. Deliberations were given on the scope of improving farmers' income per unit area through fish based integrated farming, production and health management of fish and livestock.

The input distribution program was conducted at Ganda Twisa Block, Dhalai district, Tripura in collaboration with DoF, Tripura on 12-14 Dec 2022 and 5 farmers were selected. Inputs like poultry, piglet, ducklings, poultry feed, duck feed and pig feed etc. were provided and IFS systems like pig cum fish, duck cum fish and poultry cum fish farming system including pig shed, duck shed and poultry shed were prepared to support the farmers initially. This project is mainly implemented to see the microbial load of pond water in various IFS systems through soil and water quality monitoring and best management practices and to improve the livelihood of the beneficiaries.

4.4 Skill Development Programmes (SDP)

ICAR-CIFE has conducted 22 skill development programmes for various stakeholders such as farmers, entrepreneurs, fisheries professionals, research scholars and students through online, in-person and hybrid modes during 2021, benefiting as many as 586 participants. This included one winter school and 9 customized SDPs for Bihar fish farmers. A descriptive summary of these programs is given below.

SDP on Basic and advanced computational tools for molecular genetics

Coordinators: Dr. Manoj P. Brahmane, Dr. A. Pavan Kumar, Dr. Arvind A. Sonwane and Dr. Kiran D. Rasal

The online hands-on training program was organized by Fish Genetics and Biotechnology Division during 3-10 Jan 2022 where 33 participants (12 men and 21 women) from different ICAR institutes and ASUs/CAUs attended. Dr. Aparna Chaudhari, Course Director and HoD, FGBD highlighted the importance of computational tools in basic as well as high throughput sequence analysis. The program includes molecular basis of evolution, basic sequence analysis, biological database, primer designing, DNA barcoding, phylogenetics, protein modeling, etc in form of both theory and practical sessions. The training also covered high-throughput data analysis which includes pre-processing of NGS data, mapping and assembly, transcriptome data analysis, SNPs discovery using Geneious Prime software and a training manual was provided to the trainees. The pre and post-training evaluation of trainees showed 60-70% improvement in their knowledge with regard to DNA sequence data analysis.

SDP on ISO/IEC 17025-general requirements for the competence of testing and calibration laboratories

Coordinators: Dr. S. Jahageerdar and Dr. A. Pavan Kumar

A training program was organized by CIFE Mumbai during 1-3 March 2022. Mr. S. Subramanian, Lead Assessor (ISO/IEC 17025: 2017 standard) was the main resource person and 25 scientists from different Divisions of CIFE participated. In his inaugural address, Dr. Ravishankar, Director emphasized the importance of ISO/IEC 17025: 2017 standard to demonstrate the lab competence and accreditation of labs to produce valid results and global recognition. The training programme covered all clauses of the standard, procedure for internal auditing and accreditation. Mr S. Subramanian explained all clauses of the standard, and procedure for internal auditing and accreditation with several lectures, practice sessions and case studies. A test was also performed to assess the knowledge gain by the participants.

SDP on Geospatial analysis using open-source software

Coordinators: Dr. Vinod Kumar Yadav, Dr. Vidya Shree Bharti and Dr. Arpita Sharma

An online training programme was organized by Fisheries Economics, Extension and Statistics (FEES) Division, CIFE Mumbai from 30 May to 4 June 2022 with a total of 22 participants (13 men and 9 women). The sessions included basic principles of remote sensing and GIS and its applications; spatial analysis and image processing; mapping and monitoring mangroves, inland and coastal water quality and PFZ with remote sensing; multicriteria analysis, and habitat modeling. Participants were present brief concept notes related to geospatial area and the recorded lecture videos were shared to reinforce learning. Pre-training and post-training assessments of the participants were recorded to assess the effectiveness of the training programme with reference to knowledge level of the trainees.

SDP on Intellectual property rights in fisheries sector

Coordinators: Dr. Arpita Sharma and Dr. V. K. Yadav

This training programme was conducted in hybrid mode by the FEES Division, CIFE Mumbai during 2-8 August 2022. Identifying trademarks as an ice breaker and lectures on understanding innovation systems, basic concepts of IPR, WTO and TRIPS, Current IPR regime, interactive session cum talk on political economy of IPR and fisheries scenario and importance of IPR were organised. Practical exercises included patent search from Indian patent database, patent search from USPTO, WIPO, Espace net database, live patent searches, preparation of patent search report, awareness sessions on forms to be filled for patent filing, copyright filing, trademark filing, geographical indications filing, case studies of granted patents CIFE-Eco hatchery and fish skin leather. Landmark cases of patenting of life forms, and ICAR-IPR guidelines were discussed alongside ITKs and grassroot innovations in fisheries, CBD, IPRs in fisheries. It also included energiser session on creativity, visit to CIFE's ABI Unit, and lecture on patent filing and processing by Shri. Manoj Somkuwar, Asst. Controller of Patent from Patent Office, Mumbai .

SDP on Basic tools for taxonomy and biological studies of fishes

Coordinator: Dr. Monalisha Devi, Dr. Karan K. Ramteke, Mr. Dayal Devdas and Dr. A. Pawan Kumar

A short term training programme was conducted during 22-26 August 2022 for nine post graduate students and researchers from different colleges studying oceanography, fisheries science and zoology. The programme offered theory and practicals in the areas of fishery biology, taxonomy of resources and biodiversity assessment.

SDP on Prospects of biofloc technology in aquaculture

Coordinator: Dr. Babita Rani A. M

CIFE Rohtak organized a skill development programme during 3-7 October, 2022 customized for participants from Veraval, Gujarat. A total of 7 participants including 2 officials from DoF, Veraval, Gujarat attended the program. The theory sessions dealt with various aspects of biofloc

aquaculture including an overview of aquaculture, site selection, biofloc inoculums development, design and construction of biofloc tanks, species selection, water quality management, pre-stocking and stocking management, disease control and prophylaxis, feed and feeding management and cost-benefit analysis. The various aspects related to the theory were practically demonstrated and the participants were given hands-on training including a field visit to biofloc fish farm.

SDP on Value added products from fish and shellfish

Coordinator: Dr. A. K. Balange

Agri Business Incubation (ABI) Unit, CIFE conducted a training program during 1-3 November 2022 for 11 selected women incubatees from 3 SHGs. Dr. Ravishankar C. N., Director, CIFE, Mumbai interacted with the trainees and explained the scope for value-added fish product business. Dr. B. B. Nayak, HoD, FRHPHM and SIC, ABI along with FRHPHM staff delivered lectures on different aspects of fish processing and value addition for the trainees. All the trainees practically prepared fish cutlet, *Acetes* papad, prawn wafers, fish vada, fish sev, fish chakli, Acetes chatney, fish samosa and prawn pickle. Mr. Suresh Londhe, Joint Director of Industries (Export & Cluster Development), Maharashtra also discussed with the trainees about different Govt schemes available.

SDP on Fermented mackerel technology

Coordinator: Dr. A. K. Balange

The programme was conducted by ABI Unit, CIFE, Mumbai at CMRC, Ratnagiri, Maharashtra during 23-25 Nov 2022 for a total 29 women members from different SHGs. Dr. B. B. Nayak, HoD, FRHPHM and SIC, ABI, CIFE Mumbai interacted with all the trainees and explained the scope of fermented mackerel technology. All the trainees practically learned fermented mackerel preparation. During training, the ABI team, CMRC-Ratnagiri team and Officials from State DoF, Ratnagiri discussed with trainees about different Govt schemes and future development. Also, a location visit was conducted for establishment of value added fish and shellfish products unit at CMRC, Ratnagiri.

SDP on Microbiological quality testing of seafood- tools and techniques

Coordinators: Dr. Manjusha L. and Dr. Sanath Kumar H.

A short-term training programme was conducted during 19-23 December 2022 by the Fish Processing Technology Section, CIFE Mumbai and a total of nine trainees participated. The topics covered theory and practical sessions on biosafety in microbiology laboratory and basic microbiological techniques such as media preparation, plating, enrichment, isolation of pure cultures and biochemical identification of both normal and pathogenic bacteria from fish and shellfish. The training also covered the standard methods of isolation of fish-borne human pathogens such as *Escherichia coli*, *Salmonella*, and *Vibrio* spp., and their identification by conventional biochemical methods and PCR. Emphasis was given on learning basic molecular methods that can be employed in a seafood testing laboratory for detection of pathogens of human health significance associated with seafood.

SDP on Spirulina biomass production and utilization

Coordinator: Dr. S.P. Shukla, Dr. Kundan Kumar and Dr. Saurav Kumar

Three short-term training programs were organized by Aquatic Environmental Management Section, CIFE Mumbai during Dec 2022 to Jan 2023 for 28 participants (21 men and 7 women) from various parts of India. The practical classes focused on light microscopy studies on *Spirulina*,

media preparation, inoculation of mother culture in indoor and outdoor units, estimation of water quality parameters, batch culture techniques of *Spirulina*, techniques for growth measurement using spectrophotometric methods, Secchi disc, Chlorophyll estimation, cell/filament counting technique for pigments estimation, microbiological techniques for evaluation of biomass purity, protein estimation techniques, drying methods, extraction and estimation of the concentration and purity of Phycocyanin, CHNS analysis of biomass, etc. In addition, a visit of the trainees to CIFE laboratories, library, wetlabs and other facilities was arranged to acquaint the trainees with ongoing research and the facilities and a training manual was shared.

SDP on Health management in freshwater fish culture

Coordinator: Dr. R.P. Raman and Dr. Saurav Kumar

Aquatic Animal Health Management Section, CIFE Mumbai organized a SDP from 13 to 20 December 2022 for nine participants (8 men and woman) from Department of Industrial Fish & Fisheries, R.D.S. College, Muzaffarpur, Bihar. The sessions covered an overview of Indian aquaculture, diseases (viz. bacterial, viral, parasitic and non-infectious) of freshwater aquaculture; water & sediment management, feed management in aquaculture, health management, prophylaxis, probiotics, disease diagnosis, haematology, histology, microbiology, PCR & effective therapeutics etc. In addition, visits to CIFE's labs, library and other facilities were made to expose trainees to available facilities. The pre and post training evaluation of trainees revealed 40-55 % improvement in their knowledge related to the subject.

Molecular biology and bioinformatics tools and applications

Coordinators: Dr. Manoj P. Brahmane, Dr. A. Pavan Kumar, Dr. A. Sonwane and Dr. Kiran D. Rasal

A hands-on training program was organized by Fish Genetics and Biotechnology Division, CIFE, Mumbai from 12-21 Dec 2022 for 14 participants (4 men and 10 women) from Guru Ghasidas Central University, KUFOS, and CIFE. Dr. Aparna Chaudhari, Course Director, highlighted the important applications of molecular biology, genetic engineering and bioinformatics. Theory and practical sessions covered topics like nucleic acid isolation, agarose and SDS-PAG electrophoresis, PCR, Real-time PCR, genetic engineering and downstream processes including HPLC and ELISA.

Principles of DNA sequencing methods including NGS were also taught along with basic sequence analyses, and primer designing. Pre- and post-training evaluation of the trainees showed 70-80% improvement.

SDP on Fish and prawn culture for Bihar farmers

Coordinators: Dr. Muralidhar P. Ande, Dr. K. Syamala, Dr. P. Srinivasa Rao and Ms. M. Usha Rani

CIFE Kakinada conducted nine demand driven and customised skill development programmes from March to Dec 2022 for 211 fish farmers from Madhubani, Samastipur, Banka, Vaishali, Begusrai, Purnea and Patna districts of Bihar. Farmers were given training on various aspects of freshwater fish culture, prawn culture, feed management and disease management. Field exposure visits were conducted to the freshwater finfish hatcheries and demonstration was conducted on integrated farming systems to practically show the nursery management, harvesting and packing procedures for IMC and Magur.

4.5 Workshops, Seminars, Farmers Meets and More

1. National Fish Farmers Day 2022

ICAR-CIFE Commemorates National Fish Farmers Day 2022: A Report

July 10th is a water shed day for Indian fisheries. On this day in 1957, two ICAR Scientists Dr. Hiralal Chaudhuri and Dr. K.H. Alikunhi achieved a breakthrough in induced breeding of carps. To mark this milestone event 10th July is commemorated as National Fish Farmers Day since 2001. Saluting the countless fish farmers and fishers, who toil to provide nutritious and affordable fish for all, CIFE Mumbai and its regional centres celebrated the day with enthusiasm and exuberance with participation of nearly 250 farmers, fishers, staff from DoF, KVK, ICAR experts, and industry representatives. CIFE honoured the contribution of 21 innovative farmers, fishers and aquapreneurs including women and tribal farmers from across India. Be it the biofloc-based tilapia aquaculture or innovative live fish marketing or value addition in Maharashtra and Jharkhand or the entrepreneurial shrimp farming in salt-affected areas of Punjab, Haryana and Andhra Pradesh or successful fish seed production and rearing in the interiors of Madhya Pradesh and West Bengal are all stories of success and hope. Befitting the zeal of *Azadi Ka Amrit Mahotsav* and the spirit of International Year of Artisanal Fisheries and Aquaculture (IYAFA) 2022, CIFE organized four farmer-centric workshops to make ICAR's R&D and outreach activities more responsive to primary producers' needs.

1.1 *Fish from farm ponds:* Developing strategies for Maharashtra (CIFE Mumbai)

Dr. Ravishankar C.N., Director, CIFE presided over the function while Dr. Vijay Mahajan, Director, Directorate of Onion and Garlic Research, Rajgurunagar was the Chief Guest. Dr. N.P. Sahu, Joint Director, and Dr. S. N. Ojha, HoD, FEES chaired the technical sessions. A study tour of 45 tribal farmers from Nandurbar district was also organised. Fish farmers shared their stories of success first hand highlighting their initial failures, subsequent struggles in sourcing the right information, quality seed, feed and finding a marketing solution that ensured a good price. The stakeholder workshop focused on identifying challenges and finding ways to tap the potential of nearly 3.7 lakh farm ponds constructed for protective irrigation in Maharashtra to rear fish and diversify farm enterprises. Farmers from Satara, Pune and Ahmednagar districts have demonstrated that aquaculture in farm ponds not only reduced risk but more than doubled their income, achieved the goal of 'more crop per drop' and met the local demand for fish. The workshop identified the lack of awareness and custom-made aquaculture package of practices for the unique farm pond resource (varying in size, depth, and polythene lining) as primary hurdles in large-scale adoption and limited success rate. Many farmers cited the unavailability of quality fish seed and feed and being cheated by unscrupulous middlemen as major constraints. CIFE has promised to develop a technological package as well as IFS/aqua-tourism models in collaboration with ICAR institutes, and work with development departments and KVKs to promote aquaculture in farm ponds. The event was organised by Dr. Shivaji Argade, Dr. Ankush Kamble and Dr. Ananthan P.S.

1.2 *Small is Big:* Enhancing productivity in small scale aquaculture (CIFE Kolkata Centre)

Swami Shivapurnanandaji Maharaj, Ramakrishna Mission Vivekananda Educational and Research Institute, Naredrapur was the Chief Guest. Dr. G.H. Pailan (OIC), scientists and staff from ICAR institutes, KVK and the Fisheries Dept. along with 40 farmers participated in the event. Inaugurating the event and the workshop Swamiji emphasized on the importance of skill and knowledge-based farming to enhance the fish productivity by small and marginal farmers. He urged the farmers to prosper through community-based development by adopting scientific methods. Importance of integrated farming systems for livelihood improvement, fusion of traditional knowledge with modern technologies, adoption of improved methods of water recycling and harvesting were emphasized by experts. An open-house saw a spirited discussion, experience sharing and exchange of advisories among farmers and experts leading to better understanding on utilizable know-how on enhancing productivity in aquaculture. Five progressive farmers and aquapreneurs were felicitated who shared their stories of hard-earned success. Two leaflets on Fish Pickle Preparation, and Calendar of Fish Diseases & Management were released on this occasion. An exhibition and a plantation program were organized in the institute campus for the benefit of farmers. Dr. G. Biswas, Senior Scientist coordinated the program.

1.3 *Responsible Growth is Sustainable Growth*: Regulating Chemicals Usage in Aquaculture (CIFE Kakinada Centre)

Dr. P. Koteswara Rao, Principal & Additional Director, State Institute of Fishery Technology, Kakinada was the Chief Guest on the occasion. Dr. Muralidhar P. Ande, OIC and other staff with 40 farmers participated in the program. Mr. S. Balaji, State Coordinator, NaCSA flagged the concerns over growing number of aqua chemical products in market (estimated to be nearly 6000 chemicals/ drugs), their indiscriminate usage in aquaculture and the resultant effects on the industry including development of anti-microbial resistance (AMR) and adverse health effects. The emergence of highly intensive aquaculture systems seems to have led to the usage of chemicals in every step of fish/shrimp culture (pond preparation chemicals, piscicides, herbicides, water treatment chemicals, disinfectants, nutrient modifiers, feed additives & diseases regulating drugs, preservatives and adulterants. The workshop identified the need for a concerted national campaign to educate the farmers to guard against misleading info/ads that aid unnecessary and excessive use of chemicals, resulting in higher costs and crop losses. Sensitization about FSSAI regulations on permissible limits of various chemicals/drugs in fish and fishery products to prevent export rejections and consumer health shall be part of such a campaign. Promotion of BMPs, widespread adoption of pre-harvest check-up, monitoring for presence of spurious and restricted chemicals in market, etc. shall be an integral part of aquaculture practices.

1.4 *Biofloc for Blue Growth:* Promoting Small Scale Aquaculture in Inland Salt-affected Areas (CIFE Rohtak Centre)

Mrs. Asha Hooda, DFO, Haryana was the Chief Guest on the occasion while Dr. Babitha Rani, OIC Chaired the proceedings. The feasibility as well as the benefits of biofloc technology in terms of water and space requirement, reduction in feed cost, profitability, etc. in inland saline shrimp aquaculture were highlighted. Recognising the role being played by CIFE Centre in providing technological support and training in the region that is transforming farmers' livelihoods, farmers expressed the need for training and demonstrations on biofloc based shrimp aquaculture. The process to set-up the biofloc unit, inoculum preparation, selection of suitable candidate species, ammonia management, stress management, and do's & don'ts in biofloc based aquaculture were illustrated to the farmers during the workshop. The progressive farmer - entrepreneur, Mr. Raj Kumar shared his experience and the benefits of adopting nursery rearing technology for shrimp farming using biofloc technology as it reduces days of culture and controls disease occurrence in earlier stages. Interaction sessions with farmers helped clear many queries. Workshop drew attention towards discharge of the aquaculture waste water and possibilities to their reuse after settling of solids and treatment in a designated area, as it might affect sustainable expansion of aquaculture in salt affected areas. Awareness about various State schemes in addition to PMMSY was also created among farmers. Dr. Sreedharan K and Dr. Pankaj Kumar coordinated the event.

1.5 *Seed for Growth:* Driving Aquaculture development in Central India (CIFE Powarkheda Centre)

Shri U.S Tomer, Joint Director of Fisheries (Retd.), Madhya Pradesh graced the occasion as Chief Guest. Progressive farmer Mr. Atul Chandel shared his experience with farmers about the challenges fish farmers face in central India and the ways to address them. In addition to the shortage of quality fish seed in Madhya Pradesh, concerns over farmers getting misguided by social media and incurring losses were flagged. Dr. S. K. Nayak, OIC gave a lecture on hatchery

operation of D-85 for cohort breeding of Indian major carps while Mr. Dhalongsaih Reang explained on breeding of Magur and seed production to encourage species diversification. The workshop created awareness about the various schemes on aquaculture under PMMSY and state government besides experience sharing and doubt clearance during scientist-farmers' interaction.

2. ICAR – CIFE's Technology Awareness Programme

To bring awareness among stakeholders about the CIFE Technologies, ICAR's National Agricultural Innovation Fund (NAIF), CIFE's ITMU and ABI organized a "CIFE Technology Awareness Programme" at the Department of Fisheries, Palghar on 5th December, 2022. Dr. A. K. Balange, SIC, ITMU welcomed and briefed everyone about the program ABI. The programme was presided by Mr. Dinesh Patil (ACF, Palghar), who appreciated ICAR-CIFE and the team for their collaborative effort and the awareness programme. Dr. Kapil Sukhdane delivered a talk on "Introduction to Cage culture" and Dr. A. K. Balange talked about "CIFE Technologies and what the Agri Business Incubation (ABI) does to help the enterprising youth". Total 35 participants, comprising fishers, shrimp and fish farmers, and the women SHG members. DoF staff actively took part in this program.

3. *Azadi ka Amrut Mahotsav Celebrations*

3.1 National Campaign on Diversification in Aquaculture

ICAR-CIFE, Mumbai under the National Campaign – Azadi ka Amrut Mahotsav, organised an invited talk on **Development Priority of Aquaculture in India by Dr. Dilip Kumar,** Former Director and Vice-Chancellor, ICAR - CIFE, Mumbai on 10 March, 2022. A total of 498 participants including faculty, students and farmers attended. Dr. Ravishankar C.N., Director and VC, welcoming the speaker and the participants, highlighted the importance of the national campaign on diversification of aquaculture. Dr. Dilip Kumar highlighted that marine resource utilization is highly capital intensive in view of near exploitation levels, while in the inland fishery sector, development remained slow due to technology not being transferred down to the producer level, and absence of an adequate number of trained personnel. Only in recent years, the immense scope for fish production through scientific aquaculture has been brought to the attention of planners. Aquaculture has developed through two main dimensions: industry based /corporate scale aquaculture, mostly prevalent in western countries which has access to finance, technology, market and conducive policies; the second is small-scale family-based aquaculture, seen in developing countries such as India and Bangladesh, which will ensure sustainable use of aquatic resources for economic growth, nutritional security, improved livelihoods while preserving the health of the ecosystem in the future. He suggested that the policy guidelines for small-scale fishery as well as participation from public and private sectors are essential for delivering equitable development outcomes. His lecture was followed by fruitful interaction with the participants. Dr. N.K. Chadha, Head, Division of Aquaculture, coordinated the programme and proposed vote of thanks.

3.2 National Campaign on Fish Health Management in Aquaculture

Under the *Bharat ki Azadi ka Amrut Mahotsav*, a nation-wide campaign on "Fish Health Management in Aquaculture' was organised on 29 July, 2022. Dr. P. K. Sahoo, Principal Scientist, CIFA was invited as guest lecturer under this campaign. He delivered a lecture on 'The battle against freshwater fish ectoparasites: lessons learnt so far'. The lecture was held in hybrid mode and was attended by around 250 participants. Dr. K.V. Rajendran, Head, AEHM Division, introduced the speaker and gave a brief overview of the various threats to fish health. Dr. Ravishankar C. N., Director, CIFE spoke about the importance of the National Campaign on 'Fish Health Management in Aquaculture' as a part of celebrating 75 years of India's independence

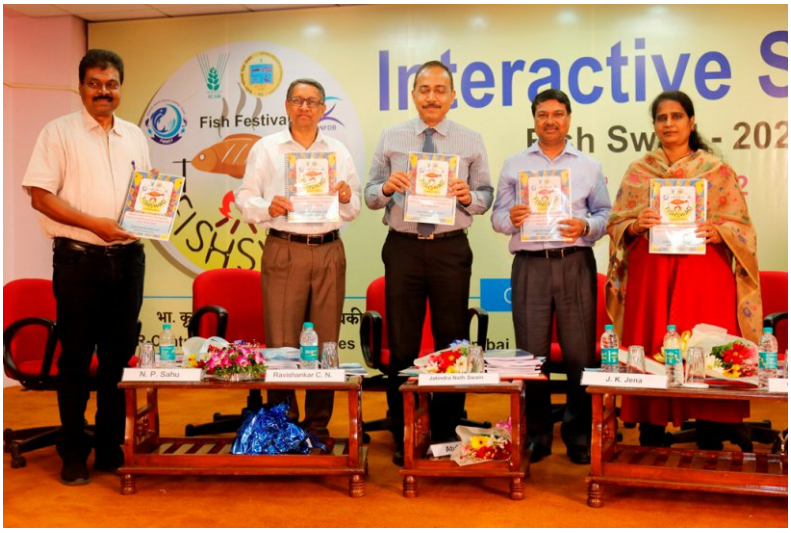
3.3 Farmers Field Day-cum-Awareness Programs

A Farmers Field Day-cum-Awareness Training was organized under the *Mera Gaon Mera Gaurav* (MGMG) Programme on 7 January, 2022 at Shashpur, Indas, Bankura, West Bengal to create awareness and provide technical guidance on sustainable aquaculture practices. Another similar program was organized under the MGMG on 23 June, 2022 at Orgram, Purba Bardhman, West Bengal. Dr. G.H. Pailan, OIC, Dr. G. Biswas, Senior Scientist, Dr. Suman Manna, Scientist, and Mr. P.K.

Behera, Technical Officer discussed various aspects of sustainable aquaculture practices, feed and feeding management, and soil and water quality management. Moreover, methods of water parameter analysis were demonstrated to the farmers using CIFE-developed kits. Fourty-five progressive aqua farmers benefited. Dr. P.S. Banerjee, Principal Scientist & Head, ICAR-IVRI, Eastern Regional Centre, Kolkata was the chief guest at Orgram and highlighted the importance of integrated fish-cum-livestock farming for accelerating the farmers' income from the existing water bodies.

4 First Fish Swad Festival – 2022

ICAR-CIFE, Mumbai organised a first of its kind Fish Swad-2022 festival on 24 April, 2022 in collaboration with NFDB, Hyderabad to celebrate different fish cuisines of India, increase domestic fish consumption and create awareness about PMSSY. It was inaugurated by Shri Jatindra Nath Swain, Secretary, Fisheries Department, India in presence of , Dr. C. Suvarna, CE, NFDB, Dr. J. K. Jena, DDG (Fisheries), ICAR, Dr. Ravishankar C. N, Director, CIFE and Dr. N.P. Sahu, Joint Director, CIFE. An innovation competition "*Matsyiki Anveshan*" was held, where students presented posters on innovative topics alongside the ABI stall where CIFE incubates displayed their products.



Fish Swad Festival had 14 stalls and participation from all corners of India. From South, the festival had teams from Karnataka (*Karnataka Vaind*), Kerala, Tamil Nadu (*Tamil Virundhu*), Andhra Pradesh and Telangana (*Telugu Ruchulu*). From the North and Central region, representation was from Rajasthan, Punjab, Jammu and Kashmir, Uttar Pradesh and Uttarakhand (*A taste of Exotic India)*. From Western region, participation was from Gujarat (*Garvi Gujarat*) and Maharashtra (*Kokan Katta*). Odisha (*Utkal Mahaka*), West Bengal (*Bengali Tardi fish swad*), Bihar and Jharkhand (*Johar fish stall*) were from the Eastern region and seven sister states from North Eastern India (*Taste of 7 sisters*) were represented. Stalls from the CIFE-IJSC team, *Koli* community and a special vegetarian stall from the Women's club of CIFE added flavour. This festival provided a platform for students and staff of ICAR-CIFE, Mumbai to create awareness and demonstrate a variety of fish products across various states of India for promoting fish consumption. This was a display of wealth of fish biodiversity and combined with Indian culinary diversity making it a treasure of well-balanced symbiosis between spices and herbs, offering very tasty fish cuisines. 'Recipe Book: The Fish Cuisines of India' was released during the interactive session held before the inauguration of Fish Swad festival. This Recipe Book offers different fish food items that are a part of culture, ethnography and history of different states of India.

Along with ICAR-CIFE staff, their families and students, public from all ages: kids to senior citizens from all over the Mumbai visited the stalls and had amazing experiences to share. Various celebrities also visited the festival and provided positive feedback. Fish Swad was visited by representatives of fisheries cooperative societies, fishing groups, entrepreneurs, budding startups, youth, fish farmers, fishers, photo-journalists, media, influencers, food bloggers, novelists, business people, bankers and many others making the event a huge success. It also demonstrated the perfect teamwork among CIFE students and staff.

Fisher's/Farmer's Meets

Title	Date and Place	No. of farmers registered	Name of Coordinators
World Pulse Day	10 February, 2022	30	Dr. S. K Nayak Mr. Dhalongsaih Reang Dr. Harsha Haridas
Development priority for aquaculture in India during Azadi ka Amrut Mahotsab	10 March, 2022	30	Dr. S. K Nayak Mr. Dhalongsaih Reang Dr. Harsha Haridas
Awareness-Cum-Training Programme on Freshwater Fish Farming	13 June, 2022 Krishi Vigyan Kendra, Pune	20	Dr. Shivaji Argade
Field Day-cum-Awareness training at Patrabad, North 24 Parganas, West Bengal	7 July, 2022	20	Dr. G.H. Pailan Dr. G. Biswas Dr. Suman Manna Mr. P.K. Behera
Stakeholder workshop on Biofloc for Blue Growth: Promoting Small Scale Aquaculture in Inland Salt-affected Areas	10 July, 2022 Rohtak	56	Dr. Babitha Rani. A.M Dr. Pankaj Kumar Dr. Sreedharan Dr. Ashok Kumar
Prime Minister Kisan Samman	17 October, 22 Powarkheda	46	Dr. S. K Nayak Mr. Dhalongsaih Reang Dr. Hasan Javed
PM Kisan Samman Sammelan	17 October, 2022 Kakinada	22	Dr. Muralidhar P. Ande Dr. P. Srinivasa Rao
PM Kisan Samman Sammelan	17 October, 2022 Kakinada	22	Dr. Muralidhar P. Ande Dr. P. Srinivasa Rao
Awareness program conducted on the occasion of National Pollution Control Day	2 December, 2022	137	Dr. A. K. Balange
Farmer's meet was organised on celebration of Kisan Diwas on Water management for Aquaculture	23 December, 2022	30	Dr. Sunil Kumar Nayak Mr. Dhalongsaih Reang
Current status and future prospects in Brackishwater Aquaculture	23 December, 2022 Kakinada	15	Dr. Muralidhar P. Ande
Current status and future prospects in Brackishwater Aquaculture	23 December, 2022 Kakinada	15	Dr. Muralidhar P. Ande
Workshop on water management in aquaculture on National Farmer's Day	23 December, 2022 Rohtak	25	Dr. Babitha Rani. A.M Dr. Ashok Kumar

4.6 Invited Lectures delivered in other Universities / Institutions

Faculty Name	Title of Lecture	University & Place	Date
Dr. Swadesh Prakash	Production Function, Marketing and Consumers Behavio for ICAR JRF-SRF, NET- ARS Exam (Online)	Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth (MPKV) Rahuri, Maharashtra	03 January, 2022
Dr. G.H. Pailan	Importance of Water and Soil Quality Parameters for Better Productivity	West Bengal University of Animal and Fishery Sciences, Kolkata	05 January, 2022
Dr. K.V. Rajendran	Emerging Diseases in Shrimp Aquaculture (Online)	ICAR-NBFGR, Lucknow	05 January, 2022
Dr. Shrinivas Jahageerdar	Quantitative trait loci and genomic selection (Online)	ICAR-NBFGR, Lucknow & Asia-Pacific Association of Agricultural Research Institutions	19 January, 2022
Dr. Shrinivas Jahageerdar	Designs for Animal Experiments (Online)	IACR-NAARM, Hyderabad	21 January, 2022
Dr. Subodh Gupta	Advances in Fish Physiology and its Application in Fisheries	SKUAST-Kashmir, Srinagar	23 February, 2022
Dr. K.V. Rajendran	Lessons we learn from pandemics (Online)	Dept. of Aquatic Biology and Fisheries, University of Kerala	24-25 February, 2022
Dr. Sikendra Kumar	Feed Formulation and Management in Freshwater Aquaculture	College of Fisheries Science, Jabalpur	28-February, 2022
Abuthagir Iburahim. S	Preparing for ICAR-JRF	Central Agriculture University, Tripura	27-31 March, 2022
Dr. K.V. Rajendran	Emerging Shrimp Diseases and How to Minimise the Risk	SMART AQUA EXPO INDIA 2022, Nocci Business Park, Balasore, Odisha	4-5 March, 2022
Dr. Sunil Kumar Nayak	Freshwater aquaculture: Hatchery, Seed Production and Grow-out Technologies	LINAC-NCDC Fisheries business Incubation centre (LIFIC), Gurugram, Harayana	08 March, 2022
Dr. Shivaji Argade	Gender and Empowerment	Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth (MPKV) Rahuri, Maharashtra.	09 March, 2022
Dr. Shivaji Argade	Preparing for ARS Mains and *Viva-voce* in Agril. Extension	Post Graduate Institute, Mahatma Phule Krishi Vidyapeeth (MPKV) Rahuri, Maharashtra.	10-March, 2022
Dr.K. K. Krishnani	UGC Faculty Induction Program " GURUDAKSHITA" (Online)	Pt Ravishankar Shukla University, Raipur	Jul-22

Dr S.N Ojha	*Pradhan Mantri Matsya Sampada Yojanuarya*	College of Fisheries, Jabalpur	14 March, 2022
Dr. Manish Jayant	On farm Feed Preparation and its Application	College of Fisheries, Kawardha, Chhattisgarh	24 March, 2022
Dr. Shamna N	Use of Phytobiotics in Aquafeed (Online)	SKAUST-Kashmir, Srinagar	29 March, 2022
Dr S.N Ojha	Revitalization-Collective Action for the Oceans	Centre for Excellence in Marine Studies (CEMAS), University of Mumbai.	08 May, 2022
Dr. Annam Pavan Kumar	Application of Molecular Markers for Sustainable Fisheries (Online)	Aquatic and Fisheries Science Talks	21 May, 2022
Dr Neha Wajahat Qureshi	*m-Jhinga* for Shrimp Aquaculture in Inland Saline Areas (Online)	ICAR-CIFT, Kochi	31-May, 2022
Abuthagir Iburahim.S	Marine Beach Walk for Public	Ladybird Environmental Consultancy, Mumbai	02 April, 2022
Dr. Sunil Kumar Nayak	Integrated Aquaculture	DAESI, KVK, Narmadapuram, MP	01 June, 2022
Dr. A.K. Verma	Enhancement of Water Productivity through Integration of Aquaculture and Agriculture	School of Fisheries, Centurion University of Technology and Management, Gajapati, Odisha	29 June, 2022
Dr. Sunil Kumar Nayak	Freshwater Aquaculture: Hatchery, Seed Production and Grow-out Technologies	LINAC-NCDC Fisheries business Incubation centre (LIFIC), Gurugram, Haryana	30 June, 2022
Dr. Manjusha L.	Food-borne Pathogens, *Vibrio* spp. and *Salmonella* sp.	CUSAT, Kochi	01 July, 2022
Dr. K K Krishnani	UGC-Faculty Induction Program "Gurudakshita" (Online)	Pt Ravishankar Shukla University, Raipur	01 July, 2022
Dr. Annam Pavan Kumar	High Throughput Sequencing Platforms: Principles and Applications (Online)	ICAR-NRC on Meat, Hyderabad	30-July, 2022
Dr. Deepitha R.P	Fish Processing for ICAR-JRF Exam (Online)	Central Agriculture University, Tripura	01 August, 2022
Dr S.N OJha	Innovative Fish Business Models: Sustainable - Techno – Organizational & Ecosystem – Transformation	ICAR-IARI, New Delhi	02 August, 2022

Dr. Sunil Kumar Nayak	*Machali palan Ki Adhunik Taknike*	College of Fisheries Science & Research Centre, CSAUAT, Kanpur	13 August, 2022
Dr. Sunil Kumar Nayak	*Krishakon hetu matashya palan main uplabdh yojanuaryayein*	Agriculture Extension & Training Centre, Narmadapuram, MP	23-28 August, 2022
Dr. S. Munilkumar	Isolation and Culture of Marine Cladocerans	Marine Planktonology & Aquaculture Laboratory, School of Marine Sciences, Bharathidasan University, Tamil Nadu.	24 August, 2022
Dr. P. Sardar	Entrepreneurial Opportunities in Feed Sector (Animal-Fishery)	(MANAGE, Hyderabad	26 August, 2022
Dr. Mukunda Goswami	Applications of Fish Cell Lines In Vitro Research	Guru Ghasidas Vishwavidyalay, Bilaspur	05 September, 2022
Dr. Sunil Kumar Nayak	Use of Innovative Technologies for Sustainable Fisheries Development	Brilliant Convention Centre, Indore, Madhya Pradesh	24 September, 2022
Dr. Sunil Kumar Nayak	*Matashya palan evam use hone bale labh*	Agriculture Extension and Training Centre, Narmadapuram, MP	27 September, 2022
Dr. Mujahidkhan A Pathan	Strain-Stock Comparison-Evaluation-Genetic Evaluation of Stocks	College of Fisheries, SKAUST-Kashmir, Srinagar	08 October, 2022
Dr. Arun sharma	Fish Health Management	Gandatwisa Dept. of Fisheries, Tripura	19 October, 2022
Dr. Sunil Kumar Nayak	Freshwater Aquaculture: Hatchery, Seed Production and Grow-out Technologies	LINAC-NCDC Fisheries business Incubation Centre (LIFIC), Gurugram, Harayana	03 November, 2022
Dr. Sunil Kumar Nayak	Basics of Shrimp Farming, Good Aquaculture Practices & PMMSY Schmes	IECCI (NGO), Bhopal	07 November, 2022
Dr Rupam Sharma	Nanotechnology Initiative at ICAR-CIFE	Murdoch University, Australia	15 November, 2022
Dr. Madhuri S. Pathak	Freshwater Fish Farming	NES Science College, Nanded, Maharashtra	16 November, 2022
Dr. Sanath Kumar H	Food Safety Concerns in Era of Antimicrobial Resistance in Aquaculture (Online)	Fisheries College and Research Institute, Thoothukudi (TNJFU)	16 November, 2022
Dr. Sunil Kumar Nayak	*Krishakon hetu matashya palan main uplabdh yojanuaryayein*	Agriculture Extension & Training Centre, Narmadapuram, MP	17,19,22,25,29-November & 01 December, 2022

Dr. Sanath Kumar H	Antibiotic Resistance in Seafood-borne Enterobacterales: Sources, Genotypes, and Dissemination (Online)	ICAR-CIFT, Kochi	22 November, 2022
Dr Neha Wajahat Qureshi	Shescaping: Empowering Women Globally (Panel Discussion)	International Collective in Support of Fish Workers (ICSF), GAF8 Conference, Kochi	22 November, 2022
Dr. Martin Xavier	Guidance on Research Paper Publication & Research Advances in Fisheries (Online)	Dr. MGR Fisheries College and Research Institute, Thalainayeru, Tamil Nadu	01 December, 2022
Dr. H. Mandakini Devi	Entrepreneurship Opportunities in Fish Processing and Value-added Fish Products	Department of Vocational Studies and Skil Development, Manipur University, Imphal	01 December, 2022
Mr. Angom Lenin Singh	Inbreeding and its Consequences	Fisheries College and Research Institute, TNJFU, Tuticorin	08 December, 2022
Dr. Sujata Sahoo	Achieving Nutritional Security and Food Safety by Nutrigenomics (Online)	IVASUM2022, ICAR-CCARI, Goa	11 December, 2022
Dr. G.H. Pailan	Ornamental Fish Nutrition	College of Fisheries, Tripura	14 December, 2022
Dr. Arpita Sharma	Percolation Tank Based Aquaculture: Entrepreneurship Opportunity for Rural Tribal Youth (Online)	MANAGE, Hyderabad and Aquaculture Technology & Research Foundation India (AQUAFIN), Chennai	20 December, 2022
Dr. Swadesh Prakash	Marketing Channels and Supply Chain Management in Fisheries	College of Fisheries, Etawah CSAUAT, Kanpur	12-13 August, 2022

Invited Lectured by Scientists, CIFE Rohtak Centre

Name of the faculty	Title of lecture delivered	Name of university / place etc.	Date
Babitha Rani. A.M	Biofloc technology for sustainable intensification in aquaculture	National seminar on Reorienting the strategies towards sustainable aquaculture and fisheries organized by Faculty of fisheries Science, Kerala University of Fisheries and ocean studies, Kochi, Kerala	6-7 January, 2022.
Babitha Rani. A.M	Biofloc fish farming	Department of Fisheries, Lathur District, Maharashtra	28 January, 2022
Babitha Rani. A.M	Aquapreuneurship through biofloc aquaculture	Webinar on World wetlands day, which was broadcasted live in youtube Gopal Narain Singh University, Bihar	2 February, 2022
Sreedharan K Ashok Kumar	Saline water species culture/saline soil parameter/feeding/productivity/ RAS	Aquaculture Research and Training Institute (ARTI), Hisar	5th February, 2022
Babitha Rani. A.M	Implementation of biofloc technology in agro climatic conditions of the state of Kerala : A success story in aquaculture	National webinar on surviving the pandemic through aquaculture the Kerala experience: Kerala University, which was broadcasted live in youtube	24-25 February, 2022
Pankaj Kumar Sreedharan K	Fisheries and its career perspectives	Govt. College for Women, Lakhan Majra, Rohtak	4 June, 2022
Babitha Rani. A.M	Biofloc machli paalan	Kamdhenu University and Department of Fisheries, Veraval District, Gujarat	12 July, 2022
Babitha Rani. A.M	Biofloc Aquaculture: A Technology for Converting Waste to Wealth	UGC-Sponsored Online Refresher Course in Bio-Sciences (Interdisciplinary), conducted by the Human Resource Development Centre of Bharathidasan University	15 July, 2022
Pankaj Kumar Sreedharan K	Shrimp Culture, Feeding, Soil & water Parameter, Disease	ARTI, Hisar	10 August, 2022
Babitha Rani. A.M	Aquaculture : A way forward	International Institute for Veterinary Education and Research (IIVER), Rohtak	17 November, 2022
Babitha Rani. A.M	Prospects and problems of high intensive aquaculture system viz, RAS, biofloc, Aquaponics etc	World Fisheries Day celebrations by National Fisheries Development Board, Dhanute, Daman	21 November, 2022
Babitha Rani. A.M Pankaj Kumar	New Technology of aquaculture to enhance fish Production to Class I & II Officers of Haryana Fisheries Department	ARTI, Hisar, Haryana	30 November, 2022

4.7. Technology Transfer, Consultancy and Advisory Services

1. Commercialisation of Prawn Pickle Recipe

CIFE Mumbai transferred the technology (Technology no. 22B/PD/0075, Prawn Pickle) to Mrs. Rekha Phande (ABI – Incubatee & Proprietor, Ekvira Seafoods), Juhu, Mumbai who will manufacture the product on commercial-scale. The technology was transferred in a non-exclusive mode. Dr. C.N. Ravishankar, Director, CIFE and Mrs. Rekha Phande signed the MoA on 12th December, 2022 in the presence of Dr. A.K. Balange (ISIC, ITMU), Dr. B.B. Nayak (HoD, FRHPHM) and Mr. Avinash Sabale (Technical Officer,). The technology was developed by Dr. B.B. Nayak, Dr. A.K. Balange, Dr. M.K. Chouksey and Mr. Avinash Sable, Mr. Bhanudas Phande, Ms. Snehal Shitole (SRF) and Ms. Pranita Chande (SRF), CIFE.

2. Commercialization of CIFE-Argunil: Medicated Feed against Fish Lice (*Argulus*)

CIFE- Argunil, an Ivermectin based medicated feed mix for treatment of fish parasites and growth restoration in fish (Patent No. IN330484, 28th January, 2022), was transferred to Godrej Agrovet Ltd., Vikhroli, Mumbai, who will develop commercial-scale feed premix/ feed for freshwater fishes. The technology was transferred on a non-exclusive mode. This is the first fish feed technology for freshwater fish transferred by an ICAR institute to the industry. Dr. C.N. Ravishankar, Director, CIFE and Mr. Dhrubajyoti Banerjee (CEO, Aqua Feed) / Dr. Kamlesh Pai Fondekar (Head Research and Development) signed the MoA on 9th December, 2022 in the presence of Dr. N P Sahu, Joint Director, co-inventors, SIC (ITMU) and other officials of ICAR-CIFE and GAVL, Mumbai. Inventors of the technology are Dr. Md. Aklakur , Dr. A.K. Pal (Retd.) and Dr. N.P. Sahu, CIFE.

3. Commercialisation of Fish Vaccines against Bacterial Diseases, Edwardsillosis and Columnaris

ICAR-CIFE transferred the technologies of two fish vaccines developed against two major bacterial diseases, Columnaris caused by *Flavobacterium columnare* and Edwardsillosis caused by *Edwardsiella tarda* to Indian Immunological Private Limited (IIL), Hyderabad, who will develop commercial-scale vaccines for use in fresh water fish. These two vaccines are inactivated vaccines which will protect fish from these bacterial diseases. The technologies were transferred in a non-exclusive mode. This is the first fish vaccine technology for bacterial diseases transferred by an ICAR institute to the industry. Dr. C.N. Ravishankar, Director, CIFE, signed MoA with Dr. K Anand Kumar, Managing Director, IIL, Hyderabad on 28th November 2022 in the presence of Dr. N P Sahu, Joint Director, co-inventors and other officials of ICAR-CIFE and IIL, Hyderabad. Inventors of the technology are Dr. Megha Kadam Bedekar, Dr. Rajendran KV, Dr. Kundan Kumar, Dr. Saurav Kumar , Mrs. Puja Vinde (SRF), Dr. Gopal Krishna (Retd.) and Dr. Gaurav Rathore. ICAR-CIFE acknowledges funding provided by ICAR Consortium Research Platform on Vaccines and Diagnostics.

4. Technology for Microalgae Biomass Production

CIFE transferred an innovative technology for producing microalgae, developed with funding from DBT, to Phoenix Agrotech, Mumbai. The newly designed photobioreactor enhances utilization of natural light through a tubular module installed under outdoor conditions. An integrated harvesting module and LED light panels for illumination of indoor culture tanks facilitates easy harvesting of the biomass. The photobioreactor is useful for microalgae biomass production throughout the year including the rainy season when outdoor cultivation is hindered due to low light and rainwater accumulation in open culture systems. Transfer of the technology was in a non-exclusive mode. Dr. S. P. Shukla and his team, the co-developers of the technology, supported the industry through training and transfer of technical know-how. The agreement for transfer of technology was signed by Dr. C.N. Ravishankar , Director, CIFE and Shri Vinit Rathod, CEO of Phoenix Agrotech on 30th July, 2022.

5. CIFE's Model Mobile Feed Mill

Mobile feed mill (CIFE Model) developed by FNBP Division, CIFE was inaugurated by Shri Jatindra Nath Swain, Secretary, Fisheries, GoI in presence of Dr. J.K. Jena, DDG (Fisheries), ICAR on 24th April 2022 and Dr. C. Suvarna, CE, NFDB. The mobile feed mill has the capacity for producing 40 kg pelleted feed per hour. It is being used for demonstration and hands-on training of farmers especially under the TSP scheme at remote locations for preparing pellet feed on the farm to transition them to scientific feed-based aquaculture for enhanced productivity and income.

In addition to the above, many CIFE scientists provided technical support and advisory services to farmers, entrepreneurs and the industry ranging from farm management, disease diagnostics and management (Dr. Jeena K), *Spirulina* production (Dr. S. P. Shukla), cultivated seafood development (Dr. Mukunda Goswami), Polyculture of carp and catfish, and biofloc based tilapia culture (Powarkheda Centre), just to name a few.

Kakinada Centre

Scientists and staff at CIFE Kakinada provided customised technical support to following farmers

Name	Place	Areas
Mr. G. Y. Narasimha	Rajahmundry Govt. College, East Godavari Dist.	Freshwater Fish culture aspects
Mr. Manoj Varma	Kakinada	Mud crab culture practices
Sh. Suribabu	Kakinada	*C. magur* culture techniques
Ms. P. Pranusha	Andhra University Visakhapatnam	*P. vannamei* culture-current disease problems
Mr. G. Krishna	Vemulapalem (V), Rathpadu, East Godavari Dist.	Mud crab culture practices
Ms. Baby Rani	Rajahmundry	Biofloc culture
Mr. Ramakrishnam Raju	Bhimavaram West Godavari Dist.	*Mugil cephalus* culture
Sh.Datta Srinivasa Raju	Vipparu, West Godavari Dist.	*Mugil cephalus* and Scampi culture

4.8 TV talks/ Radio talks / YouTube Videos / Print Media

TV Talks

Dr. G.H Pailan & Dr. G. Biswas: Feed and Feeding Management in Aquaculture on 3 March, 2022 in Bengali, DD Krishi Darshan, Kolkata

Dr. Geetanjali Deshmukhe, समुद्रीशेवाळे लागवड आणि उपयोग, (Seaweed Utilization & Cultivation) on 13 May, 2022 in Marathi in Krishi Darshan, DD Sahyadri, Mumbai

Dr. Kapil Sukhdhane delivered following talks on DD Krishidarshan-Phone-in-Live Programme (Marathi), Mumbai

- Freshwater Fish Farming on 30 June, 2022 and 26 July, 2022.
- Fish Farming as a Business Opportunity on 22 December, 2022

Dr. Madhuri S. Pathak delivered a talk on on Brackishwater Shrimp Farming on DD Krishidarshan Programme (Marathi) on 02 November, 2022, Mumbai

గుంటూరు

చేపల పెంపకంపై రైతులకు శిక్షణ

दैनिक भास्कर घाटशिला 17-03-2022

कृषि विज्ञान केंद्र में चल रहे तीन दिनी मछली पालन प्रशिक्षण का समापन

भास्कर न्यूज | गालूडीह

कृषि विज्ञान केंद्र दारीसाई में चल रहे पूर्वी सिंहभूम के तीन दिवसीय मछली पालन प्रशिक्षण शिविर का बुधवार को समापन हुआ। इस प्रशिक्षण शिविर में प्रशिक्षकों ने मछली पालन हेतु आए किसानों को चारा चुनने और पीएच ऑक्सीजन आदि नापने का तरीका बताया। इस प्रशिक्षण में आए वैज्ञानिक डॉ सुमन मात्रा, कृषि विज्ञान केंद्र दारीसाई की वैज्ञानिक व प्रधान डॉ आरती विणा एक्का, कृषि विज्ञान केंद्र के वैज्ञानिक भूषण प्रसाद सिंह, आदि उपस्थित थे।

दैनिक भास्कर घाटशिला 17-03-2022

कृषि विज्ञान केंद्र में चल रहे तीन दिनी मछली पालन प्रशिक्षण का समापन

भास्कर न्यूज | गालूडीह

कृषि विज्ञान केंद्र दारीसाई में चल रहे पूर्वी सिंहभूम के तीन दिवसीय मछली पालन प्रशिक्षण शिविर का बुधवार को समापन हुआ। इस प्रशिक्षण शिविर में प्रशिक्षकों ने मछली पालन हेतु आए किसानों को चारा चुनने और पीएच ऑक्सीजन आदि नापने का तरीका बताया। इस प्रशिक्षण में आए वैज्ञानिक डॉ सुमन मात्रा, कृषि विज्ञान केंद्र दारीसाई की वैज्ञानिक व प्रधान डॉ आरती विणा एक्का, कृषि विज्ञान केंद्र के वैज्ञानिक भूषण प्रसाद सिंह, आदि उपस्थित थे।

সুন্দরবনের মৎস্য চাষীদের জন্য বিশেষ প্রশিক্ষণ শিবির

বাবলু হাসান লস্কর | SatSakal.com

দক্ষিণ ২৪ পরগণা: চলতি বছরের ১১ ফেব্রুয়ারি "ভারত সরকারের একটি প্রকল্পে" গোসাবা ব্লকের ১০০ জন মৎস্য চাষীদের নিয়ে 'গদখালী বাগবাগান সমবায় সমিতির কমিউনিটি হলে' অনুষ্ঠিত হল একটি "মৎস্য চাষের প্রশিক্ষণ শিবির"।

'আইসিএআর-সিআইএফই কোলকাতা'-র বিভাগীয় প্রধান ডঃ গৌরহরি পৈলান মহাশয়ের নির্দেশক্রমে, এলাকার বিশিষ্ট শিক্ষক ও সমাজসেবী তপন মাইতির ব্যবস্থাপনায়, এদিন উক্ত শিবিরে উপস্থিত থেকে মৎস্যচাষীদের হাতে কলমে প্রশিক্ষণ দেন বিজ্ঞানী দেবাশীষ দাশগুপ্ত, বিজ্ঞানী সুমন মান্না মহাশয়ের পাশাপাশি প্রকাশ বেহারা মহাশয়ও।

প্রশিক্ষনের শুরুতে প্রত্যেক চাষীদের হাতে তুলে দেওয়া হয় একটি সুদৃশ্য ব্যাগ, ডায়েরী ও পেন। প্রশিক্ষণ শেষে গোসাবার মৎস্যচাষীরা জানান, এই প্রশিক্ষণ শিবিরে উপস্থিত হয়ে তাঁরা ভীষণ উপকৃত হয়েছেন।

সিআইএফই-এর বিজ্ঞানী দেবাশীষ দাশগুপ্ত জানান, আগামী কয়েক দিনের মধ্যেই আজ শিবিরে অংশগ্রহণকারী প্রত্যেক চাষীদের কে আমরা আরও একটি ১৮ নং হাঁড়ি, ৯০ কেজি মৎস্য খাবার, ১০০ কেজি চুন, ১টি খেপলা জাল ও মৎস্য চাষের অন্যান্য সামগ্রীও প্রদান করবো।

সাতসকাল

সাতসকাল ফিচার | সাতসকাল ই-পেপার | সাতসকাল নিউজ

চান্দেলদা ঙামীশিংগী ট্রেনিং হৌদোকখ্রে

చేపల పెంపకందారులకు ఫుడ్ అందజేత

पुढारी

जुन्नर येथे पिंजरा प... मत्स्यपालनाची कार्यशाळा

ICAR-CIFE Kolkata extends help to fisheries farmers of Sikkim

मासे विक्री बाजारपेठेत स्वच्छता मोहिम – Prahaar Digital

मासे विक्री बाजारपेठेत स्वच्छता मोहिम

भाकृअप (ICAR) -केंद्रीय मात्स्यिकी शिक्षण संस्था, मुंबईचा उपक्रम

Prahaar | Digital | News

https://prahaarkonkan.c... 179356

रत्नागिरी खबरबात

मासे विक्री बाजारपेठेत स्वच्छता मोहिम

भाकृअप (ICAR) -केंद्रीय मात्स्यिकी

ఈనాడు

epaper.eenadu.net

చేపల మేత అందజేత

EditionName : GUNTUR

মাছ চাষের প্রশিক্ষণ শিবির

'মাছ চাষের অত্যাধুনিক পদ্ধতির মাধ্যমে জীবন ও জীবিকার উন্নয়ন' বিষয়ক প্রশিক্ষণ শিবির

ডিব্ৰুগড় জিলা মীন বিভাগৰ প্ৰশিক্ষণ সম্পন্ন

ডিব্ৰুগড় জিলা মীন বিভাগৰ প্ৰশিক্ষণ

Skill Development Programme conducted

মৎস্যজীবীদের আধুনিক প্রযুক্তি শেখাতে কেন্দ্রীয় মৎস্য শিক্ষা সংস্থানের 'অনবদ্য' প্রয়াস

శాస్త్రీయపద్ధతులతో లాభసాటిగా ఆక్వాసాగు

ABN ఆంధ్రజ్యోతి

ఆక్వా కల్చర్‌లో నూతన పద్ధతులు

Date : 20/03/2022 EditionName : Guntur PageNo : 7

मासे विक्री बाजारपेठेत स्वच्छता मोहिमभाकृअप (ICAR) -केंद्रीय मात्स्यिकी शिक्षण संस्था, मुंबईचा उपक्रम http://voiceofratnagiri.com/?p=15644

https://www.facebook.com/...

कोकण न्यूज नेटवर्क

कन्द्रीय मंत्री रूपाला ने मत्स्य शिक्षा प्रशिक्षण संस्थान का निरीक्षण किया

50 व्यक्तियों ने प्राप्त किया प्रशिक्षण

अधिकारियों ने मत्स्य पालन, मछली आहार व्यवस्था, रोगों व रोजगार संभावनाओं की दी जानकारी

ARUNACHAL OBSERVER

ধেমাজিত দুদিনীয়া মীন পালন প্ৰশিক্ষণৰ সফল সামৰণি

The Arunachal Times

উত্তরবঙ্গ সংবাদ

মাছ চাষের প্রশিক্ষণ

দেশি মাছ চাষের প্রশিক্ষণ শিবির

Print Media

Title (Headline of the article)	Date	Name of newspaper	Language
मत्स्य किसानो को मत्स्या आहार निरमाण के बारे मे दी गयी जानकारी	27 January, 2022	PRO Barwani district	English
Press release: Matas kisanno ko ahar ki bare mein di jankari	27 January, 2022	Office of PRO Barwani district	English
मत्स्य पालन करने वाले किसानों को दी जानकारी	28 January, 2022	Dainik Bhaskar	Hindi
मत्स्य पालन करने वाले 10 किसानों को लिया गौद, इनकी आय बढ़ाएंगे	30 January, 2022	Dainik Bhaskar	Hindi
Sunderbaner matsya chashider jonnyo bishesh prashikshan shibir (Special training prograame for fish farmers of Sunderban)	18 February, 2022	Online (satsakal.com)	Bengali
Deshi mach chasher prashikshyan shibir	19 February, 2022	Anadabazar Patrika	Bengali
केंद्रीय मंत्री परषोतम रूपाला ने गॉव लाहली स्थित केंद्रीय मत्स्य शिक्षा संस्थान का किया निरिक्षण	26 February, 22	रोहतक दैनिक भास्कर	Hindi
केंद्रीय मंत्री रूपाला ने किया केंद्रीय मत्स्य शिक्षा संस्थान का किया निरिक्षण	26 February, 22	जागरण सिटी रोहतक	Hindi
केंद्रीय मंत्री परषोतम रूपाला ने मत्स्य शिक्षा संस्थान का किया निरिक्षण	26 February, 22	रोहतक केसरी	Hindi
Training of marginal fish farmers at Cooch Behar	27 February, 2022	Uttarbanga Sambad	Bengali
Capacity building of SC fish farmers of Cooch Behar by ICAR-CIFE	28 February, 2022	Krishi Jagran	Bengali
Press release: Awareness cum input distribution program for fish farmers held in Longtharai valley sub division	04 March, 2022	Directorate of information and cultural affairs, Govt of Tripura	English
Dibrugarh jila meen bibhagab prashikshan	11 March, 2022	Dainik Janambhumi	Assamese

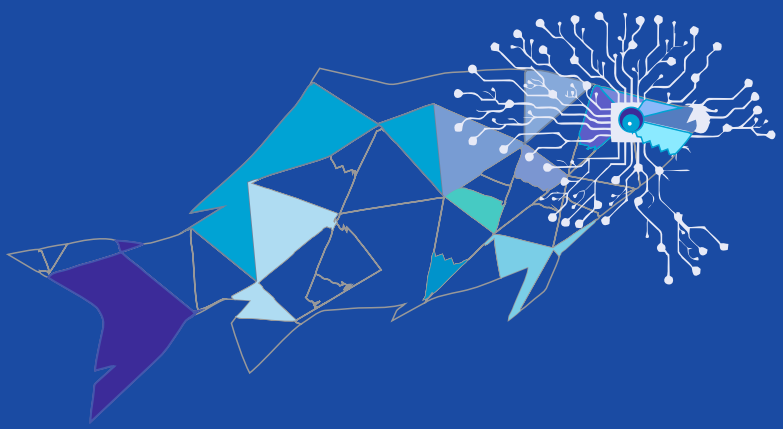
Dibrugarh jila meen bibhagab prashikshan sampanna	11 March, 2022	Asom aditya	Assamese
Dhemajit dudiniya meen palan prashikshan safal sambani	11 March, 2022	Dainandin Bartab Seba	Assamese
Training program for fishermen inaugurated	15 March, 2022	Sangai Express	Manipuri
Capacity building of fish farmers concludes	15 March, 2022	Nagaland Post	English
Krishi vigyan Kendra mein chal rahe tin dino machhli palan prashikshan ka samapan	17 March, 2022	Dainik Bhaskar	Hindi
Chepala Pempakam Pai RaithulakuShikshana	19 March, 2022	Andhra Prabha	Telugu
Aqua Raithulaku Melakuvalu	19 March, 2022	Eenadu	Telugu
SasthriyaPaddathulathoLabhasatiga Aqua Saagu	20 March, 2022	Praja Shakthi	Telugu
Yajamanya Veedhanalatho Chepala Pempakam lo Aadhika Raabadi	20 March, 2022	Sakshi	Telugu
Chepala Pempakamdharulaku food Andhajetha	20 March, 2022	Andhra Prabha	Telugu
Aqua Raithulaku Chepala metha Andhajetha	20 March, 2022	Eenadu	Telugu
Aquaculture lo Nuthana Paddathulu	20 March, 2022	ABN Andhra Jyothi	Telugu
50 व्यक्तियो ने प्राप्त किया प्रशिक्षण	25 March, 2022	सिरसा केसरी	Hindi
केंद्रीय मंत्री रूपाला ने मत्स्य शिक्षा प्रशिक्षण संस्थान का निरीक्षण किया	26 March, 2022	रोहतक हरिभूमि	Hindi
3 days training program organised by KVK and CIFE	29 March, 2022	Agartala Newslive	English
Three Days Training Cum Input Distribution Programme Organized By KVK	29 March, 22	Orissa Today	English
3 days training program organised by KVK and CIFE	30 March, 2022	Orissa Today	English
Fishery educationer tin din vaapi karmashala	31 March, 2022	Rashtriya Kantha	Bengali

Dakhin Tripura Krishi vighyan kendre tin diner prashikhan karmashala anusthita	31 March, 2022	Ganadhoot	Bengali
Dakshin Tripura Krishi Vigyan Kendra Tin Dinar Prashikan Karmashala	01 April, 2022	Jagaran	Bengali
Fishery of educationer tin din bapi karmashala	01 April, 2022	Rashtriya Kanta	Bengali
Dakshin Tripura Krishi Vigyan Kendra Tin Dinar Prashikan Karmashala anusdith	01 April, 2022	Dainik Ganaduth	Bengali
Three Days Training Cum Input Distribution Programme Organized By KVK	01 April, 2022	Agartala newslive	English
Aquasaagulo Avaghahana Mukhyam	11 July, 2022	ABN Andhra Jyothi	Telugu
Avaghahanathone Adhika Dhigubadulu	11 July, 2022	Sakshi	Telugu
SCST yuvakon ko diya gaya matasya palan ka parsikshan	23 August, 2022	Hindustan newspaper	Hindi
Kisano ke liye parsikshan	23 August, 2022	Sach Bharat news	Hindi
Gandacharay Matsa Daptarer Prashikhan (Bengali)	23 October, 2022	Satya bhasan pratinidhi	Bengali
Parishodhanalo Aashajanaka Maarpu	06 November, 2022	Eenadu	Telugu
Fish farmers' training underway	24 November, 2022	Arunachal Times	English
Fish farmers' training underway at Emchi	24 November, 2022	The Echo of Arunachal	English
Fish farmers' training begins at Emchi	24 November, 2022	Arunachal Observer	English
Different way of skill development of fish farmers by ICAR-CIFE	10 December, 2022	Krishi Jagran	Bengali
Towards livelihood improvement of small and marginal farmers through training	10 December, 2022	Aajkaal	Bengali
Training on aquaculture	10 December, 2022	Uttarbanga Sambad	Bengali
Sikhyarthiyon ne kia Powarkheda learning centre ka nirikshyana	29 December, 2022	Haribhumi, Jabalpur-Narmada bhumi	Hindi

Participation in Exhibitions

Date	Event	Venue	Approx. No. of visitors
02 March, 2022	Farmers Fair-cum-Exhibition	ICAR-NINFET, Kolkata	300
22-24 March, 2022	1st Indian Fisheries Outlook 2022: Printing Indian Fisheries in Attaining Sustainable Development Goals	ICAR-Central Inland Fisheries Research Institute (CIFRI) Barrack pore	1000+
5-7 May, 2022	12th Indian Fisheries and Aquaculture Forum (12th IFAF) On the theme "Fish for Nutritional Security and Economic Sustainability	Image hall Chennai	1000+
19-20 May, 2022	Exhibition during the National Seminar on "Contemporary Issues in Fisheries and Aquaculture".	College of Fisheries, G. B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand	500
24-27 August, 2022	25th National Agriculture Exhibition, organized by Central Calcutta Science & Culture Organization for Youth.	Central Park, Maidan, Salt Lake City, Kolkata, West Bengal	1000
11-12 October, 2022	KISAN BIZ-2022 (Agri Business Show)	CIDCO Exhibition Centre, Vashi (Navi Mumbai).	5000
11-13 November 2022	Agriculture fair and exhibition by Ministry of Agriculture and farmer welfare and State govt. departments	Dr. Bhimrao Stadium, Morena, Madhya Pradesh	400
21 November, 2022	Prospects and Problems of high intensive aquaculture intensive Aquaculture system viz RAS, Biofloc, aquaponics	Daman, Gujarat	1000+
13-16 December, 2022	Exhibition during the International Conference on "Responsible Aquaculture and Sustainable Fisheries Interact (RASHI)".	College of Fisheries, Tripura	500

05 HRD




भा.कृ.अनु.प.-केंद्रीय मात्स्यिकी शिक्षा संस्थान,मुंबई
ICAR-CENTRAL INSTITUTE OF FISHERIES EDUCATION

5.1. Faculty & Staff

CIFE Head Quarters, Mumbai

RMP

Director
Dr. Ravishankar C.N. (wef 11.01.2022)

Joint Director
Dr. N.P. Sahu

Scientific Staff

Heads of Division
Dr. B.B. Nayak (Acting)
Dr. S.N. Ojha (Acting)
Dr.K.V.Rajendran (Acting)
Dr.N.K.Chadha (Acting) (upto 30.09.2022)
Dr. Aparna Chaudhari (Acting)
Dr. Parimal Sardar (Acting) (upto 06.06.2022)
Dr. Subodh Gupta (Acting) (wef 07.06.2022)
Dr. Sukham Munil Kumar (Acting) (wef 01.10.2022)

Principal Scientists
Dr. Naresh S. Nagpure
Dr. Geetanjali Deshmukhe
Dr. Gopal Krishna (upto 31.05.2022)
Dr. Kishore Kumar Krishnani
Dr. S. Jahageerdar
Dr. Arpita Sharma
Dr. K. Pani Prasad
Dr. P.P. Srivastava (On deputation)
Dr. R.P. Raman
Dr. Ashok Kumar Jaiswar
Dr. Rupam Sharma
Dr.Gayatri Tripathi
Dr. Satya Prakash Shukla
Dr. Swadesh Prakash
Dr. Subodh Gupta
Dr. Sukham Munil Kumar
Dr. Mukunda Goswami
Dr. Ashutosh D. Deo
Dr. Manoj Pandit Brahmane
Dr. P.S. Ananthan
Dr. Megha Kadam Bedekar
Dr. Sanath Kumar H.
Dr. A.K. Balange
Dr. Paramita Banerjee Sawant

Senior Scientists
Dr. Asha T. Landge
Dr. Ajit Kumar Verma
Dr. Vidya Shree Bharti
Dr. Babitha Rani A.M.
Dr. Sonwane Arvind Asaram
Dr. A. Pavan Kumar
Dr. Kundan Kumar
Dr. Vinod Kumar Yadav
Dr. Ankush Lala Kamble
Dr. Manjusha L.
Dr. Sukham Monalisha Devi
Dr. Martin Xavier K.A. (wef 01.01.2022)

Scientists
Dr. Arun Sharma
Dr. Thongam Ibemcha Chanu
Dr. Sikendra Kumar
Dr. Jeena K.
Dr. Saurav Kumar
Dr. Tincy Verghese
Dr. Mujahidkhan Ajamalkhan Pathan
Dr. Shashi Bhushan
Dr. Shamna N.
Dr. Dhamotharan K.
Dr. Karankumar K. Ramteke
Dr. Kiran Dashrath Rasal
Dr. Rathi Bhuvaneswari G. (upto 23.08.2022)
Dr. Shivaji Dadabhau Argade
Dr. Layana P
Dr. Manish Jayant
Dr. Neha Wajahat Qureshi
Dr. Sukhdhane Kapil Sukhdeo
Mr. Angom Lenin Singh
Dr. Upasana Sahoo
Dr. Madhuri Pathak
Ms Deepitha R.P. (wef 29.04.2022)
Ms. Husne Banu (upto 31.08.2022)
Ms. Shobha Rawat
Mr. Dayal Devadas
Ms. V. Vidhya
Mr. Abuthagir Iburahim S.

Technical Staff

Chief Technical Officers (T-9)
Dr. S.K. Pandey (upto 31.03.2022)
Dr. M.K. Chouksey
Mr. S.S. Kamat (upto 30.06.2022)
Dr. Dasari Bhoomaiah
Mr. P.K. Das
Dr. Nalini Poojary

Asst. Chief Technical Officers (T-7/8)
Dr. Chandrakant M.H.
Mr. Subhash Chand
Ms. Revati B. Dhongde (upto 31.01.2022)
Mrs. Rekha Nair
Mrs. Rajani H. Khandgale

Sr. Technical Officers (T-6)
Mr. Sanjeevan Kumar
Mr. S. Maity

Technical Officers (T-5)
Mr. B.G. Mandhare (upto 31.05.2022)
Mr. B.J. Rathod
Mr. N.K. Aglave
Mrs. G. Aruna Devi (wef 02.06.2022)
Mr. S.R. Bandkar (upto 31.01.2022)
Mrs. Bharati Ghagare (upto 31.10.2022)
Mr. Avinash Sable
Mr. Suryakant L. Koli (upto 05.02.2022)
Mr. Anil Kumar Kulsange (upto 07.06.2022)
Mr. Sagar Suresh Sawant
Mr. Rajarshee Moitra
Dr. Pawan Kumar
Mr. Yogesh J. Jadhao (upto 21.03.2022)
Mr. Mohd. Baqar (wef 09.10.2020)

Sr. Technical Assistants (T-4)
Mr. Arun Puri Gosavi (upto 31.05.2022)
Mr. R.D. Deshmukh (upto 28.02.2022)
Mrs. Reshma K. Raje
Mr. Dhanpat Singh Rawat
Mr. V.K. Bhave (upto 31.08.2022)

Technical Assistant (T-3)
Sh. Pranaya Kumar Biswal

Sr. Technicians (T-2)
Mr. Mohd Sadiq M. Mulla
Mr. Abhijeet Vijay Jadhav
Mr. T.G. Gaikwad
Mr. G.B. Kamble (wef 16.05.2022)

Non-Ministerial Staff (Cook)
Mr. S. Kamaraju (upto 31.05.2022)

Administrative Staff

Joint Secretary /Sr. Registrar
Mr. Rajeev Lal (08.08.2022 to 09.11.2022)

Chief Administrative Officer (SG)
Mr. G. G. Harakangi (upto 19.03.2022)
Dr. Pankaj Kumar (Add. Charge wef. 14.06.2022)

Comptroller
Mr. Rajneesh Kumar Sing (wef 19.03.2022)

Sr. Administrative Officer
Mr. B.L. Kokkula (upto 31.12.2022)

Administrative Officer
Mrs. Poonam N. Behl
Mr. Yogesh R. Pathare (wef 01.06.2022)

Finance & Accounts Officer
Mr. S.V. Kasabe

Asstt. Director (Official Language)
Mr. Devendra Kumar Dharam (upto 06.09.2022)

Asstt. Finance & Accounts Officer
Mr. Deepak M. Bhokse (upto 12.12.2022)

Asstt. Admn .Officer
Mrs. F.G. Fernandes
Ms. C.S. Khundol
Mrs. Swati S. Koli
Mr. V.S. Kuveskar
Mr. Suraj Gupta
Mr. Devendra V. Raorane (wef 30.8.2022)
Mrs. Sanyuja S. Parab (wef 08.09.2022)

Principal Private Secretary
Mr. Sureshbhai S. Patelia (wef 05.08.2022)
Mr. B. M. Chavan (wef 19.09.2022)

Private Secretary
Mr. P.R. Ninawe
Mrs. Pragati R. Gadre

Stenographer (Grade – III)
Mr. Amey A. Sakpal (wef 02.12.2022)

Assistant
Mrs. A.U. Joshi
Mr. A.G. Kolambkar
Mr. B.P. Chauhan
Mr. N.L. Ghane
Mr. M.B. Waghela

Upper Division Clerk
Mrs. C.C. Raut
Mrs. Anu Grover
Mr. S.H. Bhosale
Mr. Shirish P. Malvankar
Mr. Prasenjit P. Sonawane
Mr. Raju N. Kamble

Lower Division Clerk
Mr. Ninad V. Kandalgaonkar
Mr. Sambhaji S. Shelke
Ms. Ujjawala V. Tiwari

Skilled Support Staff

Mr. G.G. Zendekar
Mr. Surajbali R. Jaiswar (upto 31.03.2022)
Mr. Ashok R. More
Mr. D.B. Gaikwad
Mr. Sitaram B. Padyal (upto 31.07.2022)
Mr. J.K. Makwana
Mr. Bandu R. Chavan
Mr. Ankush R. Dore
Mr. M.P. Kotian
Mr. Ashok R. Shingade
Mr. Jagdish N. Dhanu
Mr. Vasant N. Ondkar
Mr. Arvind M. Lavande
Mr. Vinod Kumar Yadav
Mrs. R.H. Chavan
Mr. Ankush N. Joyashi
Mr. Ganesh N. Zendekar
Mr. Anil D. Sonawane
Mrs. Reshma Naik
Mrs. Sabita Devi
Mr. Akhtar Fakirmiyan Mullaji (wef 02.06.2022)

CIFE Kakinada Centre

Scientific Staff

Officer Incharge / Senior Scientist
Dr. Muralidhar P. Ande

Scientist
Dr. Karthireddy Syamala

Technical Staff

Chief Technical Officer (T-9)
Dr. P. Srinivas Rao

Technical Assistants (T-3)
Mr. A. Gurraiah (upto 31.01.2022)
Mrs. Usharani Maradana

Sr. Technicians (T-2)
Mr. V. Shivaji (upto 30.06.2022)
Mr. Sheikh Valisha (wef 16.05.2022)
Mr. G.V.V. Satyanarayana (16.05.2022)

Administrative Staff

Asst. Administrative Officer
Mr. B. Laxmana Rao

Upper Division Clerk
Mrs. M. Rama Mani

Skilled Support Staff
Mr. O. Veera Raju (upto 31.10.2022)
Mr. T. Satyanarayana
Mr. P.V.K. Reddy
Mr. P.D. Reddy
Mr. S.S. Reddy (upto 30.06.2022)
Mr. Y. Buchilingam (upto 30.06.2022)
Mr. M. Govindu
Mr. Kurru Suresh
Mr. M. Kondala Rao

CIFE Kolkata Centre

Scientific Staff

Officer Incharge / Principal Scientist
Dr. G.H. Pailan

Principal Scientist
Dr. B.K. Mahapatra (upto 30.06.2022)
Dr. Shubendu Dutta
Dr. S. Das Gupta

Sr. Scientist
Dr. Gouranga Biswas
Dr. Sujata Sahoo

Scientist
Dr. Dilip Kumar Singh
Dr. Suman Manna
Ms.Husne Banu (upto 31.08.2022)
Ms Sweta Pradhan
Dr. Hanjabam Mandakini Devi

Technical Officer (T-5)
Mr. Prakash Kumar Behera
Mr. Tapas Kumar Ghosh

Assistant Administrative Officer
Mr. C.N. Sahani

Private Secretary
Ms. Kaberi Biswas

Upper Division Clerk
Mr. Kishore Bose
Mr. Ram Milan Singh

Skilled Support Staff
Mrs. Suman Pandey
Mr. Rajesh Mahato

CIFE Powerkheda Centre

Scientific Staff

Officer Incharge/ Scientist
Dr. Sunil Kumar Nayak

Scientist
Mr. Dhalongsaih Reang
Dr. Harsha Haridas

Asstt. Chief Technical Officer
Mr. L.P. Bamalia (upto 31.12.2022)
Mr. Hasan Javed

Technical Assistant (T-3)
Mr. Raghuvir Prasad

Sr. Technician (T-2)
Mr. S. Prajapati (wef 16.05.2022)

Asstt. Administrative Officer
Mrs. Asha Dhurve

Skilled Support Staff
Mr. Sambhu Dayal
Mr. Hari Singh
Mr. Manohar Lal
Mr. Ram Swarup
Mr. Deepak Kumar Kushwaha

CIFE Rohtak Centre

Scientific Staff

Officer Incharge/ Scientist
Mr. Hari Krishna (upto 30.05.2022)
Dr. Babitha Rani A.M. (wef 15.06.2022)

Scientist
Dr. Pankaj Kumar
Dr. Sreedharan K.
Sh. Satya Prakash (study leave wef 01.04.2021)

Sr. Technical Officer (T-7/8)
Mr. Ashok Kumar

Technical Officer (T-5)
Mr. Lokesh Kumar (upto 15.11.2022)
Mr. Satyendra Singh (wef 17.07.2020)

Sr. Technical Assistant (T-4)
Mr. Krishan Kumar

Sr. Technician (T-2)
Shri Kuldeep Singh
Mr. Lavesh Kumar (wef 16.05.2022)

Skilled Support Staff
Mr. Gyani Ram (upto 12.10.2022)
Mr. Gyan Chand

CIFE Motipur Centre

Scientific Staff

Officer Incharge/ Scientist
Dr. Md. Aklakur

Technical Staff

Technical Assistant (T-3)
Dr. Parmanand Prabhakar (upto 16.03.2022)

5.2. Appointments and Promotions

Appointments

S.No.	Name of the Official	Designation	Joining Date
1	Dr. Ravishankar C.N.	Director & Vice-Chancellor	11.01.2022
2	Mr.Rajneesh Kumar Singh	Comptroller	19.03.2022
3	Ms. Deepitha R. P.	Scientist	29.04.2022
4	Mr. Yogesh Pathare	Administrative Officer	01.06.2022
5	Mr. Akhtar Fakirmiyan Mullaji	Skilled Support Staff	02.06.2022
6	Dr. Pankaj Kumar	CAO (SG) Additional Charge	14.06.2022
7	Mr. Sureshbhai S. Patelia	Principal Private Secretary	05.08.2022
8	Mr. Rajeev Lal	Joint Secretary / JD (Admn)/Sr. Registrar	08.08.2022
9	Mr. B.M. Chavan	Principal Private Secretary	19.09.2022
10	Mr. Amey Avinash Sakpal	Steno Gr. III	02.12.2022 (lien reversion)

Promotions

Scientific Staff

S.No.	Name of the Employee	From	To	w.e.f.
1.	Dr. Babitha Rani A.M.	Senior Scientist (RGP8000)	Senior Scientist (RGP9000)	07.01.2020
2.	Dr. Gouranga Biswas	Senior Scientist (RGP8000)	Senior Scientist (RGP9000)	08.01.2020
3.	Dr. Vidya Shree Bharti	Senior Scientist (RGP8000)	Senior Scientist (RGP9000)	27.06.2020
4.	Dr. Annam Pavan Kumar	Senior Scientist (RGP8000)	Senior Scientist (RGP9000)	07.01.2021
5.	Dr. Muralidhar P. Ande	Senior Scientist (RGP8000)	Senior Scientist (RGP9000)	21.04.2021
6.	Dr. Sujata Sahoo	Senior Scientist (RGP8000)	Senior Scientist (RGP9000)	15.12.2021
7.	Dr. Kundan Kumar	Senior Scientist (RGP8000)	Senior Scientist (RGP9000)	23.12.2021
8.	Dr. Ankush Lala Kamble	Scientist (SS)	Senior Scientist (RGP8000)	20.04.2019

9.	Dr. Vinod Kumar Yadav	Scientist (SS)	Senior Scientist (RGP8000)	17.01.2020
10.	Dr. Manjusha L.	Scientist (SS)	Senior Scientist (RGP8000)	11.05.2020
11.	Dr. Sukham Monalisha Devi	Scientist (SS)	Senior Scientist (RGP8000)	15.09.2021
12.	Dr. Martin Xavier K.A.	Scientist (SS)	Senior Scientist (RGP8000)	01.01.2022
13.	Dr. Layana P.	Scientist	Scientist (SS)	19.12.2019
14.	Dr. Dilip Kumar Singh	Scientist	Scientist (SS)	01.01.2020
15.	Dr. Manish Jayant	Scientist	Scientist (SS)	01.01.2020
16.	Dr. Sukhdane Kapil Sukhdeo	Scientist	Scientist (SS)	01.01.2020
17.	Ms. Husne Banu	Scientist	Scientist (SS)	01.01.2020
18.	Dr. Sreedharan K.	Scientist	Scientist (SS)	01.01.2020
19.	Dr. Upasana Sahoo	Scientist	Scientist (SS)	07.02.2020
20.	Dr. Madhuri S. Pathak	Scientist	Scientist (SS)	01.07.2020
21.	Mr. Dhalogsaih Reang	Scientist	Scientist (SS)	01.07.2020

Technical Staff

S. No.	Name of the Employee	From	To	w.e.f.
1.	Mr. Satyendra Singh	Sr. Tech. Assistant (T-4)	Technical Officer (T-5)	17.07.2020
2.	Mr. Pranaya Kumar Biswal	Sr. Technician (T-2)	Technical Assistant (T-3)	02.04.2021
3.	Mr. Yogesh J. Jadhav	Sr. Tech. Assistant (T-4)	Technical Officer (T-5)	04.03.2022
4.	Mr. Mohd. Baqar	Sr. Tech. Assistant (T-4)	Technical Officer (T-5)	09.10.2020
5.	Mr. Gautam B. Kamble	Technician (T-1)	Sr. Technician (T-2)	16.05.2022
6.	Mr. Shaikh Vallisha	Technician (T-1)	Sr. Technician (T-2)	16.05.2022
7.	Mr. G.V.V. Satyanarayana	Technician (T-1)	Sr. Technician (T-2)	16.05.2022
8.	Mr. Satendra Prajapat	Technician (T-1)	Sr. Technician (T-2)	16.05.2022
9.	Mr. Lavesh Kumar	Technician (T-1)	Sr. Technician (T-2)	16.05.2022

Administrative & Supporting Staff

S.No.	Name of the Employee	From	To	w.e.f.
1	Mr. Devendra V. Raorane	Assistant	Asstt. Admn Officer	30.08.2022
2	Mrs. Sanyuja S. Parab	Assistant	Asstt. Admn. Officer	08.09.2022
3	Mrs. Chaitali C. Raut, UDC	Grade Pay 2800	Grade Pay 4200	29.09.2022
4	Mr. Ashok R. Shingade, SSS	Grade Pay 2000	Grade Pay 2400	01.10.2021
5	Mr. Jagdish N. Dhanu, SSS	Grade Pay 2000	Grade Pay 2400	04.01.2022
6	Mr. Vasant N. Ondkar, SSS	Grade Pay 2000	Grade Pay 2400	19.12.2022

Retirements

S.No.	Name of the Employee	Date of Retirement
1	Mr. Pradeep G. Angne, Assistant	19.01.2022 (VRS)
2	Mr. Sanjeev R. Bandkar, Technical Officer	31.01.2022
3	Ms. Revati Dhongde, Asstt. Chief Tech. Officer	31.01.2022
4	Mr. A. Gurraiya, Sr. Technici an, Kakinada Centre	31.01.2022
5	Mr. Suryakant Koli, Technical Officer	05.02.2022 (VRS)
6	Mr. Rajendra D. Deshmukh, Sr. Technical Asstt.	28.02.2022
7	Dr. S.K. Pandey, Chief Technical Officer	31.03.2022
8	Mr. Surajbali Jaiswar, Skilled Support Staff	31.03.2022
9	Mr. S. Kamaraju, Cook (Non-Ministerial Staff)	31.05.2022
10	Dr. Gopal Krishna, Former Director	31.05.2022
11	Mr. Bhaskar G. Mandhare, Technical Officer	31.05.2022
12	Mr. Arun Puri A. Gosavi, Sr. Technical Asstt.	31.05.2022
13	Dr. B.K. Mahapatra, Principal Scientist, Kolkata Centre	30.06.2022
14	Mr. Satish S. Kamat, Chief Technical Officer	30.06.2022
15	Mr. S.S. Reddy, SSS, Kakinada Centre	30.06.2022
16	Mr. V. Shivaji, Technician, Kakinada Centre	30.06.2022
17	Mr. Y. Buchilingam, SSS, Kaki nada Centre	30.06.2022
18	Mr. S.B. Padyal, SSS	31.07.2022
19	Mr. Vishwanath K. Bhave, Sr. Technical Asstt.	31.08.2022
20	Dr. N.K. Chadha, Principal Scientist &HOD (Acting)	30.09.2022
21	Mr. O. Veeraraju, SSS, Kakinada Centre	31.10.2022
22	Mrs. Bharati S. Ghagare, Technical Officer	31.10.2022
23	Mr. L.P. Bamaliya, Asstt. Chief Tech. Officer, Powarkheda Centre	31.12.2022
24	Mr. B.L. Kokkula, Sr. Administrative Officer	31.12.2022

Transfers from CIFE

S.No.	Name of the Employee	Transfer to	Date of Relieving
1	Mr. Parmanand Prabhakar, Technical Assistant	College of Fisheries, Bihar, Patna	16.03.2022
2	Mr. G.G. Harakangi, CAO (SG)	ICAR-IIHR, Bangalore	19.03.2022
3	Mr. Yogesh Jadhav, Technical Officer	ICAR-CCRI, Nagpur	21.03.2022
4	Mr. Anil Kumar Kulsange, Technical Officer	ICAR-CIRCOT, GTC, Nagpur	07.06.2022
5	Dr. Rathi Bhuvaneswar, Scientist	ICAR-CMFRI, Kerala	23.08.2022
6	Ms. Husne Banu, Scientist	ICAR-CIFA, Bhubaneswar	31.08.2022
7	Mr. Devendra Kumar Dharam, Assistant Director (OL)	ICAR-NBSSLUP, Nagpur	06.09.2022
8	Mr. Rajeev Lal, Joint Secretary (Admn.)	ICAR, Hdqrs. New Delhi	09.11.2022
9	Mr. Lokesh Kumar, Technical Officer, Rohtak Centre	ICAR-NBPGR, New Delhi	15.11.2022
10	Mr. Deepak M. Bhokse, Asstt. Fin. & Accounts Officer	ICAR-DMPAR, Anand	12.12.2022

Obituary

S.No.	Name of the Officials	Designation	Date of Death
1	Mr. V. Hari Krishna	Scientist	30.05.2022
2	Mr. Gyani Ram	Skilled Support Staff	12.10.2022

5.3 Training & Capacity Building of Faculty

Name of the faculty	Name of the training programme attended	Organizer and Place	Period
Dr. Deepitha. R.P	Fish & Marine Product Processing. (Online)	Ministry of Food Processing Industries, GoI, New Delhi	5-10 January, 2022
Dr. Deepitha. R.P	Microbiological and Biochemical Techniques Used in Industries (Online)	ICAR-Central Institute of Post-Harvest Engineering and Technology, Punjab	11-20 January, 2022
Dr. Manjusha L.	Metagenomic Data analysis (Online)	ICAR-Indian Agricultural Statistics Research Institute, New Delhi	19-24 January, 2022
Dr. Sunil Kumar Nayak	Integrating Phenomics and Genomics for Improving Livestock Production Health and Well-being (Winter School)	Division of Animal Genetics, ICAR-Indian Veterinary Research Institute, Uttar Pradesh	28 January-17 February, 2022
Dr. G. Biswas	Role of Technology in Community-Level Disaster Mitigation (Online)	Lal Bahadur Shastri National Academy of Administration, Uttarakhand	07-11 February, 2022
Mr. Abuthagir Iburahim.S	Data Visualization in Agribusiness and Agricultural Research	ICAR-National Academy of Agricultural Research Management, Hyderabad	17-22 February, 2022
Dr. Annam Pavan Kumar	Analysis of Bulk RNA-Seq data	School of Biological Sciences Bioinformatics training, University of Cambridge, England	17 February - 03 March, 2022
Dr. Sanath Kumar, Dr. Amjad K. Balange, Dr. L. Manjusha, Dr. Martin Xavier K.A, Dr. Layana P, Dr. Manish Jayant, Dr. Shamna N, Dr. Arvind A. Sonwane, Dr. Mujahidkhan Ajamalkhan Pathan, Dr. Vidya Shree Bharti, Dr. Rathi Bhuvaneswari G, Dr. Saurav Kumar, Dr. Paramita Banerjee Sawant, Dr. Babita Rani, Dr. Kapil Sukhdhane, Dr. Madhuri S. Pathak, Dr. Thongam Ibemcha Chanu and Mr. Angom Lenin Singh	ISO/IEC 17025-General Requirements for the Competence of Testing and Calibration of Laboratories	ICAR- Central Institute of Fisheries Education, Mumbai	01-03 March,2022
Dr. Vinod Kumar Yadav	Enabling Project-Based Learning with MATLAB and Hardware AI Technique for Signal Processing (Online)	MATLAB , USA	12 March, 2022
Dr. Sanath Kumar H	Seafood HACCP Segment 1 (Online)	Joint Institute for Food Safety and Applied Nutrition, University of Maryland, USA	10-14 March, 2022
Dr. Sanath Kumar H	Seafood HACCP Segment 2 (Online)		18-19 April, 2022
Dr. Madhuri S. Pathak	Academic Writing for Publishing Research Articles in High Impact Factor Journals	ICAR-Indian Veterinary Research Institute, Pune	26-30 April 2022 and 23-27 May, 2022

Dr. Ankush L. Kamble	Fisheries, Aquaculture and Post-Harvest Technology (Online)	ICAR-Central Institute of Fisheries Technology, Kochi, Kerala, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir & National Agriculture Development Co-operative Ltd., Baramulla	10-30 May, 2022
Dr. N.P.Sahu	Executive Development Program (EDP)	NAARM, Hyderabad	4-9 July 2022
Dr. Muralidhar. P. Ande & Dr. Karthireddy Syamala	Fundamentals of Statistical Tools and Visualization Techniques for Researchers	Wiley Publication House, USA	24 August, 2022 and 30 August, 2022
Dr. Rupam Sharma	International faculty attachment Training	Murdoch University, Perth, Australia	01-30 November, 2022
All Scientists of CIFE, Mumbai	Training Programme On Audit Skill: ISO 19011	Manupama Technologies Pvt Ltd	16 November, 2022
Dr. Upasana Sahoo Dr. Sweta Pradhan	Antimicrobial Resistance and Alternatives to AMR with Special Reference to Fisheries and Aquaculture (CAFT Training)	ICAR- Central Institute of Fisheries Education, Mumbai	9-18 November, 2022
Dr. Arpita Sharma	Management Development Programme on Creating Value Through Innovation and Technology Transfer Analytics	National Institute of Industrial Engineering, Mumbai and Ministry of Education, Government of India	14-19 November, 2022
Dr. Kundan Kumar,Mr. Angom Lenin Singh, Tincy Varghese, Dr.Shivaji D. Argade, Dr. Jeena K., Mr. Abuthagir Iburahim S, Dr. Nalini Poojary, Ms Rajani Khandagale and Dr. Arun Sharma ISO Internal Auditor Training Course		ICAR- Central Institute of Fisheries Education, Mumbai	15-17 November, 2022
Dr. Subodh Gupta	Management Development Programme on Leadership Development (a pre-RMP Programme)	ICAR-National Academy of Agricultural Research Management, Hyderabad	12-23 December, 2022

5.4. Conference / Symposium / Workshop Attended by Scientists

Name of the faculty	Name of the Conference / Symposium / Workshop	Organized by	Date
Dr. Gayatri Tripathi, Dr. Manjusha L, , Mr. A ngom Lenin Singh, Dr. Saurav Kumar,Dr. Vinod Kumar Yadav, Dr. Madhuri S. Pathak Dr. G. H. Pailan ,Dr. P. Sardar Dr. Dhalongsaih Reang, Dr.S K Nayak, Dr. S. Dasgupta, Dr. G. Biswas, Dr. Sujata Sahoo, Dr. Hanjabam Mandakini Devi, Sweta Pradhan, Dr. Suman Mann, Ms. Vidhya V, Mr. Abuthagir Iburahim.S (Hybrid Mode)	1st Indian Fisheries Outlook 2022 on Priming Indian Fisheries in Attaining Sustainable Development Goals	ICAR-Central Inland Fisheries Research Institute, Kolkata & Professional Fisheries Graduates Forum held at Kolkata	22-24 March, 2022
Dr. Annam Pavan Kumar Dr. A.K. Verma Dr. Neha Wajahat Qureshi Dr. Ananthan P.S.	13th Asian Fisheries and Aquaculture Forum (Online)	Asian Fisheries Society, Taiwan and National Cheng Kung University, Taiwan	31 May-02 June 2022
Dr. G. Biswas Dr. Annam Pavan Kumar Ms. Vidhya.V Dr. Monalisha Devi. S Dr. Ananthan P.S.	12th Indian Fisheries & Aquaculture Forum	Tamil Nadu Dr. J. Jayalalithaa Fisheries University (TNJFU) & Asian Fisheries Society Indian Branch (AFSIB)	May 05-07, 2022
Dr. Gayatri Tripathi	2nd Edition of World Congress on Infectious Diseases (Online)	Magnus group, USA	17-18, June 2022
Dr G. Biswas Dr. H. Mandakini Devi	International Conference on Advances in Agriculture & Food System towards Sustainable Development Goals (AAFS-2022)	Jointly by University of Agricultural Sciences, Bangalore, ICAR & Association of All Agricultural Students in India, Bengaluru	22-24 August, 2022
Dr. Sujata Sahoo	World Conference on Scholarly Publishing 2022 (Online)	The International Institute of Knowledge Management, USA	30 August, 2022
Dr. MP Brahmane, Dr. Arvind Dr.Kundan Kumar Dr. G. Biswas Dr. Saurav Kumar Dr. Arun Sharma Dr. Shamna N Dr Neha W. Qureshi Dr. Madhuri S.Pathak Mrs. Shobha Rawat Mrs. Sweta Pradhan	Sustainable Aquaculture for Atmanirbhar Bharat in Rajbhasa Hindi (Online)	ICAR-Central Institute of Freshwater Aquaculture, Bhubaneshwar	23-24 September, 2022
Dr. MP Brahmane	Responsible Aquaculture and Fisheries Interaction (Online)	College of Fisheries, CAU, Tripura	13-16 December,2022

Dr. Upasana Sahoo	Advances in Agricultural, Veterinary and Allied Sciences for Improving Livelihood and Environmental Security (AAVASILES-2022) (Online)	ICAR - Indian Grassland and Fodder Research Institute, Regional Research Station, Srinagar,	28-30 September, 2022
Dr. G. Biswas	XVIII AZRA International Conference on Advances in Applied Zoological Researches towards Food, Feed & Nutritional Security and Safer Environment	Odisha University of Agriculture & Technology Bhubaneswar	10-11 November, 2022
Dr. Shamna.N	Nutritional Technologies to Augment Livestock, Poultry, Canine and Fish Production for Global Competitiveness (Online)	Animal Nutrition Society, India & GADUVASU, Ludhiana, Punjab	16-18 November, 2022
Dr. Shivaji Argade Dr. Neha Wajahat Qureshi	8th Global Conference on Gender in Aquaculture and Fisheries, 2022	ICAR-Central Institute of Fisheries Technology, Kochi.	21- 23 November, 2022
Dr. Shivaji Argade Dr. Ankush L. Kamble	37th Annual National Research Conference Cooperative Connect	ISSC Pune & VAMNICOM, Pune	9-10 December, 2022
Dr. Kundan Kumar Dr. Monalisha Devi Ms. Vidhya.V, Dr. Upasana Sahoo, Dr. Jeena K., Ms. Shobha Rawat, Dr. Dhalongsaih R Mr. Angom Lenin S.	International conference on Responsible Aquaculture and Sustainable Fisheries Interact (RASHI) (Online)	College of Fisheries, Central Agricultural University Lembucherra, Tripura	13 -16 December, 2022
All Scientists of CIFE	Climate-Resilient Fisheries and Aquaculture (Online)	ICAR- Central Institute of Fisheries Education, Mumbai and National Institute of Abiotic Stress Management -Baramati	07 March, 2022
Mr. Satya Prakash	XX International Symposium on Fish Nutrition and Feeding Towards Precision Fish Nutrition and Feeding	Vet International, Sorrento, Italy	05-09 June, 2022
Dr. Sujata Sahoo	World Ocean Day Symposium (Online)	Centre for Excellence in Marine Studies, University of Mumbai	08 June, 2022
Dr. G. Biswas	Self-Reliant Coastal Agriculture (Online)	ICAR-Central Coastal Agricultural Research Institute, Goa	11-13 May 2022
Dr.Neha Wajahat Qureshi	Input-Output Analysis, Global Value Chain Analysis and Social Accounting Matrix (Online)	Asian Development Bank And NITI Ayog	21-24 June, 2022
Dr. Pankaj Kumar Dr. Sreedharan K	Fisheries and its Career Perspectives	Govt. College For Women, Lakhan Majra, Rohtak	4 June, 2022
Dr. Kapil Sukhdhane Dr. Shivaji Argade Dr. Karan Ramteke	Kisan Biz-2022 Agri Business Show	Cidco Exhibition Centre, Vashi (Navi Mumbai).	11-12 October, 2022
Mr. Satya Prakash	Fish Nutrition Workshop 2022, Impacts on Gut Functioning and Health	Aquaculture And Fisheries Group, Wageningen , Netherland	17-20 October, 2022

Dr. Sujata Sahoo	Globalization of Veterinary Ayurveda (Online)	Indian Veterinary Association(IVA) In Collaboration With World Ayurveda Foundation(WAF)	23-30 October, 2022
Dr. Sunil Kumar Nayak	*Matsyiki Karyashala*	State Fisheries Department And Fish Federation, Bhopal, Madhya Pradesh	24 September, 2022
Dr. Annam Pavan Kumar	Awareness Workshops on Draft National Credit Framework	Department Of Higher Education, Ministry Of Education, New Delhi, IIT-Mumbai	28 November, 2022.
Dr. Annam Pavan Kumar	Implementation of NEP 2020 in Higher Education (Online)	Department Of Educational Administration, New Delhi	07 December, 2022
Dr. Pankaj Kumar Mr. Ashok Kumar	Shrimp Farming and Pond Management	Krishi Vigyan Kendra, Chandgothi Directorate Of Extension Education, S.K. Rajasthan Agricultural University Bikaner	17-18 December, 2022
Dr. Sunil Kumar Nayak Mr. Dhalongsaih Reang	Water Management for Aquaculture	Gram Panchayat Nitaya, Narmadapuram District, Madhya Pradesh	23 December, 2022

5.5. Meetings Attended

Dr. Ravishankar, *Director & Vice-Chancellor*

Name of the Meeting	Organized by	Date
Final Review Workshop on "Development of Energy Efficient and Environment Protective Aquaculture Technologies for degraded Soils"	ICAR-CIFE, Rohtak Centre under NAHEP	March 20, 2022
A Workshop on Consultation of National Experts on National Action Plan on Antimicrobial Resistance-2022-2025 (Animal Health Sector)	FAO-DAHD, New Delhi	March 23-25, 2022
93rd Annual General Meeting of ICAR	ICAR, New Delhi	March 26, 2022
12th Indian Fisheries and Aquaculture Forum	TNJFU, Chennai	May 5, 2022
Scientific Committee Meeting of FSSAI	FSSAI, New Delhi	May 6, 2022
Inaugural Programme of the National Seminar on "Contemporary issues in Fisheries and Aquaculture" and presented the lead lecture.	GBPUAT, Pantnagar	May 19, 2022
29th Annual General Body meeting of the NAAS	NAAS, New Delhi	June 5, 2022
Consultative workshop on "Way Forward for Enhancement of Seafood Exports from India" on the occasion of Golden Jubilee Celebrations of MPEDA	MPEDA & CAA (supported by NFDB at Chennai)	June 17, 2022
International Conference at Himachal Pradesh Agricultural University	HPAU, Shimla	June 12-13, 2022
Seminar on "Innovation to build resilient, sustainable food supply for nutritional security" and delivered a talk on "Impact of Blue Revolution on Food Security"	AFST(I), CSIR-CFTRI, Mysore	July 18, 2022
XXXI Meeting of National Agricultural Education Accreditation Board (NAEAB)	ICAR, New Delhi	July 19, 2022
Attended 41st Foundation Day of College of Fisheries as a Special Guest and delivered a lecture to the Students, Teachers, Scientists and invited farmers and fishermen's "On Recent advances in Fish Processing for Entrepreneurship Development"	College of Fisheries, Ratnagiri, Maharashtra	August 4, 2022
Attended as External Speaker and delivered a lecture on "Key challenges to sustainable fisheries and the way forward" in International Conference on Sustainable Development in Hill and Coastal Ecosystems	M.S.S.R.F., Chennai	August 7, 2022
Attended 127th Executive Council Meeting of NAAS	NAAS, New Delhi	August 23, 2022
Attended a meeting of Food Hygiene, Safety Management & other systems Sectional Committee, FAD 15	Food and Agriculture Department, BIS, New Delhi	August 24, 2022
Attended Special Executive Committee Meeting	Kerala Agricultural University, Trissur	September 3, 2022
Attended as an External Expert nominated by the ICAR for the Selection of University Officers of Tamil Nadu Dr. J. Jayalalithaa Fisheries University, Nagapattinam	TNJFU, Chennai	September 14, 2022
Attended National Academy of Agricultural Sciences (NAAS) Executive Council Committee Meeting	NAAS, New Delhi	September 16, 2022

43rd Meeting of Scientific Committee of FSSAI	FSSAI, New Delhi	September 23, 2022
Meeting on Special Campaign 2.0 for disposal of Pending Matters from 2nd October to 31st October, 2022 under the chairmanship of Secretary, DARE & DG-ICAR (Online)	ICAR, New Delhi	September 26, 2022
Board of Management meeting of ICAR-CIFE	ICAR-CIFE, Mumbai	September 28, 2022
Meeting of Vice-Chancellors of Agricultural Universities	Sri Konda Laxman Telangana State Horticultural University (SKLTSHU), Hyderabad	September 30 – October 2, 2022
32nd meeting of National Agricultural Education Accreditation Board (NAEAB) under the Chairmanship of DG, ICAR (Online)	ICAR, New Delhi	October 11, 2022
Delivered an invited lecture on topic "Building the Talent Pool: Indian leaders powering the global landscape" in the Smart Protein Summit 2022	Good Food Institute India in partnership with FICCI, New Delhi	October 14, 2022
26th meeting of Regional Committee-IV for U.P ., Bihar and Jharkhand states (Online)	ICAR-IIVR, Varanasi	November 7, 2022
Presentation by Secretary, DARE & DG, ICAR on "Revitalizing ICAR: Aspirations and Action Plan" (Online)	ICAR, New Delhi	November 11, 2022
3rd ICT Steering Committee Meeting under the chairmanship of Secretary, DARE & DG, ICAR (Online)	ICAR, New Delhi	December 5, 2022
Meeting of Dr. Joykrushna Jena, Deputy Director General (Fisheries Science) with Directors of Fisheries Division (Online @ 4.30 PM)	ICAR, New Delhi	December 6, 2022
44th meeting of the Scientific Committee of FSSAI	FSSAI, New Delhi	December 8, 2022
Participated and delivered lecture in the International Conference on "Responsible Aquaculture and Sustainable fisHeries Interact (RASHI)"	College of Fisheries,, Tripura (supported by NFDB)	December 15, 2022
Live webcast of discussion on operationalization of the Academic Bank Of Credits (ABC) at the Universities by UGC Chairman, Professor Mamidala Jagadesh Kumar (Online @ 10.00 AM)	UGC, New Delhi	December 29, 2022

Dr. N.P. Sahu , *Joint Director*

Name of the Meeting	Organized by	Date
Delivered a lecture on "Valorisation of leaf meal for replacement of DORB (De Oiled Rice Bran): A forwarding approach for sustainable aquaculture" (Online)	Ravenshaw University, Cuttack, Odisha	6-8 March, 2022
Attended the NAAS Panel Discussion/Symposium (Hybrid Mode) on Climate resilient fisheries and Aquaculture.	CIFE, Mumbai & NIASM-Baramati	7 March, 2022
Attended the 27th Extension Council Meeting	ICAR-CIFE, Mumbai	11 March 2022
राजभाषा कार्यान्वयन समिति की 99 वी बैठक	ICAR-CIFE, Mumbai	17 मार्च 2022
Attended the NAHEP Workshop	CIFE Rohtak Centre	20 March 2022.
Conducted the meeting with the scientists and staffs of CIFE Kolkata	ICAR-CIFE, Kolkaa Centre	21 March 2022
Delivered a Lecture on "Outline of Fish Nutrition Research to address the future challenges for sustainable Aquaculture"	CIFRI, Barrackpore	22-23 March 2022
Attended the Meeting of Directors Conference	ICAR-NASC complex, New Delhi	13.April 2022
Jointly Organised 15th Convocation of ICAR CIFE	ICAR-CIFE, Mumbai	23 April 2022
Organised the first Fish Swad Festival	ICAR-CIFE, Mumbai	24 April 2022
Attended and Chaired the Session of Fish Nutrition of 12 Indian Fisheries and Aquaculture Forum (12 IFAF)	Dr. J. Jayalalithaa Tamil Nadu Fisheries University, Chennai	5 May 2022
Visited ICAR-DCFR, Bhimtal and interacted with Scientists and Director	DCFR, Bhimtal	18 May 2022
Attend the Inaugural Programme of the National Seminar on "Contemporary issues in Fisheries and Aquaculture"	GBPUAT, Pantnagar	19 May 2022
Attended the 62 Foundation Day of the Institute	ICAR-CIFE, Mumbai	6th June 2022
Facilitated signing of MoU between College of Fisheries MPUAT, Udaipur and ICAR -CIFE, Mumbai in the present of VC and Senior Official of MPUAT, Udaipur	College of Fisheries, MPUAT, Udaipur	17-18 Aug, 2022
मिनद्री पखवाड़ा उद्घाटन	ICAR-CIFE, Mumbai	14 -29 मसिंबर, 2022
Facilitated signing of MoU between SKUAST, Kashmir and ICAR-CIFE, Mumbai in the presence of VC and Senior Officials of both Universities	SKUAST, Srinagar, J&K	20 Sep 2022
Attended the 48th BOM Meeting on	ICAR-CIFE, Mumbai	28 Sep, 2022
Attended EMC meeting for MTHL project convened by MMRDA 3.00 PM at 9th Floor.	MMRDA, Bandra (E), Mumbai	9 Nov 2022
Attended monthly meeting with DDG conducted every month	Online	Monthly
Consultation Meeting with Directors of Fisheries of State Departments at ICAR-CIFE, Mumbai (Directors Meet)	ICAR-CIFE, Mumbai	4 -5 November 2022
Presented Lead paper in the session of Fish Nutrition at International Conference on "Strategic Nutritional Interventions to Address Sustainable Aquaculture Production"	Guru Angad Dev Veterinary Animal Science University Ludhiana, Punjab	16-18 Nov 2022

Attended meeting of the Committee Constituted for Finalization of Draft 'National Fisheries Policy, 2020	ICAR-CIFE, Mumbai	10 Dec 2022.
Delivered key note lecture in International Conference on "New Dimension of Nutritional Research for Sustainable Aquaculture Production" Responsible aquaculture and Sustainable Fisheries Interact (RASHI) & Chaired and Co-Chaired different sessions	College of Fisheries Tripura, NESFA & COFLAA), Tripura	13- 16 Dec 2022

Meetings Attended by Scientists

Name of the faculty	Name of the Meeting	Organized by	Date
Dr. Swadesh Prakash	BOS Meeting as Vice-Chancellor Expert Nominee (Online)	Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra	27-28 January, 2022
Dr. Babitha Rani A.M	Screening the Projects for Govt. of Kerala under PMMSY (Online)	Kerala University of Fisheries and Ocean Studies And Fisheries Directorate, Kerala	14 February, 2022
Dr. Dasgupta	Project Progress of NASF	ICAR-Central Inland Fisheries Research Institute, Barrackpore	1 February, 2022
Dr. Kapil Sukhdhane	Open Sea Cage Farming Feasibility for the State of Maharashtra	Department of Fisheries, Maharashtra	3 February, 2022
Dr. Kapil Sukhdhane	Pradhan Mantri Matsya Sampada Yojana State Level Approval and Monitoring Committee	Department of Fisheries, Maharashtra	21 February, 2022
Dr. Dasgupta	NASF Funded Project on Captive Breeding of Hilsa, *Tenualosa Ilisha*: Phase II	ICAR-Central Inland Fisheries Research Institute, Barrackpore	25 February, 2022
Dr. Babitha Rani A.M	NAAS Panel Discussion (Online)	National Academy of Agricultural Sciences, New Delhi	07 March, 2022
Dr. K K Krishnani	External Expert for CAS of Scientists (Aquaculture) of CIBA	ICAR-CIBA, Chennai	26 April 2022
Dr. G.H. Pailan	Selection Committee Meeting	ICAR-ATARI, Kolkata (Zone-V)	18 May, 2022.
Dr. K K Krishnani	Institute Management Committee (IMC)	ICAR-CIFRI, Kolkata	30 May 2022
Dr. K K Krishnani	Annual General Body Meeting of the NAAS	National Academy of Agricultural Sciences, New Delhi	04-05 June 2022
Dr. Kapil Sukhdhane	Cage Culture Revised Policy for Maharashtra (Online)	Commissioner of Fisheries, The Department of Fisheries, Maharashtra	08 June, 2022
Dr. K K Krishnani	Consultation on R&D aspects of Agriculture in Maharashtra	ICAR-NIASM, Baramati / NAAS Pune Chapter	17 June 2022
Scientists of CIFE	Interaction Meet with Directors of ICAR Fisheries Institutes (Online)	ICAR- Central Institute of Fisheries Education, Mumbai	28 June, 2022

Dr. G.H. Pailan	8th Research and Extension Education Council	West Bengal University Of Animal And Fishery Sciences, Kolkata	04 July, 2022
Dr. G.H. Pailan	Department of Science & Technology and Biotechnology	Vigyan Chetana Bhavan, Directorate Of Fisheries, Govt. Of West Bengal	14 July, 2022
Dr.Babitha Rani A.M Dr. Sreedharan, K. Mr. Ashok Kumar	Meeting with the Director of Fisheries and other Officials of Department of Fisheries, Haryana	Directorate of Fisheries, Panchkula, Haryana	18 July, 2022
Dr. G.H. Pailan	Network Project On Agricultural Bioinformatics And Computational Biology	ICAR-Central Inland Fisheries Research Institute, Barrackpore	26 July, 2022
Dr. Kapil Sukhdhane	MMRDA - Environmental Monitoring Committee on Mumbai Trans Harbour Link Project (Online)	Department Of Fisheries, Maharashtra	27 July, 2022 08 August, 2022
Dr. Babitha Rani A.M	Project Management Committee of PMMSY- Cluster Development Project (Online)	National Fisheries Development Board, Hyderabad	6 August, 2022
Dr. Ashutosh D Deo	Second Steering Committee Meeting Of NEPPA (Online)	National Agricultural Science Complex, New Delhi	10 August,2022
Dr.Babitha Rani A.M	29th Project Appraisal Committee Meeting (Online)	National Fisheries Development Board, Hyderabad	11 August, 2022
Dr. G. Biswas	External Member Of Selection Committee for World Bank Funded Project, REWARD	ICAR-NBSSLUP, Kolkata Regional Centre	18 August, 2022
Dr. G.H. Pailan	Subject Expert for Selecting a Research Associate (RA) in A DS T-Funded Project	Sasya Shyamala KVK, RKMVERI, Narendrapur	23 August 2022
Dr. Babitha Rani A.M	Scientific Advisory Board Meeting (Online)	Krishi Vigyan Kendra, Jhajjar	30 August, 2022
Dr. G.H. Pailan	9th Meeting of the Scientific Advisory Committee (SAC)	Sasya Shyamala KVK, RKMVERI, Narendrapur	30 August, 2022.
Dr. G.H. Pailan	9th Meeting of the Research and Extension Education Council	West Bengal University Of Animal And Fishery Sciences, Kolkata	14 September, 2022
Dr. G.H. Pailan	16th Institute Management Committee	ICAR-ATARI, Kolkata	21 September, 2022
Dr. G.H. Pailan Dr. Suman Manna	24th Annual Convention and National Conference of Clay Minerals Society of India	ICAR-NBSS&LUP, Regional Centre, Kolkata	22 September, 2022
Dr. G.H. Pailan	Utilization and Diversification of Silkworm Pupae Products For Human & Animal Consumption and Compositing"	ICAR-Central Inland Fisheries Research Institute, Barrackpore	27 September, 2022
Dr. Manjusha L.	Exploring Opportunities for Industry-R&D Institutions Collaborative Initiatives	RGSTC, MCCIA, Pune	07 October 2022

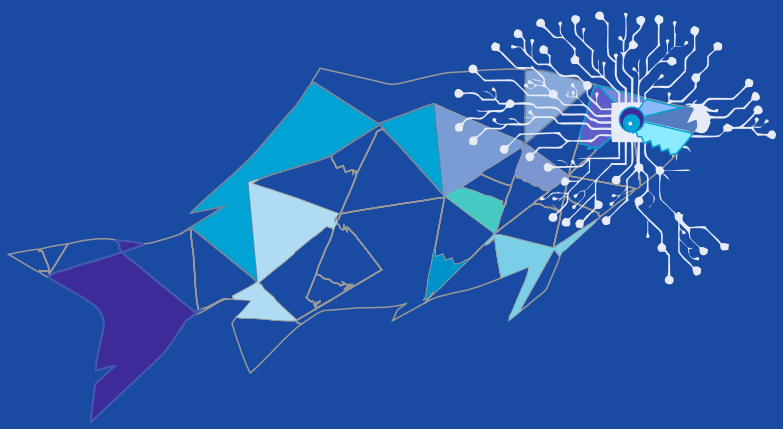
Dr.Babitha Rani A.M	32nd Project Appraisal Committee Meeting (Online)	National Fisheries Development Board,Hyderabad	12 October, 2022
Dr. G.H. Pailan Dr. Muralidhar. P. Ande	6th Meeting Of ICAR Regional Committee-II	ICAR-National Rice Research Institute, Cuttack	14 October, 2022
Dr. G.H. Pailan	Consultation Meeting of All the Directors of State Fisheries Departments	ICAR- Central Institute of Fisheries Education, Mumbai	4-5 November, 2022
Dr.Babitha Rani A.M	XXVI Meeting of ICAR Regional Committee IV (Online)	ICAR, New Delhi	7 November, 2022
All staffs of CIFE	DG Meeting: Revitalizing ICAR: Aspirations and Action Plan (Online)	ICAR, New Delhi	11 November, 2022
Dr.Babitha Rani A.M	Detailed Project Report on Integrated Aquapark at Garwa	Department of Fisheries, Haryana	12 November, 2022
Dr.Babitha Rani A.M	World Fisheries Day Celebration	National Fisheries Development Board, Dhanute, Daman	21 November, 2022
Dr.Babitha Rani A.M	Detailed Project Report on Integrated Aquapark at Garwa	Department of Fisheries, Haryana	9 December ,2022
Dr. Muralidhar. P. Ande Dr. Karthireddy Syamala	World Fisheries Day (Online)	NAAS, Regional Chapter - Hyderabad & ICAR-NAARM, Hyderabad	21 November, 2022
Dr. Ananthan P.S. Dr. S.N. Ojha Dr. Neha Qureshi Dr. Munilkumar S. Dr. Subodh Gupta	Meeting of High Power Committee Constituted for Finalization of Draft 'National Fisheries Policy, 2020	ICAR-CIFE, Mumbai	10 Dec 2022.
All CIFE Scientists	Vision of ICAR 2047: Meeting with DDG, ICAR with Scientists of ICAR institutes (Online)	ICAR, New Delhi	13 December, 2022
Dr. G.H. Pailan	The Scientific Advisory Committee	Ramkrishna Ashram Krishi Vigyan Kendra, Kolkatta	23 December, 2022
Dr. H. Mandakini Devi Dr. Sujata Sahoo	Responsible Aquaculture & Sustainable Fisheries Interact (Online)	College of Fisheries, Tripura	13-16 December, 2022
Ms. Vidhya.V Ms. Shobha Rawat	Member Secretary of Rajiv Gandhi Science & Technology Commission, Mumbai	ICAR- Central Institute of Fisheries Education, Mumbai	27 December,2022

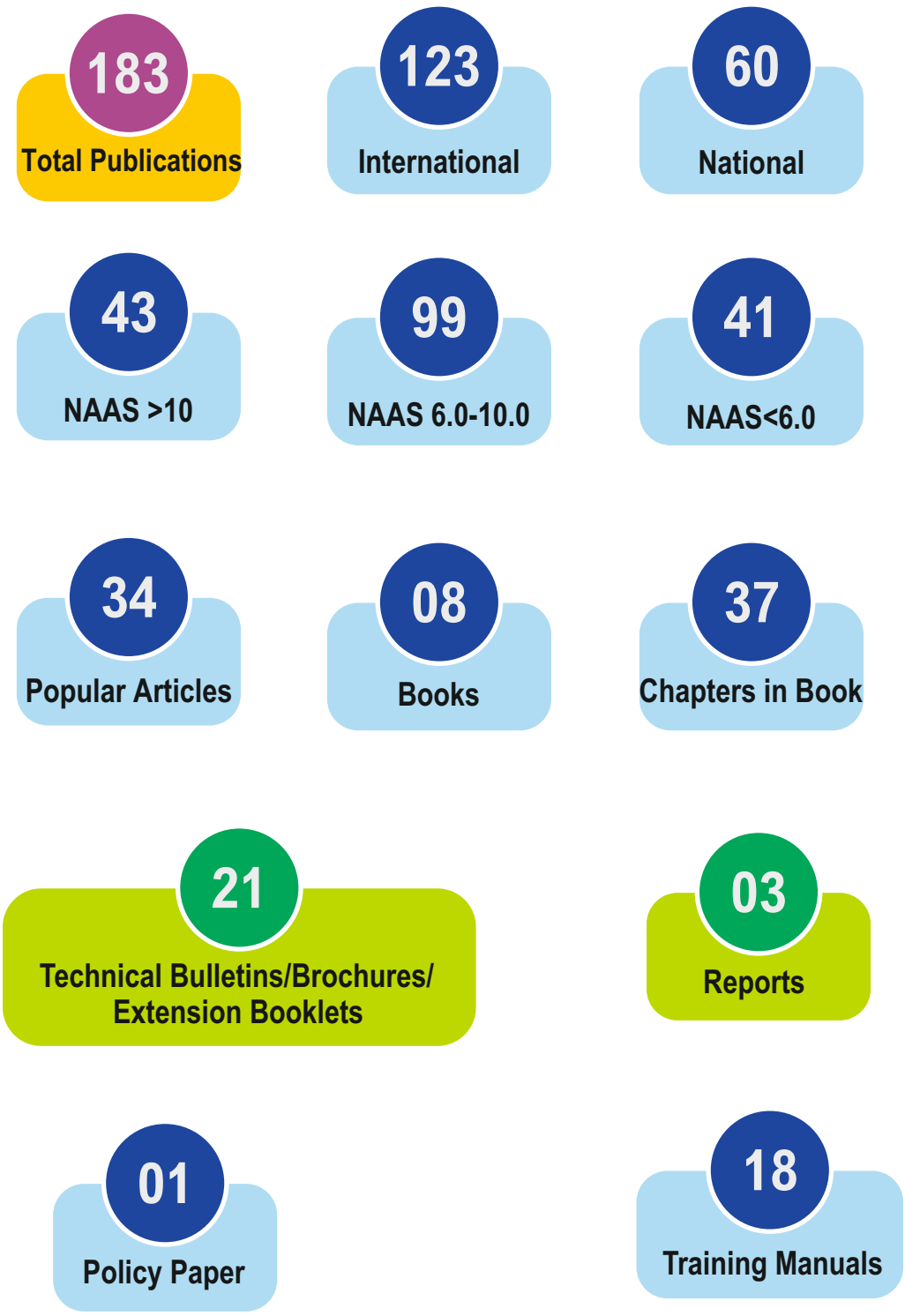
5.6 Webinar/ Lectures/ Seminars Attended

Name of the faculty	Name of the Webinar/ Lectures/Seminars attended	Organized by	Date
Dr. K.V. Rajendran	Application of Modern Biotechnological Tools for Management of Aquatic Genetic Resources (online)	ICAR-National Bureau of Fish Genetic Resources, Lucknow	05 January, 2022
Dr. Shamna N. and Dr. Babitha Rani	Reorienting the Strategies Towards Sustainable Aquaculture and Fisheries	Faculty of Fisheries Science, KUFOS, Kerala	06-07 January, 2022
Dr. Babitha Rani A.M	Review of Biofloc Shrimp Farming in Kerala (Online)	Fisheries Directorate, Kerala	09 February, 2022
Dr. Manjusha L.	Intangible Technology Transfers Focusing on Academic/Research Institutions (Online)	Institutional Bio-Safety Committee, New Delhi	23 February, 2022
Dr. Manjusha L.	Smart Agriculture and Budget Implementations (Online)	ICAR, New Delhi	24 February 2022
Dr. K.V. Rajendran	Surviving the Pandemic through Aquaculture: The Kerala Experience (Online)	Department of Aquatic Biology and Fisheries, University of Kerala	24-25 February, 2022
Dr. Manjusha L.	Dialogues in Technology and Development (Online)	Rajiv Gandhi Science & Technology, Maharashtra	03 March, 2022
Dr. Ashutosh D Deo	Developing Integrated Work Plan of Precision Aquaculture	ICAR-NePPA, ICAR- Central Institute of Freshwater Aquaculture Bhubaneshwar	03 March, 2022
Dr. K.V. Rajendran	SMART AQUA EXPO INDIA 2022	Nocci Business Park, Balasore, Odisha	04-05 March, 2022
Dr. Manjusha L.	Diversification in Aquaculture- Azadi Ka Amrit Mahotsav (Online)	ICAR- Central Marine Fisheries Research Institute, Kochi	10 March, 2022
Dr. N. S. Nagpure	Online Financial Transactions and Security Measures (Online)	Ministry of Electronics and Information Technology, GOI	10 March, 2022
Dr. Babitha Rani A.M	Diversifying Crustacean Culture -Developing Future Climate Resilience (Online)	ICAR- Central Institute of Brackish water Aquaculture, University of Southampton, The Pirbright Institute, UK	22-24 March, 2022
All Staffs of CIFE	Fish Shark Tank	ICAR- CIFE, Mumbai	March, 2022
Dr. Manjusha L. Dr. Muralidhar. P. Ande Dr. Dr. Karthireddy Syamala	National Campaign on Fish for Health and Prosperity (Online)	ICAR- Central Institute of Fisheries Technology, Kochi	16 July, 2022
Dr. Manjusha L.	Value Addition and Nutraceuticals from Fish and Shellfish	ICAR- Central Institute of Fisheries Technology	16 July, 2022
Ms. Vidhya.V	Phycopreneurship In India: Status and Prospects of Seaweed Culture	ICAR - Central Marine Fisheries Research Institute, Manadapam, Tamil Nadu	27 July, 2022
Scientists of FRM	The National Campaign on Participatory Approach for Sustainable Development and Biodiversity Conservation (Online)	ICAR- Central Institute of Fisheries Education, Mumbai	04 August, 2022

Scientists of FRM	Participatory Approach for Mahseer Conservation- Invited Lecture by Dr. Unmesh Katwade, BNHS (Online)	ICAR- Central Institute of Fisheries Education, Mumbai	05 August, 2022
Scientists of FRM	Climate Change in Fisheries by Dr. Vivekanadan, P . S. (retd), ICAR-CMFRI (Online)	ICAR- Central Institute of Fisheries Education, Mumbai	16-18 August, 2022
Dr. Kapil Sukhdhane	Initiatives of MPEDA for Promotion of Diversified Aquaculture in India, with Special Focus on Maharashtra and Gujarat State- Way Forward	MPEDA & RGCA, Sakinaka, Mumbai	16 August, 2022.
Scientist of CIFE	Agri-Startup-Conclave (Online)	ICAR, New Delhi	17 August, 2022
Dr. Pankaj Kumar	One Day Field visit cum seminar to Sirsa in connection with Hon'ble Chief Minister Haryana visit	District Fisheries Officer, Sirsa, Haryana	19 September, 2022
Dr. Ankush L. Kamble	Daryavardi Udyojika Mahotsav	Vrutti foundation, Versova, Mumbai	23 September, 2022
Dr. Karthireddy Syamala	Recent Trends in Biotechnology and Future Prospects	Ideal College of Arts & Sciences, Kakinada	30 September 2022- 1 October, 2022
Dr. N. S. Nagpure	Diversification in Aquaculture (Online)	ICAR - CMFRI Kochi	06 October, 2022
Dr. Manjusha L.	Emergence and spread of Antimicrobial Resistance in Aquaculture (Online)	Tamil Nadu Dr. J. Jayalalithaa Fisheries University, Nagapattinam	16 November, 2022
Dr. Manjusha L.	Interventions for Control of AMR: Harnessing One Health Knowledge (Online)	ICAR- Central Institute of Fisheries Technology, Kochi	22 November, 2022
Dr. Swadesh Prakash	Awareness among Agri Startups, Agri Entrepreneurs, Faculties, Scholars, Students & other Stakeholders Regarding the Agri Startup Ecosystem (Online)	MANAGE Centre for Innovation and Agripreneurship, Hyderabad	26 November, 2022
Scientists of CIFE	Directors Conclave: Energising Pathways for Fisheries Development	ICAR- Central Institute of Fisheries Education, Mumbai	04-05 November, 2022
Dr. Babitha Rani A.M Dr. Pankaj Kumar	New Technology of Aquaculture to Enhance Fish Production	Aquaculture Research & Training Institute, Hisar	30 November, 2022
M Mr. Angom Lenin Singh	Animal Breeding Strategies in the era of Genomics and Phenomics	ICAR-National Bureau of Animal Genetic Resources, Karnal	17-18 December, 2022

06 Publications




183
Total Publications
123
International
60
National
43
NAAS >10
99
NAAS 6.0-10.0
41
NAAS<6.0
34
Popular Articles
08
Books
37
Chapters in Book
21
Technical Bulletins/Brochures/
Extension Booklets
03
Reports
01
Policy Paper
18
Training Manuals

NAAS rating > 10.0 (NAAS: IF)

1. Bhat RAH, Khangembam VC, Thakuria D, Pant V, Tandel RS, Tripathi G, Sarma D (2022) Antimicrobial activity of an artificially designed peptide against fish pathogens. ***Microbiological Research*** 260: 127039. Doi.org/10.1016/j.micres.2022.127039 **(11.07; 5.07)**
2. Biswas G, Kumar P, Ghoshal TK, Das S, De D, Bera A, Shyne-Anand PS, Kailasam M (2022) Periphyton: A natural fish food item for replacement of feed at optimized substrate surface area for cost-effective production in brackishwater polyculture. ***Aquaculture*** 561: 738672. https://doi.org/10.1016/j.aquaculture.2022.738672. **(11.14; 5.135)**
3. Chakraborty P, Krishnani KK (2022) Emerging bioanalytical sensors for rapid and close-to-real-time detection of priority abiotic and biotic stressors in aquaculture and culture-based fisheries. ***Science of the Total Environment*** 838(2): 156128-41. **(16.75; 10.75)**
4. Chintada B, Ranjan R, Rani AB, Santhosh B, Megarajan S, Ghosh S, Gopalakrishnan A (2022) Effects of salinity on survival, reproductive performance, population growth, and life stage composition in the calanoid copepod *Acartia bilobata*. ***Aquaculture*** 563:739025. **(11.14; 5.135)**
5. Chrispin CL, Ananthan PS, Ramasubramanian V, Sugunan VV, Panikkar P, Landge AT (2022) Rapid reservoir fisheries appraisal (r-RAPFISH): Indicator based framework for sustainable fish production in Indian reservoirs. ***Journal of Cleaner Production*** 379:134435. **DOI:** 10.1016/j.jclepro.2022.134435 **(17.07; 11.072)**
6. Chutia A, Xavier KM, Shamna N, Rani AB (2022) Application of bio-flocculating agent in inoculum enhances quality of biofloc and influences growth, feed utilization and stress responses of GIFT tilapia reared in-situ. ***Aquaculture*** 553: 738050. **(11.14; 5.135)**
7. Dayakar B, Xavier KM, Ngasotter S, Layana P, Balange AK, Priyadarshini B, Nayak BB (2022) Characterization of spray-dried carotenoprotein powder from Pacific white shrimp (*Litopenaeus vannamei*) shells and head waste extracted using papain: Antioxidant, spectroscopic, and microstructural properties. ***LWT*** 159:113188. **(12.06; 6.056)**
8. Debbarma N, Gurjar UR, Ramteke KK, Bhushan S, Shenoy L, Nayak BB, Geethalakshmi V, Xavier KAM (2022) Microplastic abundance in gastrointestinal tracts and gill tissues of croaker fish (*Johnius dussumieri*) from the north east coast of Arabian Sea. ***Marine Pollution Bulletin*** **176: 113473. (13.01; 7.001)**
9. Garg CK, Sardar P, Sahu NP, Maiti MK, Shamna N, Varghese T, Deo AD, Harikrishna V (2022) Dietary lysine requirement of genetically improved farmed tilapia (GIFT) juvenile reared in inland saline water of 10 ppt salinity. ***Aquaculture*** 555: 738223. **(11.14; 5.135)**
10. Gurjar UR, Xavier KM, Shukla SP, Jaiswar AK, Deshmukhe G, Nayak BB (2022) Microplastic pollution in coastal ecosystem off Mumbai coast, India. ***Chemosphere*** 288:132484**. (13.09; 7.085)**
11. Gurjar UR, Xavier KM, Shukla SP, Jaiswar AK, Deshmukhe G, Nayak BB (2022) Microplastic pollution in coastal ecosystem off Mumbai coast, India. ***Chemosphere*** 288:132484. **(14.94; 8.94)**
12. Haque R, Sawant PB, Sardar P, Varghese T, Xavier KM, Chadha NK, Sundaray JK, Haldar C, Jana P, Pattanaik SS (2022) Shrimp shell waste-derived astaxanthin in synergistic combination with its commercial variant augments gonadal maturation and upregulates vitellogenin gene expression of discus (*Symphysodon aequifasciatus*). ***Aquaculture*** 562:738828. **(11.14; 5.131)**
13. John VC, Verma AK, Krishnani KK, Chandrakant MH, Bharti VS, Varghese T (2022) Optimization of potassium (K+) supplementation for growth enhancement of *Spinacia oleracea* L. and *Pangasianodon hypophthalmus* (Sauvage, 1878) in an aquaponic system. ***Agricultural Water Management*** 261(2): 107339. **(12.61; 6.611)**
14. Kantharajan G, Govindakrishnan PM, Chandran R, Singh RK, Kumar K, Anand A, Krishnan P, Mohindra V, Shukla SP, Lal KK (2022) Anthropogenic risk assessment of riverine habitat using geospatial modelling tools for conservation and restoration

planning: a case study from a tropical river Pranhita, India. ***Environmental Science and Pollution Research*** 23(6): 1-19. (11.19; 5.19)

15. Kiruba-Sankar R, Saravanan K, Haridas H, Praveenraj J, Biswas U, Sarkar R (2022) Policy framework and development strategy for freshwater aquaculture sector in the light of COVID-19 impact in Andaman and Nicobar archipelago, India. ***Aquaculture*** 548: 737596. **(11.14; 5.135)**

16. Krishnani KK, Boddu VM, Chadha NK, Chakraborty P, Kumar J, Krishna G, Pathak H (2022) Metallic and non-metallic nanoparticles from the plant, animal, and fisheries wastes: potential and valorization for application in agriculture. ***Environment Science & Pollution Research*** 29: 81130–81165. Doi.org/10.1007/s11356-022-23301-4. **(11.19; 5.19)**

17. Kumar CB, Kumar A, Paria A, Kumar S, Prasad KP, Rathore G (2022) Effect of spatio temporal variables, host fish species and on farm biosecurity measures on the prevalence of potentially pathogenic *Aeromonas* species in freshwater fish farms. ***Journal of Applied Microbiology***. 132(3):1700-12. **(10.06; 4.061)**

18. Kumar G, Gireesh-Babu P, Rajendran KV, Goswami M, Chaudhari A (2022) Gain of function studies on predicted host receptors for white spot virus. ***Fish and Shellfish Immunology*** 131: 196–205. **(10.62; 4.622)**

19. Kumar VS, Sarkar DJ, Das BK, Samanta S, Tripathi G, Behera BK, Sarkar SD (2022) Recycling banana pseudostem waste as a substrate for microalgae biofilm and their potential in arsenic removal. ***Journal of Cleaner Production*** 367: 132772. Doi.org/10.1016/j.jclepro.2022.132772 **(17.07; 11.07)**

20. Kumar VS, Sarkar SD, Das BK, Sarkar DJ, Gogoi P, Maurye P, Mitra T, Talukder AK, Ganguly S, Nag SK, Munilkumar S, Samanta S (2022) Sustainable biodiesel production from microalgae *Graesiella emersonii* through valorization of garden wastes-based vermicompost. ***Science of the Total Environment*** 807: 150995. **(16.75; 10.75)**

21. Nadella RK, Panda SK, Badireddy MR, Kurcheti PP, Raman RP, Mothadaka MP 2022. Multi-drug resistance, integron and transposon-mediated gene transfer in heterotrophic bacteria from *Penaeus vannamei* and its culture environment. ***Environmental Science and Pollution Research*** 23:1-6. (11.19; 5.19)

22. Nageswari P, Verma AK, Gupta S, Jeyakumari A, Chandrakant MH (2022) Optimization of stocking density and its impact on growth and physiological responses of *Pangasianodon hypophthalmus* (Sauvage, 1878) fingerlings reared in finger millet based biofloc system. ***Aquaculture*** 551: 737909. **(11.14; 5.135)**

23. Naidu BC, Xavier KM, Shukla SP, Jaiswar AK, Nayak BB (2022) Microplastics in the foreshore coastal waters, sediment, and coastal fauna of a highly populated megacity-A study on the effect of anthropogenic discharge on clams. ***Marine Pollution Bulletin*** 185:114262. **(13.01; 7.001)**

24. Naskar S, Biswas G, Kumar P, De D, Sawant PB, Das S, Roy U (2022) Effects of estuarine oyster, *Crassostrea cuttackensis* as the extractive species at varied densities on productivity and culture environment in brackishwater integrated multi-trophic aquaculture (BIMTA) system. **Aquaculture** 554: 738128. https://doi.org/ 10.1016/j.aquaculture.2022.738128. **(11.14; 5.135)**

25. Ngasotter S, Sampath L, Xavier KM (2022) Nanochitin: An update review on advances in preparation methods and food applications. ***Carbohydrate Polymers*** 291(11):119627-37. **(16.75; 10.745)**

26. Nissa MU, Pinto N, Mukherjee A, Reddy PJ, Ghosh B, Sun Z, Ghantasala S, Chetanya C, Shenoy SV, George T, Moritz RL, Goswami M, Srivastava S (2022) Organ based protein and post translational modification profiling of a widely cultivated tropical water fish *Labeo rohita*. ***Journal of Proteome Research*** 21(2): 420-437. **(11.37; 5.370)**

27. Nissa MU, Reddy PJ, Pinto N, Sun Z, Ghosh B, Moritz RL, Goswami M, Srivastava S (2022) The Peptide Atlas of a widely cultivated fish *Labeo rohita*: A resource for the Aquaculture Community. ***Nature Scientific Data*** 9(171): 245-253. **(14.50; 8.501)**

28. Nuzaiba PM, Varghese T, Gupta S, Sahu NP, Srivastava PP (2022) Estrogenic and vitellogenic responses in genistein fed adult male *Cyprinus carpio*. ***Aquaculture*** 548: 737559. **(11.14; 5.135)**

29. Parvathy AJ, Das BC, Jifiriya MJ, Varghese T,

Pillai D, Rejish Kumar VJ (2022) Ammonia induced toxico physiological responses in fish and management interventions. ***Reviews in Aquaculture*** Doi.org/10.1111/raq.12730. **(16.62; 10.618)**

30. Patel RK, Verma AK, Krishnani KK, Sreedharan K, Chandrakant MH (2022) Growth performance, physio-metabolic, and haemato-biochemical status of *Labeo rohita* (Hamilton, 1822) juveniles reared at varying salinity levels using inland saline groundwater. ***Aquaculture*** 559: 738408. **(11.14; 5.135)**

31. Patil PK, Mishra SS, Pradhan PK, Manna SK, Abraham TJ, Solanki HG, Shahi N, Swain P, Sahoo SN, Avunje S, Sharma K, Geetha R, Priyadarshini R, Vinay TN, Prasad KP, Ashok KK, Debnath D, Panikkar P, Ananda-Raja R, Saraswathy R, Bhuvaneswari T, Mallik SK, Sood N, Kumar CB, Sanil NK, Vinoth S, Alavandi SV, Vijayan KK, Jithendran KP, Jena JK (2022) Usage pattern of chemicals, biologicals and veterinary medicinal products in Indian aquaculture. ***Reviews in Aquaculture*** 14 (4): 2038-2063. **(16.62; 10.62)**

32. Pavan-Kumar A, Singh S, Mishra A, Suman S, Gireesh-Babu P, Chaudhari A, Shen KN, Borsa P (2022) Characterization of mitochondrial genome of Indian Ocean blue-spotted maskray, *Neotrygon indica* and its phylogenetic relationship within Dasyatidae Family. ***International Journal of Biological Macromolecules*** 223(31): 458-467. **(14.02; 8.025)**

33. Pownkumar V, Ananthan PS, Ekka A, Qureshi NW, Velumani T. Fisheries as ecosystem services: A case study of the Cauvery river basin, India. ***Frontiers in Environmental Science*** Doi.org/10.3389/fenvs.2022.892012. **(11.41;5.411)**

34. Prakasan S, Lekshmi M, Ammini P, Balange AK, Nayak BB, Kumar SH (2022) Occurrence, pathogroup distribution and virulence genotypes of *Escherichia coli* from fresh seafood. ***Food Control*** 133:108669. **(11.55; 5.55)**

35. Rajanna GA, Manna S, Singh A, Babu S, Singh VK, Dass A, Chakraborty D, Patanjali N, Chopra I, Banerjee T, Kumar A (2022) Biopolymeric superabsorbent hydrogels enhance crop and water productivity of soybean–wheat system in Indo-Gangetic plains of India. ***Scientific Reports*** 12(1):11955. **(11.00; 4.996)**

36. Stephen J, Lekshmi M, Ammini P, Kumar SH, Varela MF (2022) Membrane efflux pumps of pathogenic Vibrio species: Role in antimicrobial resistance and virulence. ***Microorganisms*** 10(2):382. **(10.92; 4.92)**

37. Stephen J, Lekshmi M, Nayak BB, Kumar SH (2022) First report of a multidrug-resistant Salmonella enterica Serovar Infantis carrying pESI megaplasmid isolated from marine shrimp in India. ***Journal of Global Antimicrobial Resistance*** 31:248-51. **(10.04; 4.04)**

38. Sunish KS, Sreedharan K, Shadha Nazreen SK (2022) Actinomycetes as a promising candidate bacterial group for the health management of aquaculture systems: A review. ***Reviews in Aquaculture*** Doi.org/10.1111/raq.12771. **(16.59; 10.592)**

39. Meena LL, Verma AK, Bharti VS, Nayak SK, Chandrakant MH, Haridas H, Reang D, Javed H, John VC (2022) Effect of foliar application of potassium with aquaculture wastewater on the growth of okra (*Abelmoschus esculentus*) and *Pangasianodon hypophthalmus* in recirculating aquaponic system. ***Scientia Horticulture*** **302: 111161.** https://doi.org/10.1016/j.scienta.2022.111161 **(10.34; 4.34)**

40. Verma DK, Sood N, Paria A, Swaminathan TR, Mohan CV, Rajendran KV, Pradhan PK (2022) Reassortment and evolutionary dynamics of tilapia lake virus genomic segments. ***Virus Research*** 308:198625. **(12.29; 6.29)**

41. Waikhom D, Jeena K, Krishnan R, Varghese T, Prasad KP, Rajendran KV (2022) Beta-glucan stimulation induces trained immunity markers in common carp, *Cyprinus carpio*. ***Fish and Shellfish Immunology*** 131: 855–861. Doi.org/10.1016/j.fsi.2022.10.069. **(10.62; 4.622)**

42. Wisdom KS, Bhat IA, Pathan MK, Chanu TI, Kumar P, Gireesh-Babu P, Walke P, Nayak SK, Sharma R (2022) Teleost nonapeptides, isotocin and vasotocin administration released the milt by abdominal massage in male catfish, *Clarias magur*. ***Frontiers in Endocrinology*** doi.org/10.3389/fendo.2022.8994. **(12.05; 6.055)**

43. Yadav B, Sharma A (2022) Gender Analysis of Ornamental Fish Production Units in Maharashtra, India. ***Frontiers in Marine Sciences*** 9: 907069. **(11.25; 5.247)**

NAAS rating (10.00 < 6.00)

1. Abisha R, Krishnani KK, Sukhdhane K, Verma AK, Brahmane MP, Chadha NK (2022) Sustainable development of Climate-resilient aquaculture and culture-based fisheries through adaptation of abiotic stresses- A review. ***Journal of Water and Climate Change*** 13(7): 2671–2689. **(8.80; 2.80)**
2. Ahirwal SK, Jaiswar AK, Chakraborty SK, Sarma K, Kumar T, Singh J, Bavithra R (2022) Analysis of reproductive patterns of *Sardinella longiceps* (Val. 1847) from the Mumbai Sea, Maharashtra, India. ***Indian Journal of Geo Marine Sciences*** 50(12): 1037-1042. (**6.50; 0.496)**
3. Aralappanavar VK, Bharti VS, Mukhopadhyay R, Prakash S, Harikrishna V, Bhuvaneswari GR, Tripathi G, Krishna G, Sarkar B (2022) Inland saline aquaculture increased carbon accumulation rate and stability in pond sediments under semi-arid climate. ***Journal of Soils and Sediments*** 8(2): 1-10. **(9.31; 3.30)**
4. Basumatary B, Verma AK, Verma MK (2022) Global research trends on aquaponics: a systematic review based on computational mapping. ***Aquaculture International*** https://doi.org/10.1007/s10499-022-01018-y **(8.95; 2.950)**
5. Bhargavi K, Krishnan P, Anand A, Kantharajan G, Landge AT, Nayak BB (2022) A remote sensing approach to explore the available water spread for fisheries development in the reservoirs of Godavari River Basin, Telangana, India. ***Indian Journal of Fisheries*** 69(4): 14-27. **(6.59; 0.59)**
6. Bhoomaiah D, Pandian K, Kantharajan G, Agarwal S, Hemalatha M, Rajendran KV, Rao S (2022) Mapping the research impact of collaboration and networking of ICAR fisheries research institutes in India: A scientometric study. ***Indian Journal of Fisheries*** 69(1): 1-21. **(6.59; 0.59)**
7. Borah S, Vaisakh G, Jaiswar AK, Bhattacharjya BK, Deshmukhe G, Sahoo AK, Gogoi P, Meena D K, Mohanty D, Das BK (2022) Food spectrum dynamics of anadromous Hilsa, *Tenualosa ilisha* (Hamilton, 1822) inhabiting River Brahmaputra, India curtailing apprehension of food selectivity: An insight into its domestication. ***Indian Journal of Geo Marine Sciences*** 51(01): 67-77. **(6.50; 0.496)**
8. Borah S, Vaisakh G, Jaiswar AK, Bhattacharjya BK, Sahoo AK, Deshmukhe G, Behera BK, Meena DK, Das P, Das BK (2022) On the population characteristics of anadromous *Tenualosa ilisha* (Hamilton, 1822) occurring from River Brahmaputra, India. ***Aquatic Ecosystem Health & Management*** 25(2):44-52. **(7.44; 1.44)**
9. Chintada B, Ranjan R, Rani B, Megarajan S, Ghosh S, Xavier B, Achamveettil G (2022) Evaluation of suitable micro algal diets for intensive culture of the calanoid copepod *Acartia bilobata*. ***Aquaculture Research*** 3(17):6193-204. **(8.18; 2.184)**
10. Debroy S, Chadha NK, Sawant P, Krishna H, Pathan MK, Haque Ramjanul, Jana P, Roy U (2022) Effect of salinity on growth, survival, hemato-biochemical and antioxidative status of *Anabas testudineus* (Bloch,1792) juveniles reared in inland saline water. ***Aquaculture Research*** 00:1–14. doi.org/10.1111/are.16149. **(8.18; 2.184)**
11. Devassykutty M, Ignatius B, Vijayagopal P, Ebeneezar S, Sawant PB, Babitha Rani AM, Varghese E, Sayooj P, Sajina KA (2022) Effect of dietary tryptophan supplementation on growth, body composition and digestive enzymes activity of juvenile silver pompano *Trachinotus blochii* (Lacepede, 1801). ***Indian Journal of Fisheries*** 69(4):73-80. **(6.59; 0.59)**
12. Devivilla S, Lekshmi M, Salam F, Valappil RK, Roy SD, Nayak BB (2022) Influence of polyamine production and proteolytic activities of co-cultivated bacteria on histamine production by *Morganiella morganii*. ***The Journal of General and Applied Microbiology*** 68(5):213-8. **(7.45; 1.45)**
13. Devivilla S, Lekshmi M, Salam F, Valappil RK, Roy SD, Nayak BB (2022) Influence of polyamine production and proteolytic activities of co-cultivated bacteria on histamine production by *Morganiella morganii*. ***The Journal of General and Applied Microbiology*** 68(5):213-8. **(7.45; 1.45)**
14. Ebeneezar S, Vijayagopal P, Srivastava PP, Gupta S, Sukumaran S, Sebastian W, Varghese T, Prabu DL, Varghese E, Tejpal CS, Sayooj P (2022) Optimum dietary levels of lysine and methionine reduces the crude protein requirement and improves growth in Snubnose pompano (*Trachinotus blochii*). ***Animal Feed Science and Technology*** 290: 115370-84. **(9.31; 3.313)**

15. Fawole FJ, Sahu NP, Shamna N, Adeoye AA, Phulia V, Emikpe BO (2022) Effects of Dietary Detoxified *Jatropha curcas* protein isolate on some physiological parameters, intestine, and liver morphology of *Labeo rohita* fingerlings. ***Turkish Journal of Fisheries and Aquatic Sciences*** 23(1): 56-66. **(7.26; 1.26)**

16. Fawole FJ, Shamna N, Memudu HA, Abdullahi N, Hassaan MS, Gbadamosi OK (2022) Housefly maggot meal complement soybean meal in a fish-free diet for hybrid catfish (*Clarias gariepinus*♀ *x Heterobranchus longifilis*♂): Effect on growth, body composition, blood biochemistry and antioxidant enzyme activity. ***Animal Feed Science and Technology***, 295: 115543-51. **(9.31; 3.313)**

17. Ghode G, Rathore G, Tripathi G, Davane K, Prasad KP (2022) Molecular cloning, characterization and constitutive expression analysis of TLR4 gene in *Pangasianodon hypophthalmus*. ***Indian Journal of Animal Sciences*** 92(10): 1245-1250. **(6.29; 0.29)**

18. Ghosh A, Dana SS, Sharma A, Sahu PK, Basu D, Goswami R (2022) Impacts of Fishers' Livelihood Developmental Interventions in Indian Sundarbans: An Explorative Study. ***Indian Journal of Fisheries*** 34: 56-61. **(6 . 5 0 ; 0.446)**

19. Ghosh SK, Reddy R, Xavier KM, Balange AK, Kumar HS, Nayak BB (2022) Comparative evaluation of microbial ensilaging of fish, vegetable and fish-vegetable composite wastes. ***Waste and Biomass Valorization*** 29:1-10. **(9.45; 3.449)**

20. Gupta G, Srivastava PP, Gangwar M, Varghese T, Chanu TI, Gupta S, Ande MP, Krishna G, Jana P (2022) Extra-fortification of zinc upsets vitellogenin gene expression and antioxidant status in female of *Clarias magur* brooders. ***Biological Trace Element Research*** 200(4): 861-1871. **(9.73; 3.73)**

21. Haldar C, Ram R, Pavan-Kumar A, Gireesh-Babu P, Koringa P, Joshi CG, Chaudhari A (2022) Studies on the Indian catfish *Clarias magur* reveal Insulin-Like Growth Factor II to be the major type and its upregulation in high-growth performing fish. ***Aquaculture Research*** 53 (15): 5253-5260. **(8.18; 2.184)**

22. Jana P, Sahu NP, Sardar P, Varghese T, Deo AD, Shamna N, Harikrishna V, Paul M, Chuphal N, Krishna G (2022) Dietary lipid requirement of juvenile white leg shrimp, *Penaeus vannamei* (Boone, 1931) reared in inland ground saline water of 15 ppt. ***Aquaculture Research*** https://doi.org/10.1111/are.16012. **(8.18; 2.184)**

23. Janarthanan G, Javith S, Vignaesh D, Kumar VL, Nagarajan M, Xavier KAM, Nayak BB, Balange AK (2022) Exploration and Evaluation of Pony fish (*Leiognathus* sp) mince as a source of surimi and study its thermal, spectral and textural attributes. ***Indian Journal of Animal Research*** Doi: 10.18805/IJAR.B-4999 **(6.43; 0.43)**

24. Javith S MA, Gunasekaran J, Xavier KM, Nayak BB, Krishna G, Balange AK (2022) Influence of histidine on gelation properties of low sodium surimi from tilapia (*Oreochromis niloticus*). ***International Journal of Food Science & Technology*** DOI: 10.1111/ijfs.15802 **(9.71; 3.713)**

25. Kantharajan G, Anand A, Krishnan P, Singh RK, Kumar K, Kumar YA, Mohindra V, Shukla SP, Lal KK (2022) Applications of Sentinel-2 satellite data for spatio-temporal mapping of deep pools for monitoring the riverine connectivity and assessment of ecological dynamics: a case from Godavari, a tropical river in India (2016–2021). ***Environmental Monitoring and Assessment*** 194(8): 558-569. **(9.31; 3.30)**

26. Kantharajan G, Yadav AK, Chandran R, Singh RK, Mohindra V, Krishnan P, Kumar K, Shukla SP, Lal KK (2022) Impact of terrestrial protected areas on the fish diversity and habitat quality: Evidence from tropical river Pranhita, India. ***Journal for Nature Conservation*** 68: 126187. **(8.58; 2.57)**

27. Katira NN, Nayak BB, Jaiswar AK, Joshi NH, Kardani H, Deshmukhe G (2022) Occurrence of Scleractinian corals from the outer Gulf of Kachchh, West coast of India***. Indian Journal of Geo-Marine Sciences*** 50(9): 723-728. **(6.50; 0.496)**

28. Kumar M, Gupta G, Muhammed NP, Varghese T, Srivastava PP, Bhushan S, Shukla SP, Krishna G, Gupta S (2022) Toxicity ameliorative effect of vitamin E against super-paramagnetic iron oxide nanoparticles on haemato-immunological responses, antioxidant capacity, oxidative stress, and metabolic enzymes activity during exposure and recovery in *Labeo*

rohita fingerlings. ***Aquaculture International*** pp.1-29. **(8.94; 2.94)**

29. Kumar M, Gupta G, Varghese T (2022) Effect of dietary gamma-aminobutyric acid on growth performance, haemato-immunological responses, antioxidant enzymes activity, ghrelin and IGF-I expression of Labeo rohita (Hamilton, 1822) fingerlings. ***Comparative Clinical Pathology*** 6:1-13. **(6.98; 0.98)**
30. Kumar M, Gupta G, Varghese T, Shankregowda AM, Srivastava PP, Bhushan S, Shukla SP, Krishna G, Gupta S (2022) Synthesis and characterisation of super-paramagnetic iron oxide nanoparticles (SPIONs) for minimising *Aeromonas hydrophila* load from freshwater. ***Current Nanoscience*** 18(2): 224-236. **(7.82; 1.824)**
31. Kumar M, Gupta G, Varghese T, Srivastava PP, Gupta S (2022) Preparation and characterization of glucose conjugated super paramagnetic iron oxide nanoparticles (G SPIONs) for removal of Edwardsiella tarda and *Aeromonas hydrophila* from water. ***Microscopy Research and Technique***, Doi.org/10.1002/jemt.24037. **(8.77; 2.769)**
32. Kumar P, Behera P, Biswas G, Ghoshal TK (2022) Oocyte growth, gonadosomatic index, hepatosomatic index and levels of reproductive hormones in goldspot mullet *Planiliza parsia* (Hamilton, 1822) reared in captivity. ***Indian Journal of Fisheries*** 69: 84-96. **(6.59; 0.59)**
33. Kumar P, Behera P, Biswas G, Ghoshal TK, Das S, Kailasam M, Jithendran KP (2022) Gonad recrudescence and annual sex steroid patterns in female goldspot mullet, *Liza parsia* reared in brackishwater pond. ***Animal Reproduction Science*** 248: 107161. **(8.22; 2.22)**
34. Kumar R, Rahangdale S, Dineshbabu AP, Gohel J, Jaiswar AK (2022) New Distributional Record for the Two Gobies (Gobiidae) from the North-Eastern Arabian Sea, Indian Ocean. ***Journal of Ichthyology*** 62(4):528-34. **(6.75; 0.675)**
35. Kumari R, Rao MB, Kumar G, Gireesh Babu P, Tripathi G, Rajendran KV, Bedekar MK (2022) Development of a novel shRNA construct pSh-IRAK-4 for silencing of IRAK-4 gene and delineating TLR-mediated pathway in *Penaeus monodon* in-vitro. ***Acta Scientific Microbiology***. 5(11): 24-37. **(7.41; 1.416)**
36. Kumawat T, Saravanan R, Vinod K, Joshi KK, Jaiswar AK, Deshmukhe G, Shenoy L (2022) Scyphozoan jellyfish diversity and distribution along the north-eastern Arabian Sea, off Gujarat coast, India. ***Indian Journal of Fisheries*** 69(3): 126-134. **(6.59; 0.59)**
37. Kumawat T, Sarvanan R, Vinod K, Joshi KK, Jaiswar AK, Deshmukhe G, Shenoy L (2022) Scyphozoan jellyfish diversity and distribution along the north-eastern Arabian Sea, off Gujarat coast, India. ***Indian Journal of Fisheries*** 69(3):126-134. **(6.59; 0.59)**
38. Kusunur AB, Velayudhan LK, Vaiyapuri M, Gaurav R, Tripathi G, Prasad KP, Badireddy MR, Joseph TC (2022) Microbial diversity and composition in acidic sediments of freshwater finfish culture ponds fed with two types of feed: a metagenomic approach. ***Letters in Applied Microbiology*** 75(1): 171-181. **(8.86; 2.858)**
39. Lekshmi S, Xavier KM, Kumar S, Balange AK (2022) The preservative impact of the brown seaweed (Padina tetrastromatica) extract on the quality of tilapia (*Oreochromis mossambicus*) during chilled storage. ***Journal of Food Processing and Preservation*** 45(11): 15931. **(8.61; 2.609)**
40. Maiti MK, Sahu NP, Sardar P, Garg CK, Varghese T, Shamna N, Deo AD, Harikrishna V (2022) Dietary lysine requirement of juvenile Pacific white shrimp, *Litopenaeus vannamei* (Boone, 1931) reared in inland saline water of 10 ppt salinity. ***Animal Feed Science and Technology*** 291: 115378. **(9.24; 3.24)**
41. Meena DK, Sahoo AK, Jayant M, Sahu NP, Srivastava PP, Swain HS, Behera BK, Satvik K, Das BK (2022) Bioconversion of *Terminalia arjuna* bark powder into a herbal feed for *Labeo rohita*: Can it be a sustainability paradigm for Green Fish production?. ***Animal Feed Science and Technology*** 284: 115132. **(9.24; 3.24)**
42. Mondal A, Sardar P, Jayant M, Shamna N, Radhakrishnan G, Jana P, Sahu NP (2022) Mixed leaf meal supplemented with exogenous enzyme and limiting amino acids can completely replace DORB (de-oiled rice bran) in the diet of *Labeo rohita*. ***Aquatic Living Resources*** 35: 7-18. **(7.89; 1.885)**

43. Moorthy AK, Shukla SP, Govindarajan RB, Kumar K, Bharti VS. Application of microalgal physiological response as biomarker for evaluating the toxicity of the textile dye alizarin red S. ***Bulletin of Environmental Contamination and Toxicology*** 109(2): 401-8. **(8.80; 2.807)**

44. Mushtaq Z, Prasad KP, Jeena K, Rajendran KV, Martina P, Gireesh Babu P (2022) Class a scavenger receptor-A5 gene in *Cirrhinus mrigala*: Cloning, characterisation and expression patterns in response to bacterial infection. ***Gene*** https://doi.org/10.1016/j.gene.2022.146897. **(9.91; 3.913)**

45. Nabi S, Qureshi NW, Krishnan M (2022) Awareness, perceptions and adaptation strategies of fisher community towards marine plastic pollution along Mumbai coast, Maharashtra, India. ***Indian Journal of Fisheries*** 9(3): 135-143. **(6.5; 0.5)**

46. Nageswari P, Verma AK, Gupta S, Jeyakumari A, Hittinahalli CM (2022) Effects of different stocking densities on haematological, non-specific immune, and antioxidant defence parameters of striped catfish (*Pangasianodon hypophthalmus*) fingerlings reared in finger millet-based biofloc system. ***Aquaculture International*** 34: 1-17. **(8.94; 2.94)**

47. Nageswari P, Verma AK, Gupta S, Jeyakumari A, Hittinahalli CM (2022) Haematological, serum biochemical and anti oxidative enzymes responses of sutchi catfish (*Pangasianodon hypophthalmus*) against *Aeromonas hydrophila* using various carbon sources in biofloc system. ***Aquaculture Research*** 53(5): 1851-1861. **(8.18; 2.184)**

48. Nair SM, Kumari K, Kumar AP, Raghavan R, Jaiswar AK (2022) The identity and distribution of striped bagrid catfish, *Mystus tengara* (Hamilton 1822) revealed through integrative taxonomy. ***Molecular Biology Reports*** 49(1): 351-361. **(8.74; 2.742)**

49. Nair SM, Kumar AP, Singh LK (2022) New Record of Rare Skeletal Anomaly, Pug Head Deformity in Striped Catfish, *Mystus tengara* (Hamilton, 1822) from India. ***National Academic Science Letters*** 46: 17–21. **(6.79; 0.649)**

50. Nikita Gopal, Rakesh M. Raghavan, P. Sruthi, K. Rejula & P. S. Ananthan (2022) Traditional access rights and methods of fishing in inland water bodies: Are women slowly losing out? A study from Kerala, India, *Gender, Technology and Development, 26:3, 522-543* **(7.96; 1.966) DOI:** 10.1080/09718524.2022.2120844

51. Nino T, Sasidharan A, Sabu S, Sunooj KV, Pradhan C, Xavier KM. Effect of vacuum tumbling assisted marination on textural and sensory properties of deep-fried Indian white shrimp. ***Indian Journal of Fisheries*** 69(3):100-107. **(6.59; 0.59)**

52. Nissa MU, Pinto N, Varshnay A, Goswami M, Srivastava S (2022) Ecological monitoring and omics: A comprehensive comparison of workflows for mass spectrometry-based quantitative proteomics of fish (*Labeo rohita*) liver tissue. *OMICS: A Journal of Integrative* Biology 22: 489-503. **(9.98; 3.978)**

53. Pachiyappan P, Kumar P, Reddy KV, Kumar KN, Konduru S, Paramesh V, Rajanna GA, Shankarappa SK, Jaganathan D, Immanuel S, Kamble AL (2022) Protected cultivation of horticultural crops as a livelihood opportunity in Western India: An economic assessment. ***Sustainability*** 14(12): 7430-41. **(9.25; 3.25)**

54. Pattusamy A, Hittinahalli CM, Chadha NK, Sawant PB, Krishna H, Verma AK (2022) Water budgeting for culture of *Penaeus vannamei* (Boone, 1931) in earthen grow-out ponds using inland saline groundwater. ***Aquaculture Research*** 53(12): 4521–4530. **(8.18; 2.184)**

55. Paul M, Sardar P, Sahu NP, Deo AD, Varghese T, Shamna N, Jana P, Krishna G (2022) Effect of dietary protein level on growth and metabolism of GIFT juveniles reared in inland ground saline water of medium salinity. ***Journal of Applied Aquaculture*** 21(2): 1-27. **(7.31; 1.31)**

56. Paul M, Sardar P, Sahu NP, Jana P, Deo AD, Harikrishna V, Varghese T, Shamna N, Kumar P, Krishna G (2022) Effect of dietary lipid level on growth performance, body composition, and physio-metabolic responses of Genetically Improved Farmed Tilapia (GIFT) juveniles reared in inland ground saline water. ***Aquaculture Nutrition*** Doi.org/10.1155/2022/5345479. **(9.50; 3.50)**

57. Pavan-Kumar A, Varshney S, Suman S, Das R, Chaudhari A, Krishna G (2022) Complete mitochondrial genome of freshwater pearl mussel *Lamellidens marginalis* (Lamarck,

1819) and its phylogenetic relation within unionidae family. ***Molecular Biology Reports*** 49: 9593–9603. **(8.74; 2.742)**

58. Prabhath GPWA, Shukla SP, Srivastava PP, Kumar K, Sawant PB, Verma AK, Chouksey MK, Nuwansi KKT (2022) Downstream processing of biomass produced in aquaculture wastewater for valuable pigments from the cyanobacterium *Spirulina (Arthrospira) platensis*: a green and sustainable approach. ***Aquaculture International*** 30(6): 3081–3106. **(8.95; 2.950)**

59. Pradhan PK, Verma DK, Yadav SC, Dev AK, Swaminathan TR, Paria A, Rajendran KV, Sood N (2022) Carps, *Catla catla, Cirrhinus mrigala* and *Hypophthalmichthys molitrix* are resistant to experimental infection with Tilapia lake virus (TiLV). ***Fishes*** 6: 56-67. **(9.17; 3.170)**

60. Pradhan SK, Srihari M, Roul SK, Ghosh S, Jaiswar AK, Nayak BB, Bhushan S (2022) Relationship between fish and otolith dimensions of flathead sillago *Sillaginopsis panijus* (Hamilton, 1822) (Perciformes: Sillaginidae) in the north-western Bay of Bengal. ***Indian Journal of Fisheries*** 69(3): 155-160. **(6.59; 0.59)**

61. Prajapat PS, Sharma BK, Nayak BB, Ramasubramanian V, Varghese T, Pathak V, Abidi ZJ (2022) Delineation of the stock structure of white sardine *Escualosa thoracata* (Valenciennes, 1847) along the Indian waters based on biometric analysis. ***Indian Journal of Animal Research*** 3: 362-368. **(6.43; 0.43)**

62. Prasad KP, Zaffar I, Saxena M, Mushtaq Z, Martina P 2022. Study on withdrawal period of emamectin benzoate in orally medicated silver carp (*Hypophthalmichthys molitrix*). ***Aquaculture Research*** 53 (12): 4561-4564 **(8.18; 2.18)**

63. Prasad MS, Ande MP, Syamala K, Chadha NK, Sawant PB, Xavier B, Gireesh-Babu P (2022) Effect of Different Dietary Protein Levels on Physio-metabolic Response during Stunting of Milkfish, *Chanos chanos* (Forsskal, 1775) Reared under Pond Conditions. ***Indian Journal of Animal Research*** 56(4): 444-450. **(6.43; 0.43)**

64. Praveen Kumar G, Xavier KA, Nayak BB, Kumar HS, Venkateshwarlu G, Benerjee K, Priyadarshini MB, Balange AK (2022) Quality evaluation of vacuum pack ready to eat hot smoked pangasius fillets during refrigerated storage. ***Journal of Food Processing and Preservation*** 46(7): 16636. **(8.61; 2.609)**

65. Priyadarshini MB, Balange A, Xavier M, Nayak BB (2022) Effect of spray dried cluster bean seed protein extract on the gel properties of single washed Nile tilapia surimi. ***Journal of Food Processing and Preservation*** 46(11):e17104. **(8.61; 2.609)**

66. Priyadarshini MB, Balange AK, Xavier KM, Reddy R, Nayak BB, Sanath Kumar H (2022) The effect of lyophilized coconut mesocarp—aqueous and ethanol phenolic extracts on the gel quality of tilapia surimi. ***Journal of Aquatic Food Product Technology*** 30(10): 1330-43. **(8.01; 2.006)**

67. Radhakrishnan G, Deo AD, Shamna N, Mondal A, Varghese E, Sahu NP (2022) Pyrroloquinoline quinone supplemented diet enhances metabolism, feed intake and growth in common carp (*Cyprinus carpio* Linnaeus, 1758) reared at low temperature. ***Indian Journal of Fisheries*** 69(3): 67-81. **(6.59; 0.59)**

68. Radhakrishnan K, Chrispin CL, Sendhil R, Krishnan M, Shil S, Infantina JA, Karthy A, Chutia A, Prakash S (2022) Vulnerability of whiteleg shrimp production to climate change in coastal India: An indicator approach. ***Aquaculture Research*** 53(16): 1–14. **(8.18; 2.184)**

69. Raghuvaran N, Sardar P, Sahu NP, Shamna N, Jana P, Paul M, Bhusare S, Bhavatharaniya U (2022) Effect of L-carnitine supplemented diets with varying protein and lipid levels on growth, body composition, antioxidant status and physio-metabolic changes of white shrimp, *Penaeus vannamei* juveniles reared in inland saline water. ***Animal Feed Science and*** Technology 296: 115548. **(9.31; 3.313)**

70. Rajendran KV, Pagare S, Raut S, Prasad KP, Pathan MA (2022) Monodon baculovirus (MBV) infects wild mud crab, *Scylla serrata*. ***Journal of Invertebrate Pathology*** 187: 107701. https://doi.org/10.1016/j.jip.2021.107701 . **(8.84; 2.841)**

71. Rajesh N, Imelda J, Chadha NK, Ignatius B, Sukumaran S, Suresh Babu PP, Anuraj A, Sawant PB, Babitha Rani AM (2022) Genetic

identity and length-weight relationships of Indo-Pacific sergeant *Abudefduf vaigiensis* (Quoy and Gaimard, 1825) from the south-east coast of India. ***Indian Journal of Fisheries*** 69(1):97-104. **(6.59; 0.59)**

72. Ram R, Pavan-Kumar A, Haldar C, Gireesh-Babu P, Rasal K, Chaudhari A (2022) Molecular cloning and expression profiling of insulin-like growth factor 2 and IGF-binding protein 6 in *Clarias magur* (Hamilton 1822). ***Animal Biotechnology*** DOI:10.1080/10495398.2022.2086561 **(8.28; 2.28)**

73. Raman S, Deo AD, Aklakur M, Sahu NP, Jayant M, Varghese T (2022) Comparative evaluation of dietary raw and solid-state fermented sesbania leaf meal in *Labeo rohita* (Hamilton, 1822). ***Indian Journal of Animal Research*** 5(2): 34-39. **(6.43; 0.43)**

74. Rameez R, Jahageerdar S, Chanu TI, Jayashankar J, Bangera R, Gilmour A (2022) Evaluation of alternative methods for estimating the precision of REML-based estimates of variance components and heritability. ***Heredity*** 128:197–208. **(9.83; 3.832)**

75. Ranjan A, Kumar S, Sahu NP, Jain KK, Deo AD (2022) Strategies for maximizing utilization of de-oiled rice bran (DORB) in the fish feed. ***Aquaculture International*** 67: 1-16. **(8.94; 2.94)**

76. Rathinam RB, Iburahim SA, Ramanan SS, Tripathi G (2022) A scientometric mapping of research on *Aeromonas* infection in fish across the world (1998–2020). ***Aquaculture International*** 30(1): 341-363. **(8.95; 2.95)**

77. Roshan H, Varghese T, Sahu NP, Deo AD (2022) Effects of mucuna leaf meal (Mucuna bracteata) with blood parameters, immune response and antioxidant enzyme activities of *Cyprinus carpio* (Linnaeus 1758). ***International Journal of Agriculture & Biology*** 27: 139–144. **(6.20; 0.20)**

78. Sandip P, Yadav VK, Sharma A, Ananthan PS, Qureshi NW, Dey S, Jena P, Karmakar S, Ojha SN (2022) Coastal multi-hazard vulnerability mapping: a case study along the coast of South 24 Paragnas district, East Coast of India. ***Journal of the Indian Society of Remote Sensing*** 50(9): 1701-1712. **(7.89; 1.89)**

79. Sathiyanarayanan A, Goswami M, Nagpure N, Gireesh-Babu P, Das DK (2022) Development and characterization of a new gill cell line from the striped catfish, *Pangasianodon hypophthalmus* (Sauvage, 1878). ***Fish Physiology Biochemistry***, 48(2): 367-380. **(9.01; 3.014)**

80. Sathiyanarayanan A, Yashwanth BS, Pinto N, Thakuria D, Chaudhari A, Gireesh Babu P, Goswami M (2022) Establishment and characterization of a new fibroblast-like cell line from the skin of a vertebrate model, zebrafish (*Danio rerio*). ***Molecular Biology Reports*** Doi: 10.1007/s11033-022-08009-5. **(8.74; 2.742)**

81. Sharma A, Chanu TI, Ande MP (2022) Detection and pathogenicity of *Vibrio parahaemolyticus* strains in *Penaeus vannamei*. ***Periodicum Biologorum*** 124(1-2):11-19. **(6.33; 0.235)**

82. Sharma A, Chanu TI, Nayak SK, Shrinivas J, Krishna G (2022) Pathogenesis of *Aeromonas caviae* in *Clarias magur*. ***Microbial Pathogenesis*** 169:105662-71. **(9.85; 3.84)**

83. Sharma SK, Mishra SS, Jaiswar AK (2022) Quantification of morphological variability among species of family Cynoglossidae from Indian waters. ***Indian Journal of Geo-Marine Sciences*** 51 (07): 625-632. **(6.50; 0.446)**

84. Siddaiah GM, Munilkumar S, Aklakur M, Kumari R, Balakrishna CH, Nadella RK (2022) Evaluation of sugar industry by-products for growth performance, body composition and metabolism in *Labeo rohita* (Ham) Fingerlings. ***Animal Nutrition and Feed Technology*** 21(3): 457-469. **(6.23; 0.23)**

85. Siju R, Anil MK, Gomati P, Gopidas PA, Surya S, Babitha Rani A, Sawant P (2022) Ontogenetic development of digestive tract and enzymes activity in hatchery-reared pink ear emperor, *Lethrinus lentjan* larvae. ***Turkish Journal of Fisheries and Aquatic Sciences*** 23(5): 67-74. **(7.46; 1.46)**

86. Singh R, Das R, Singh A, Jain KK, Srivastava PP, Deo A (2022) Dietary incorporation of ractopamine hydrochloride improves body composition and metabolic enzyme activity in calbasu, *Labeo calbasu* fingerlings, despite high-and low-protein-supplemented diet. ***Aquaculture Nutrition*** Doi.org/10.1155/2022/4959100. **(9.50; 3.50)**

87. Soman C, Lal DM, Haridas H, Deshmukhe G, Jaiswar AK, Shenoy L, Roshan R, Nayak BB (2022) Spatial and temporal dynamics of

water quality along coastal waters of Mumbai, India. ***Arabian Journal of Geosciences*** 15(2): 208-216. **(7.23; 1.23)**

88. SriHari M, Pavan-Kumar A, Pandian K, Ramteke K, Kathirvelpandian A, Giribhavan S, Jaiswar AK (2022) Meta-analysis of fish stock identification in India: Current status and future perspectives. ***Marine and Freshwater Research***, 74: 99-110. **(8.36; 2.36)**

89. SriHari M, Pavan-Kumar A, Russel BC, Golani D, Abidi ZJ, Edward L (2022) Deep genetic divergence in Randall's threadfin bream *Nemipterus randalli* Russell, 1986 population from northern Bay of Bengal inferred by mtDNA sequences. ***Marine Biology Research*** 18(3-4): 278-282. **(7.70; 1.609)**

90. Sudarshan S, Bharti VS, Harikrishnan S, Shukla SP, Bhuvaneswari RG (2022) Eco-toxicological effect of a commercial dye Rhodamine B on freshwater microalgae Chlorella vulgaris. ***Archives of Microbiology*** 204(10):658. **(8.73; 2.729)**

91. Surendra A, Sarma K, Jaiswar AK, Chakraborty SK, Kumar T, Singh J, Gogai P, Behera PR (2022) Age, growth and mortality parameters of Indian oil sardine *Sardinella longiceps* from Mumbai waters, off Maharashtra, India. ***Indian Journal of Fisheries*** 69(1): 22-26. **(6.59; 0.59)**

92. Surya S, Prathibha R, Abdussamad EM, Landge AT, Santhosh B, Nayak BB, Karankumar R, MiniKG, Kingsly JH, Anil MK (2022) Habitat suitability of Indo-Pacific sailfish *Istiophorus platypterus* (Shaw, 1792) in the Arabian Sea. ***Indian Journal of Fisheries*** 69(2): 19-29. **(6.59; 0.59)**

93. Sushila N, Das BK, Rathinam RB, Tripathi G (2022) Strategies for enhanced adaptive immune responses of *Pterophyllum scalare* larvae against *Aeromonas hydrophila*. ***Aquaculture Research*** 53(7): 2586-2596. **(8.18; 2.184)**

94. Thirunavukkarasar R, Kumar P, Sardar P, Sahu NP, Harikrishna V, Singha KP, Shamna N, Jacob J, Krishna G (2022) Protein-sparing effect of dietary lipid: Changes in growth, nutrient utilization, digestion and IGF-I and IGFBP-I expression of Genetically Improved Farmed Tilapia (GIFT), reared in Inland Ground Saline Water. ***Animal Feed Science and Technology*** 284: 115150. **(9.31; 3.313)**

95. Varghese T, Dasgupta S, Anand G, Kumar VR, Sahu NP, Pal AK, Puthiyottil M (2022) Dietary arginine attenuates hypoxia-induced HIF expression, metabolic responses and oxidative stress in Indian Major Carp, *Cirrhinus mrigala*. ***Comparative Biochemistry and Physiology Part B: Biochemistry and Molecular Biology*** 259: 110714. **(8.32; 2.32)**

96. Vidhya V, Jawahar P, Karuppasamy K (2022) Stock assessment of the portunid crab, *Charybdis natator* (Herbst, 1794) (Brachyura, Portunidae) from the Gulf of Mannar coast, India. ***Crustaceana*** 95(3):253-69. **(6.75; 0.758)**

97. Yadav R, Chadha NK, Saini VP, Sawant PB, Ojha ML, Jayant M, Keer NR (2022) Substitution of de-oiled rice bran with Khejri pod meal and groundnut oilcake with Khejri seed meal in the diet of *Labeo rohita* (Hamilton, 1822). ***Aquaculture Research*** 53(2): 642-656. **(8.18; 2.184)**

98. Yadav VK, Jahageerdar S, Adinarayana J (2022) Comparison between different modeling techniques for assessing the role of environmental variables in predicting the catches of major pelagic fishes off India's north-west coast. ***Indian Journal of Geo Marine Sciences*** 51(02): 194-203. **(6.50; 0.499)**

99. Yengkokpam S, Sahu NP, Pal AK, Debnath D, Jain KK, Dalvi RS, Slama P, Kesari KK, Roychoudhury S (2022) Biometric indices, physio-metabolic responses and carcass quality in rohu (*Labeo rohita*) during feed deprivation. ***Animals*** 12(6):769-78. **(8.75; 2.75)**

NAAS Rating <6.0

1. Aklakur M, Prabhakar P, Shah MI, Kumar N, Amjad M, Deo AD, Ojha SN (2022) Wetland ecosystem management for sustainable fisheries and aquaculture in Bihar: Potential and perspectives. ***Environment and Ecology*** 40(4):2188-2199. **(5.25; -)**

2. Chandran S, Singh SB, Sreekanth GB, Deshmukhe G, Nayak BB, Jaiswar AK (2022) Spatio-temporal distribution of aquatic biodiversity in Gorai creek, sub-urban Mumbai, India. ***Marine Science and Technology Bulletin*** 11: 259-270. **(-; -)**

3. Deepitha RP, Raihana R (2022) Study on consumer's perception in boosting fish sale at markets of south Andaman, India. ***Journal of the Andaman Science Association*** 27(1): 108-112. **(4.15; -)**

4. Dharmakar P, Aanand S, Kumar JSS, Ande MP, Padmavathy P, Pereira JJ (2022) Fermented cottonseed meal as an alternative for groundnut oil cake in aquafeed. ***International Journal of Fisheries and Aquatic Studies*** 10(1): 151-154. **(-; -)**

5. Dharmakar P, Aanand S, Kumar JSS, Ande MP, Padmavathy P, Pereira JJ (2022) Solid-state fermentation of sunflower meal using commercial yeast for use as an improved nutrient source in aquafeed. ***Indian Journal of Animal Research*** 8(3): 375-378**. (5.52; -)**

6. Gita S, Shukla SP, Deshmukhe G, Choudhury TG (2022) Growth and metabolism of a freshwater chlorophycean alga *Chlorella vulgaris*: Toxic effects and ecological implications of two textile dyes. ***Indian Journal of Animal Health*** 61(2):264-72. **(5.25; -)**

7. Gore SB, Xavier KM, Nayak BB, Tandale AT, Balange AK (2022) Technological effect of dietary oat fiber on the quality of minced sausages prepared from Indian major carp (*Labeo rohita*). ***Bioactive Carbohydrates and Dietary Fibre*** 27:100305. **(-; -)**

8. Goswami M, Pavan-Kumar A, Patil GS, George T, Nath R, Bhuyan RN, Siva C, Laskar MA, Sumer S (2022) Molecular identification of ornamental loaches (Cypriniformes, Cobitoidei) of North East India using mitochondrial genes. ***Animal Gene*** 26: 200136. **(-; -)**

9. Guwa S, Prakash S, Kumar NR, Sharma R, Pandey SK, Dubey K (2022) Economics of fish feed production for cage culture in Jharkhand. ***Journal of Experimental Zoology, India*** 24(2): 927-931. **(5.25; -)**

10. Hatte VM, Prakash S, Kumar NR, Vivekanandan E, Ramasubramanian V (2022) Study of Marine Fish Marketing In Ratnagiri District of Maharashtra: A Supply Chain Approach. ***Journal of Experimental Zoology, India*** 6: 1609-1616. **(5.25; -)**

11. Hatte VM, Swadesh Prakash, Kumar NR, Vivekanandan E, Ramasubramanian V (2022) Constraint analysis of Fishermen and market intermediaries of Marine Fish markets in Ratnagiri, Maharashtra. ***Asian Journal of Agricultural Extension, Economics & Sociology*** 40(10): 90-96. **(4.86; -)**

12. Joshua NE, Ojha SN (2022) Enabling Aquaculture Extension Strategy in Agricultural Technology Management Agency (ATMA), India. ***International Journal of All Research Education and Scientific Methods*** 10 (2): 1821-1826. **(-; -)**

13. Kamei M, Munilkumar S, Basudha C, Dasgupta S, Sawant PB, Mangang WR (2022) Breeding and larval rearing of juvenile of Burmese Loach, *Lepidocephalichthys berdmorei* (Blyth, 1860): A new candidate species for aquaculture. ***Journal of Experimental Zoology, India*** 26(1): 11-17. **(5.25; -)**

14. Khemraj B, Ananthan P.S., Neha W. Q, Sharma L.L. (2022) Human Developmemt of Small Scale Fishers: Evidence from Rana Pratap Sagar Reservoir Region, India. ***Journal of Indian Fisheries Association****, 49(1): 25-30*

15. Krishnani KK, Kathiravan V, Kailasam M, Nagavel A (2022) A case study on fish produced greenwater culture system for controlling *Vibrios* and achieving higher production of brackishwater shrimp. ***Research Journal of Indian Society of Coastal Agricultural Research*** 40(1): 36-41. **(5.17; -)**

16. Kumari S, Sharma A (2022) Socio-economic status of fishers and fish production trends from cage culture in Chandil reservoir, Jharkhand. ***Journal of Krishi Vigyan*** 10(2): 290-294. **(4.55; -).**

17. Kumari S, Sharma A (2022) Sustainable livelihood through fish cage culture: Case of Chandil reservoir in Jharkhand. ***Indian Journal of Ecology*** 49(3): 879-887. **(5.79; -)**

18. Mir SA, Ojha SN, Ananthan PS, Qureshi NW, Argade SD, Gul S, Thangavel V (2022) Assessment of fisheries and management-insights from Dal Lake, Kashmir. ***Indian Journal of Extension Education*** 58(4): 60-65. **(5.95; -)**

19. Naidu BC, Xavier KM, Shukla SP, Jaiswar AK, Nayak BB. Comparative study on the microplastics abundance, characteristics, and possible sources in yellow clams of different demographic regions of the northwest coast of India. ***Journal of Hazardous Materials Letters*** 1(3):100051. **(-; -)**

20. Nama S, Bhushan S, Ramteke KK, Jaiswar AK, Nayak BB, Pathak V, Akter S (2022) Stock structure analysis of *Upeneus vittatus* based on morphometric, meristic and otolith shape analysis along the Indian coast. ***Research Square*** 1-28. Doi.org/10.21203 /rs.3.rs-1426133/v1. **(-; -)**

21. Nama S, Bhushan S, Ramteke KK, Jaiswar AK, Srihari M (2022) Stock structure analysis of Yellow striped goatfish, *Upeneus vittatus* (Forsskal, 1775) based on truss morphometric analysis along the Indian coast. ***Iranian Journal of Fisheries Sciences*** 21(1):93-103. **(-; -)**

22. Naveenkumar R, Raman RP, Kumar S, Anisha V, Chandan GM (2022) Phytochemical analysis, HPTLC profile, and in-vitro antioxidant and antibacterial activity of *Cyperus rotundus L. rhizome* extracts. ***International Journal of Agriculture, Environment and Biotechnology*** 15: 567-578. **(4.54; -)**

23. Pal S, Yadav VK (2022) Forecasting of the different hydro-climatic variables and impact of climate change on marine fish production in West Bengal, India. ***Indian Journal of Animal Health*** 61(1): 84-110. **(5.25; -)**

24. Pal S, Yadav VK, Sharma A, Ojha SN (2022) Socio-economic Vulnerability Assessment of a Coastal District in West Bengal. ***Journal of Experimental Zoology, India*** 25(2): 2453-2467. **(5.25; -)**

25. Pathak V, Jaiswar AK (2022) Discrimination of six flathead fishes (Family: Platycephalidae) based on otolith morphology and morphometric features. ***Iranian Journal of Fisheries Sciences***. 21(1):174-86. **(-; -)**

26. Paul M, Sardar P, Sahu NP, Varghese T, Shamna N, Harikrishna V, Deo AD, Jana P, Singha KP, Gupta G, Kumar M (2022) Optimal dietary protein requirement of juvenile GIFT Tilapia (*Oreochromis niloticus*) reared in inland ground saline water. ***Journal of Environmental Biology*** 43(2): 205-215. **(5.57; -)**

27. Praveen KG, Balange AK, Xavier KAM, Nayak BB, Kumar SH, Venkateshwarlu G (2022) An evaluation of the suitability of *Pangasius hypophthalmus* for smoke-drying: Assessment of its nutritional quality and safety. ***Fishery Technology*** 59: 259-269. **(5.82; -)**

28. Remya L, Zacharia PU, Shukla SP, Varghese M, Jaiswar AK, AbdulNazar AK, Thirumalaiselvan S, Rajkumar M, Vinoth RK (2022) Food habit and diet composition of *Karalla dussumieri* (Val., 1835) and Gazza minuta (Bloch, 1795) from Mandapam vicinity of Gulf of Mannar, Tamil Nadu. ***Journal of Marine Biological Association of India*** Doi:10.6024/jmbai.2022.64.1.2177-06. **(4.14; -)**

29. Saikia M, Yadav VK, Pal S (2022) Assessment of Socio-Economic vulnerability in the selected reservoirs of Madhya Pradesh. ***Journal of Experimental Zoology, India*** 25(2): 2369-2382. **(5.25; -)**

30. Saikia M, Yadav VK, Pal S (2022) Temporal studies of climatic and environmental parameters and their possible impact on selected reservoir fish production of Madhya Pradesh: A different methodological approach. ***Climate Change and Environmental Sustainability*** 9(2):144-163. **(5.28; -)**

31. Sampath L, Ngasotter S, Layana P, Balange AK, Nayak BB, Eappen S, Xavier KM (2022) Impact of extended acid hydrolysis on polymeric, structural and thermal properties of microcrystalline chitin. ***Carbohydrate Polymer Technologies and Applications*** 4:100252. **(-; -)**

32. Sampath L, Ngasotter S, Layana P, Balange AK, Nayak BB, Xavier KM (2022) Effect of chemical treatment duration on physicochemical, rheological, and functional properties of colloidal chitin. ***Food Hydrocolloids for Health*** 1(2):100091-99. **(-; -)**

33. Seenivasan P, Ananthan PS, Qureshi NW, Argade S (2022) Assessing socio-economic vulnerability for development: evidence from Ahmednagar, Maharashtra. ***International Journal of Agriculture, Environment and Biotechnology*** 15: 467-475. **(4.54; -)**

34. Singh AL, Rasal K, Pathan MA, Meher PK, Udit UK (2022) Evolutionary and analysis of structural level insights of kisspeptin2 of farmed carp, *Catla Catla* (Hamilton). ***Journal of Experimental Zoology, India*** 25(2): 2237-2248. **(5.25; -)**

35. Subramaniyan S, Pailan GH, Singh DK, Sahoo S (2022) Macronutrient profiling of high valued indigenous freshwater fishes of West Bengal. ***Journal of Experimental Zoology, India*** 25: 1203-1209. **(5.25; -)**

36. Vandana VR, Poojary N, Tripathi G, PavanKumar A, Sanil NK, Valappil RK 2022. Hepatic Microsporidiosis of Mudskipper, *Boleophthalmus dussumieri* Valenciennes, 1837 (Perciformes: Gobiidae), Due to

Microgemma Sp. ***Journal of Parasitic Diseases*** doi.org/10.21203/rs.3.rs-344161/v1 **(5.95; -)**

37. Velselvi R, DasguptaS, Varghese T, Sahu NP, Tripathi G, Panmei H, Singh KP, Krishna G (2022) Taurine and/or inorganic potassium as dietary osmolyte counter the stress and enhance the growth of GIFT reared in ion imbalanced low saline water. ***Food Chemistry: Molecular Sciences*** 4:100058. Doi.org/10.1016/j.fochms.2021.100058. **(-;-)**

38. Yadav R, Sharma A, Sharma BK, Sharma LL (2022) Constraint Analysis of Pluralistic Extension Service Providers. ***Journal of Community Mobilization and Sustainable Development*** 17(2): 662-670. **(5.67; -)**

39. Yadav R, Sharma A, Sharma BK, Sharma LL, Meridia M (2022) Role of pluralistic extension service providers in fisheries development of Rajasthan. ***Journal of Inland Fisheries Society of India***, 54(1): 87-100. **(5.71; -)**

40. Yadav SR, Chavan BR, Chadha NK, Naik SD, Krishnani KK, Sawant PB (2022) Algal-bacterial intervention as a management tool for next generation aquaculture sustainability. ***Journal of Environmental Biology*** 43(4): 485-497. **(5.57; -)**

41. Yadav VK (2022) Editorial notes on smart aquaculture - The Way Forward. ***Medicon Agriculture & Environmental Sciences*** 3(1): 22-29. **(-;-)**

Popular articles

1. Biswas G, Bera A (2022) Multiple stocking and multiple harvesting (MSMH) model of milkfish (*Chanos chanos*) culture. **Agriculture & Food: E-Newsletter** 04 (11): 382-383.
2. Biswas G, Marbaniang BJ (2022) Highfin barb (*Oreichthys crenuchoides*): A native ornamental fish from Bengal waters with a promising market. **Agriculture & Food: E-Newsletter** 04 (11): 408-410.
3. Biswas G, Marbaniang BJ (2022) Sacrlet badis (*Dario dario*): A hidden gem of the Brahmaputra Basin. **Agriculture & Food: E-Newsletter** 04 (10): 127-129.
4. Biswas G, Pailan, GH (2022) New dimension for development through ornamental fish farming (in Bengali). **Samajshiksha** 66 (8): 547-551.5.
5. Deo AD, Varghese T (2022) Legally approved drugs for aquaculture. **Aquaculture Spectrum**, 31-36 p
6. Dhanalakshmi M, Kumar S, Wanjari RN, Landge AT, Iburahim AS (2022) Subterranean Fishes. **Food and Scientific reports**, 3(11): 33-41.
7. Ganesh KT, Paul T, Kumar S (2022) Endocrine disrupting compounds in aquaculture: An overview. **Aquaculture Spectrum**, 29-35.
8. Ganeshkumar K, Argade S, Johnson B, Qureshi NW (2022) Gender issues and strategies for gender mainstreaming in marine fisheries based livelihood. **Aquastar**, 4: 98-102.
9. Garg CK, Maiti MK, Sardar P, Kumar S (2022) *Mistrit machli palan me aahr khilane ki rannitiyan*. **Kheti**, 6: 34-39.
10. Garg CK, Maiti MK, Sardar P, Kumar S (2022) Talab par machli ka aahar banana. **Kheti**, 8: 34-37.
11. Iburahim AS, Bharathi R, Vidhya V, Mee SN (2022) Tools used for disseminations of Fishery information for awareness and conservation of resources. **MPEDA News Letter**, 5: 35-40.
12. Jayant M, Sahu NP (2022) Non-edible seed protein isolates formidable source for sustainable aqua production. **Aquapost**, 34-38
13. Jayant M, Shamna N, Sahu NP (2022) Strategic Nutritional Interventions to Address Sustainable Aquaculture Production. **Aquapost**, 8(3): 54-56.
14. Kamil AD, Vidhya V, Dhanalakshmi M, Landge A, Iburahim AS (2022) Fisheries Current affairs. **Food and Scientific reports**, 3(12): 8-22.
15. Kumar S, Deo AD, Jayant M (2022) Recirculatory Biofloc System in aquaculture: An innovative approach for feed management to enhance growth and production. **Food and Scientific Report**s, 3(8):42-44.
16. Lekshmi M, Stephen J, Ojha M, Kumar Sh, Varela M (2022) *Staphylococcus aureus* antimicrobial efflux pumps and their inhibitors: recent developments. **AIMS Medical Science**, 9(3): 367-393.
17. Madhulika, Sahoo S (2022) *Pangasius machhali ko talabo aur pinjaro me palne ki sahi vidhi*. **Krishisewa**, 2: 34-35.
18. Manna S (2022) *Jaliya krishi mein rasayono aur urvaroko ka prayog*. **Neelitima**, 12: 61-65.
19. Marbaniang BJ, Biswas G, Sawant PB, Haque R, Sawant K, Reena Parakashbhai H, Khundrakpam C (2022) Colour intensity in ornamental fishes: The prime factor for increased marketability and profitability. **Agri Articles** 02 (06): 250-254.
20. Meenatchi M, Kamili A, Rawat S, Iburahim AS (2022) Sport Fisheries in India and around the World. **Food and Scientific reports**, 3(11): 15-22.
21. Patekar PG, Marbaniang BJ, Halpati RP, Satheesh M, Kumar S, Munilkumar S (2022) Backyard culture of Tubifex worm: A promising live food in fish farming systems. **Aquastar**, 8: 79-85.
23. Pradeep S, Paul T, Kumar S (2022) Management of aquaculture sludge using Biocatalytic enzymes: A novel approach. **Aquaculture International**, 48-50.
24. Pradhan S, Tiwari PK, Chaudhari P, Kumari R, Paul A, Manna S, Saurabh S (2022) *Jal Krishi mein probiotics ke upyog ki sambhavana*. **Neelitima**, 12: 34-36.
25. Prakash A, Sahoo S, Rani S, Tripathi G, Pailan GH (2022) *Aapki machhali kitani swasthay hai?* **Khet***i, 8: 15-17.*

26. Praksah P, Banlam JM, Halpati R, Sateesh M, Kumar S, & Munilkumar S (2022) Backyard culture of Tubifex worm: A promising live food in fish farming. **Aquastar,** 4: 56-59.

27. Rujan J, Mushkam P, Beemalla S, Jayapratha T, Kamble A (2022) Role of SHGs in fisheries development in India. **AgriCos e-Newsletter**, 3(11): 09-11.

28. Saurabh S, Panda D, Pradhan S, Kumar PK, Suman S, Pillai, BR (2022) Meetha pani mein moti ki kheti sang matsya palan. **Neelitima**, 12: 4-5.

29. Shamna N, Sardar P, Sahu NP (2022) Leaf meal an ideal replacer of de-oiled rice bran (DORB) in aquafeed. **Aquapost**, 1: 11-17

30. Shamna N, Sardar P, Sahu NP (2022) Leafmeal: An ideal replacer of De-oiled ricebran (DORB) in aquafeed. **Aquapost**, 11(1): 11-17.

31. Shinogi KC, Srivastava S, Gurav P, Meena BP, Shirale AO, Kamble AL (2022) Resource conserving technologies for the rain-fed tribal farmlands of central India. The **Agriculture Magazine**, 1(4): 2583-1755.

32. Singh AL (2022) Factors threatening indigenous fish species. **Aquastar**, 11: 97-99.

33. Sukumaran K, Biswas G, Thomas D, Angel RJ, Bera A, Mandal B, Makesh M, Ambasankar K, Kailasam M (2022) Grey mullet aquaculture in India- Challenges and the way ahead. **MPEDA Newsletter** 10 (3): 26-30.

34. रावत शो, षवद्यावी,इबराहीम आ **(**2022) पोक्कली: खारेपानी मे धान-सह झींगा पालन की संकालिक टिकाऊ जलकृषि. **Lehrei**n, 4:32-35.

Books

Akamad KD, Vidhya V, Dhanalakshmi M, Landge AT, Iburahim AS (2022) Fisheries Current affairs: Fish in News. Amazon publisher, pp. 200

Jaiswar AK, Khot M, Sathish C (Eds.) (2022) Monograph of brachyuran crabs from Maharashtra state. ICAR-Central Institute of Fisheries Education, Mumbai, pp. 142

Makesh M, Rajendran KV (Editors) 2022 Fish immune system and vaccines. Springer Nature p289.

Naidu CB, Paul N, Ahamed KD, Iburahim AS (2022) Fish Cards (Facts on Fish). Amazon publisher, pp. 100

Pailan GH, Mahapatra BK, Datta S, Sardar P, Munilkumar S, Dasgupta S, Biswas G, Sahoo S, Mandakini Devi H, Singh DK, Manna S, Pradhan S, Biswas A (2022) Text Book on Aquaculture (PGDIF&AM Course) ICAR-CIFE, Kolkata Centre pp. 500. ISBN 978-93-95650-43-4.

Jacob J, Manimozhi E, Nuzaiba PM, Rathinam BR, Naidu CB, Iburahim AS (2022) Crack Fisheries Easy Vol 1. Amazon publisher, pp. 210

Sharma A, Chanu TI, Krishna G (2022) Diversification in the process of sustainable fish farming. Narendra Publishing House, p120.

Yadav VK (ed.) (2022) Mathematics manual for Fisheries Economics students. Astral publication pp. 223

Policy paper

Pathak H, Krishnani KK (2022) Policy paper on Climate Resilient Fisheries and Aquaculture in Maharashtra. Policy Brief-3, National Academy of Agricultural Sciences, NAAS Pune Chapter, p 11.

Chapters in Book

Argade S, Ojha SN, Kamble A (2022) Women's Aquapreneurship: Challenges and Opportunities. In: *Entrepreneurship in Livestock and Fisheries*. (Eds.) Chaudhary JK, Himar L, SharmaR, Ram D. Brillion Publishing, New Delhi, pp225-234. ISBN: 978-93-92725-34-0

Bedekar MK, Kole S (2022) Development of nano-conjugated DNA vaccine against edwardsiellosis disease in fish. In: *Vaccine Design: Methods and Protocols*, Volume 2. Vaccines for Veterinary Diseases. Springer Pp.195-204.

Bedekar MK, Kole S (2022) Development of nano-conjugated DNA vaccine against edwardsiellosis disease in fish. In: *Vaccine Design: Methods and Protocols*, Volume 2. Vaccines for Veterinary Diseases. Springer, pp. 195-204.

Bedekar MK, Kole S (2022) DNA Vaccine for Fish. In: *Advances in Fisheries Biotechnology*. (Eds.) Pandey PK, Parhi J, Springer pp. 289-336. DOI: 10.1007/978-981-16-3215-0_19

Bedekar MK, Kole S (2022) Fundamentals of fish vaccination. In: *Vaccine Design: Methods and*

Protocols, Volume 2. Vaccines for Veterinary Diseases. Springer Pp.147-173.

Bedekar MK, Kole S (2022) Types of Vaccines Used in Aquaculture. In: *Fish Immune System and Vaccines*. (Eds.) Makesh M, Rajendran KV. Springer. pp. 45-63. ISBN: 978-981-19-1268-9.0_19

Brahmchari RK, Kumar S, Kumari P, Kumar K (2022) *Argulus Parasitism* in Aquaculture: An Elevated Temperature Scenario. In: *Outlook of Climate Change and Fish Nutrition*. (Eds.) Sinha A, Kumar S, Kumari K. Spinger, pp. 133-152. ISBN: 978-981-19-5500-6

John FF, Shamna N (2022) Strategies to Mitigate Climate Change-Imposed Challenges in Fish Nutrition. In: *Outlook of Climate Change and Fish Nutrition* (Eds.) Sinha A, Kumar S, Kumari K. Springer pp. 433-443. ISBN: 978-981-19-5500-6

Kumar N, Bhushan S,, Singh DK, Kumar P, Chandan NK (2022) Application of Nanotechnology for Abiotic Stress Management. In: *Aquaculture in Advances in Fisheries Biotechnology*. Published by Springer Nature Singapore, pp. 231-244

Kumar P, Behera P, Biswas G, Ghoshal TK, Kailasam M (2022) Estradiol dependent stimulation of brain dopaminergic systems in the female gold spot mullet, *Liza parsia*. In: *Transforming Coastal Zone for Sustainable Food and Income Security*. (Eds) Lama T, Burman D, Mandal UK, Sarangi SK, Sen H. Springer International Publishing, pp. 521-535

Kumar S, Mishra S, Vijaykumar M (2022) Feed based aquaculture.In: *Evergreen technologies for Indian Agriculture*. Narendra Publishing House, Delhi. Pp. 248-249

Kumar S, Paul T (2022) Biosafety and Biosecurity for Sustainable Aquaculture development. In: *Advances in Fisheries Biotechnology* (Eds.) Pandey PK, Parhi J. Springer Nature, 453-463. ISBN: 978-981-16-3214-3

Layana P, Deepitha RP, Xavier KAM, Balange AK (2022) Edible Packaging for Fish Preservation: Fundamentals and Applications. In: *Advances in Fish Processing Technologies Preservation, Waste Utilization, and Safety Assurance* (Majumder and Balange, Eds) Apple Academic Press. 450pp

Makesh M, Bedekar MK, Rajendran KV (2022) Overview of Fish Immune System. In: *Fish Immune System and Vaccines* (Makesh M & Rajendran KV Eds.) Springer Nature pp. 1-16. ISBN: 978-981-19-1268-9.

Makesh M, Rajendran KV (2022) Viral vaccines for farmed finfish. In: *Fish Immune System and Vaccines* (Makesh M & Rajendran KV Eds.). Springer Nature 95-124. ISBN: 978-981-19-1268-9.

Manjusha L, Kumar SH, Nayak BB (2022) Emerging Pathogens of Public Health Significance Associated with Seafood. In: *Advances in Fish Processing Technologies.* Apple Academic Press. Pp 18

Nandeesha L, Malik MA, Singh SK, Munilkumar S (2022) Vulnerability and Mitigation Approach to Nutritional Pathology for Sustainable Fish Growth in Changing Climatic Conditions. In: *Outlook of Climate Change and Fish Nutrition*. Eds Sinha A, Kumar S, Kumari K (eds). Springer Nature Singapore Pvt. Ltd. https://doi.org/10.1007/978-981-19-5500-6_17 233-263

Ojha SN, Argade S, Kamble A (2022) Blue Food Entrepreneurship. In: *Entrepreneurship in Livestock and Fisheries*. (Eds.) Chaudhary JK, Himar L, Sharma R, Ram D. Brillion Publishing, New Delhi, pp. 257-267. ISBN: 978-93-92725-34-0

Pailan GH, Banu H, Manna S, Singh DK (2022) Ornamental Fish Culture for Enhancing Livelihood of Coastal Farming Communities. In: *Transforming Coastal Zone for Sustainable Food and Income Security*. Springer publisher, pp. 403-418

Pailan GH, Biswas G (2022) Advances in nutrient resource management for fisheries and aquaculture. In: *Agriculture, Livestock Production and Aquaculture*; (Eds.) Kumar A, Kumar P, Singh SS, Trisasongko BH, Rani, M. Springer International Publishing, pp.291-311

Pailan GH, Biswas G (2022) Dealing the hardship in aquaculture nutrition in a changing climatic condition. In: *Outlook of Climate Change and Fish Nutrition*; (Eds) Sinha A, Kumar S, Kumari K. Springer International Publishing, pp. 311-322

Pailan GH, Biswas G (2022) Feed and feeding strategies in freshwater aquaculture. In: *Transforming Coastal Zone for Sustainable*

Food and Income Security. (Eds) Lama T, Burman D, Mandal UK, Sarangi SK, Sen H. Springer International Publishing, pp.455-475

Paria A, Makesh M, Rajendran KV (2022) Role of pattern recognition receptors and interferons in fish vaccination. In: *Fish Immune System and Vaccines* (Makesh M & Rajendran KV Eds.). Springer Nature 245-262. ISBN: 978-981-19-1268-9.

Rajendran KV, Sreedharan K, Deepika A, Kulkarni A (2022) Shrimp immune system and immune responses. In: *Fish Immune System and Vaccines* (Makesh M & Rajendran KV Eds.) Springer Nature pp.17-45. ISBN: 978-981-19-1268-9.

Raman RP, Kumar S (2022) Adjuvants for the Fish Vaccines. In: *Fish Immune System and Vaccines* (eds.) Makesh M, Rajendran KV. Springer. pp. 231-244. ISBN: 978-981-19-1268-9.

Rathinam BR, Deepika S, Kadam D, Iburahim AS, Tripathi G (2022) Contaminants of Emerging Concern and Their Impact on Aquatic Environment. In: *Research Trends in Fisheries and Aquatic Sciences*. Ed. Sundaray JK. AkiNik Publications. pp.125

Sarkar S, Nila Rekha P, Biswas G, Nishan Raja R, Sunny A, Panigrahi A, Balasubramanian CP, Vijayan KK (2022) Integrated multi-Trophic aquaculture (IMTA): A potential farming system to enhance production of the red seaweed Agarophyton tenuistipitatum (Chang and Xia) in brackishwater. In: *Transforming Coastal Zone for Sustainable Food and Income Security*. (Eds) Lama T, Burman D, Mandal UK, Sarangi SK, Sen H. Springer International Publishing, pp. 535-552

Shamna N, John FF (2022) Regulation of Immune Responses by Lectins: *Innate Immune Defense and Therapeutics*. Springer pp. 296

Singh SK, Munilkumar S, Pawar NA, Biswas P (2022) Prebiotic–Synbiotic Nexus: Critical Dietary Role in Aquaculture. In: *Biotechnological Advances in Aquaculture Health Management*. Gupta SK, Giri SS. (eds), Springer, Singapore. https://doi.org/10.1007/978-981-16-5195-3_11

Sontakke R, Haridas H (2022) Culture of Mud Crab, *Scylla* species. In: Advance Trends in Aquaculture Practices. Eds. Balasubramanian A, Ramana TV. Astral International Pvt. Ltd., New Delhi, pp. 59-71

Sreedharan K, Kulkarni A, Rajendran KV (2022) Prospects of Vaccination in Crustaceans with Special Reference to Shrimp. In: *Fish immune system and vaccines* (Makesh M & Rajendran KV Eds.). Springer Nature 181-216. ISBN: 978-981-19-1268-9.

Tripathi G, Dhamotharan K (2022) Adverse effect of Fish Vaccines. In: *Fish Immune system and Vaccines*. Eds. Makesh M, Rajendran KV. Springer Nature Singapore, pp. 121-132. ISBN: 978-981-19-1268-9.

Vinay TN, Bedekar MK, (2022) Methods of Vaccine Delivery. In: *Fish Immune System and Vaccines* (eds.) Makesh M, Rajendran KV. Springer. pp. 217-230. ISBN: 978-981-19-1268-9.0_19

Xavier KAM, Chattopadhyay K (2022) Bioactive and Functional Nutraceuticals from Shrimp Processing Wastes. In: *Advances in Fish Processing Technologies Preservation, Waste Utilization, and Safety Assurance* (Majumder and Balange, Eds). Apple Academic Press 450pp

Yadav R, Jayant M, Surnar SR, Chadha NK, Saini VP, Sharma BK, Ojha ML, Yadav R (2022) Advancements in Indian Aquafarming Systems with Special Reference to Cage and Pen. *Latest trends in Fisheries and Aquatic Animal Health*, Volume – 3. AkiNik Publications New Delhi. Pp. 31-50. ISBN: 978-93-5570-304-0

Yadav R, Yadav R, Jayant M, Sharma BK (2022) Rack and Raft Aquaculture of India. In: *Latest trends in Fisheries and Aquatic Animal Health*, Volume – 3 AkiNik Publications New Delhi. Pp. 51-63. ISBN: 978-93-5570-304-0

Training Manuals

Ande MP, Syamala K (2022) Basic Aquaculture Practices for Livelihood improvement. ICAR-CIFE Kakinada Centre, pp. 54 (Telugu)

Chaudhari A, Brahmane MP, Pavan-KumarA, Sonwane A, Rasal K (2022) Basic and Advanced Computational Tools for Molecular Genetics. ICAR-Central Institute of Fisheries Education, Mumbai. Pp. 150

Chaudhari A, Brahmane MP, Pavan-KumarA, Sonwane A, Rasal K (2022) Molecular Biology and Bioinformatics Tools and Applications.

ICAR-Central Institute of Fisheries Education, Mumbai. Pp. 100

Lekshmi M, Nayak BB, Kumar SH (2022) Microbiological quality testing of seafood-Tools and techniques. ICAR-Central Institute of Fisheries education, Mumbai. Pp. 57.

Mahapatra BK, Pailan GH, Datta S, Manna S (2022) Ornamental fish breeding, culture and trade. ICAR-CIFE Kolkata centre, pp. 59 (Bengali)

Nayak SK, Reang D, Haridas H, Bamaliya LP, Javed H (2022) *Machhali avm shrimp palan ki aadhunik Vidhiya*. ICAR-CIFE Powarkheda Centre pp. 71

Nayak SK, Reang D, Haridas H, Bamaliya LP, Javed H (2022) *Machhali avm shrimp palan*. ICAR-CIFE Powarkheda Centre pp. 76

Pailan GH, Dasgupta S, Datta S, Sardar P, Biswas G, Sahoo S, Mandakini Devi H, Singh DK, Manna S, Pradhan S (2022) Freshwater Aquaculture. ICAR-CIFE Kolkata Centre, pp. 136 (In Hindi)

Pailan GH, Mahapatra P, Sardar P, Datta S, Munilkumar S, Dasgupta S, Biswas G, Sahoo S, Mandakini Devi H, Singh DK, Manna S (2022) Training Manual on Entrepreneurship Development in Ornamental Fish Breeding and Culture pp. 153 (ISBN 978-93-95650-33-5) English

Pailan GH, Munilkumar S, Mandakini Devi H (2022) Scientific Fish Culture. ICAR-CIFE Kolkata centre, Manipuri, pp.27

Pailan GH, Pradhan S, Biswas G, Munilkumar S, Singh DK, Manna S, Sahoo S, Behera PK(2022) Illustrated manual on Modern methods of carp seed rearing and culture. ICAR-CIFE Kolkata centre, pp. 28. (English, Hindi and Bengali)

Prasad KP, Jeena K (2022) AMR and Alternatives to AMR with Special reference to Fisheries and Aquaculture. ICAR-Central Institute of Fisheries Education, Mumbai. Pp. 121.

Raman RP, Kumar S (2022) Health Management in freshwater Fish Culture. Publisher, ICAR-Central Institute of Fisheries Education, Mumbai. Pp. 103 English

Sharma A, Yadav VK (2022) IPRs in Fisheries Sector. Published by ICAR-CIFE, Mumbai. Pp. 102.

Shukla SP, Kumar S, Kumar K (2022) Technical know-how for Spirulina culture, production and utilization. Publisher, ICAR-Central Institute of Fisheries Education, Mumbai. Pp. 76.

Yadav VK, Bharti VS, Sharma A (2022) GIS, Published by ICAR-CIFE, Mumbai. Pp. 102

Technical Bulletins / Brochures

English

Shukla SP, Kumar S, Kumar K (2022) Technical know-how for Spirulina culture, production and utilization. Pp. 4.

Raman RP, Kumar S (2022) Health Management in freshwater Fish Culture. Pp.4.

Sharma A, Chanu TI, Reang D, Verma AK (2022) Integrated Duck Cum Fish Farming. Pp.2.

Sharma, A.,Chanu, T. I.,Reang D.,Verma, A.K., (2022). Integrated Duck Cum Fish Farming. pp2.

Sharma, A.,Chanu, T. I.,Reang D., Verma, A.K.,(2022). Integrated pig Cum Fish Farming. pp2.

Sharma, A., Chanu, T. I., Reang D., Verma, A.K., (2022). Integrated poultry Cum Fish Farming. pp2.

Jahageerdar S, Mishra A, Pathan MA, Roshan R, Prakash S, Krishna G (2022) Selective Breeding of Common Carp to Develop a Strain for Aquaculture in Inland Saline Environments. Pp. 2.

Nayak SK, Reang D, Haridas H, Singh L (2022) Breeding and seed production of magur.pp. 6.

Nayak SK, Reang D, Haridas H, Singh L (2022) Aquaponics for fish and vegetable production pp. 6

Nayak SK, Reang D, Haridas H (2022) Water management of pond aquaculture, pp. 6.

Nayak SK, Reang D, Haridas H, Singh L (2022) Breeding and seed production of Indian major carp. Pp. 6.

Mishra A, Jahageerdar S, Pathan MA, Harikrishna V; Krishna G (2022) Management of Fish Welfare, Stress, and Health During Live Transportation. Pp. 2.

Hindi

Nayak SK, Reang D, Bamaliya LP, Javed H (2022) eRL; iztuu ,oa eRL; cht lao/kZu pp. 104.

Ravishankar CN, Bharti VS, Tripathi G, Nayak SK, Rao AA (2022) Tikao jaal Krishi ke liye Biochar.pp. 4.

English and Malayalam

Rani B, Shamna N, Qureshi NW (2022) Low cost leaf meal based fish feed. Pp.20.

Bilingual (English-Kokborok)

Sharma A, Chanu TI, Reang D, Verma AK, Bedekar MK, Bharti VS, Tripura M, Saha R, Sangma T (2022) An extension bulletin on aqua-based integrated farming system (volume-1) pp.26

Kokborok

Sharma A, Chanu TI, Reang D, Verma AK (2022) Aah Bai Wak Palimung. Pp.2.

Marathi

Kamble AL, Nangre DD, Singh NP, Gaikwad B, Pathak H (2022) Marketing management of rabi onion arrivals in major APMC markets of Maharashtra. Technical Report No: 36. ICAR - National Institute of Abiotic Stress Management, Baramati, Pune, Maharashtra, India. Pp 20.

English & Bengali

Biswas G, Pailan GH, Munilkumar S, Pradhan S, Singh DK, Manna S (2022) Monosex tilapia culture pp. 6.

Bengali

Pailan GH, Pradhan S, Biswas G, MunilKumar S, Singh DK, Manna S, Sahoo S, Behera PK (2022) *Adhunik padhatite ponamacher chara pratipalan o chash* pp. 30.

Rani AMB, Kumar P, Sreedharan K, Kumar A, Singh S (2022) Jheenga Palan mein pre-stocking management. Pp. 08.

Sreedharan K, Rani AMB, Kumar P, Sreedharan K, Kumar A, Singh S (2022) Jheenga rogon ka prabhandhan. Pp. 6

Sreedharan K, Rani AMB, Kumar P, Sreedharan K, Kumar A, Singh S (2022) Antersthaliya khare pani ke jheenga palan mein pramukh rog. Pp.8.

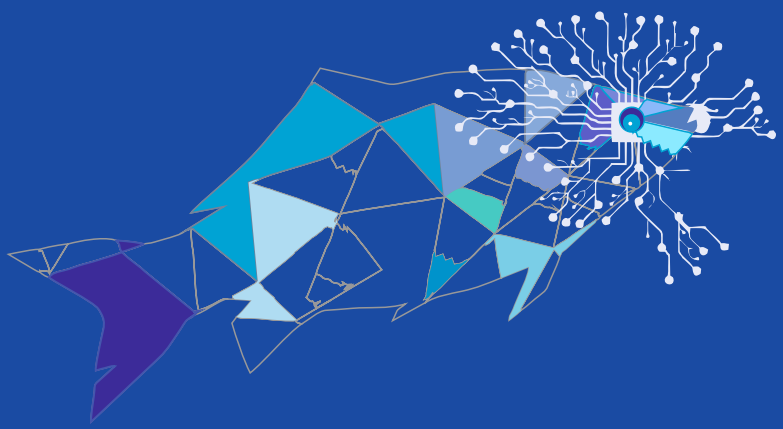
Marathi & English

Rani AMB, Sukhdhane K (2022) Biofloc aadharit matsya paalan par tantric bulletin pp.25.

Kokborok

Sharma, A., Chanu, T. I., Reang D., Verma, A.K., Aah Bai Tok Palimung., pp2.

07 Honours & Awards



Dr. G. Biswas, Senior Scientist, Kolkata Centre received **"Young Scientist Award-2022"** from Applied Zoologists Research Association (AZRA) during XVIII AZRA International Conference on "Advances in Applied Zoological Researches towards Food, Feed & Nutritional Security and Safer Environment" 10-12 February, 2022, Bhubaneswar, Odisha which was jointly organized by IRRI, Philippines-Bhubaneswar held on 10-11 November, 2022

Dr. Paramita Banerjee Sawant, Senior Scientist received **"Stree Kartitva Samman Award-2022"** (Women Achiever Award 2022) from Government of Maharashtra Public Relations Cell and NGO conglomerate for the category "Research" for the year 2022.

Endowment Awards -2022

Dr. Saurav Kumar, Scientist AEHMD received the Dr. Hiralal Chaudhuri Best Young Scientist Award 2021 (all India basis) from ICAR-CIFE, Mumbai

National Awards

K K Krishnani, Principal Scientist was awarded **"Member-Governing Body-BRSI"** for Outstanding contribution in Environmental biotechnology by Biotech Research Society of India (2021-2023) at CSIR-NIIST-Trivandrum

K K Krishnani, Principal Scientist was awarded **"Member of National Advisory Committee**" during International Conference on Biotechnology for Sustainable Bioresources and Bioeconomy -BSBB-2022, BRSI-2022 at Indian Institute of Technology, Guwahati.

Dr. Annam Pavan Kumar, Senior Scientist was awarded **"Young Scientist Award-2022"** for his outstanding research contributions by the Society of Fisheries and Life Sciences at the College of Fisheries, Mangalore, Karnataka, India, on 4 August, 2022. (Online)

Dr. G. Biswas, Senior Scientist, Kolkata Centre received **"Best Scientist Award-2022"** for his contribution to the field of fisheries and life sciences by the Society of Fisheries and Life Sciences at the College of Fisheries, Mangalore, Karnataka, India, on 4 August, 2022. (Online)

Ms. Sweta Pradhan, Scientist, Kolkata Centre received **"Best Scientist Award-2022"** for contribution to the field of fisheries and life Sciences by the Society of Fisheries and Life Sciences at the College of Fisheries, Mangalore, Karnataka, India, held on 4 August, 2022.(Online)

Dr. Arun Sharma, Scientist received the **"Young scientist Award-2022"** (AAVASILES-2022) for outstanding contribution in Fish health from University of Kashmir, India on 28 September, 2022.

Dr. Neha Wajahat Qureshi, Scientist received with the **International Travel Grant** from Australian Centre for International Agricultural Research for attending Global Symposium on Gender in Aquaculture and Fisheries (GAF8), Kochi during 21-23 November, 2022.

Oral Presentation Awards

Dr. Babitha Rani. A.M, Senior Scientist got **"Best Paper Award"** for Biofloc meal production using bioreactor: Process optimization and use of biofloc meal as a dietary ingredient in rearing GIFT tilapia from National Seminar on Reorienting the Strategies Towards Sustainable Aquaculture and Fisheries organized by Faculty of Fisheries Science, Kerala University of Fisheries and Ocean Studies, Kochi, Kerala on 6-7 January 2022.

Dr. Upasana Sahoo, Scientist got **"Best Paper Presentation"** for Nutritional interventions for reproductive performance of dwarf gourami, *Colisa lalia* (Hamilton, 1822), at International Conference on Advances in Agricultural, Veterinary and Allied Sciences for Improving Livelihood and Environmental Security (AAVASILES-2022), Baramulla, Jammu and Kashmir held on 28-30 September, 2022.

Annual Institutional Awards (Year 2021-22)

Inorder to recognize the significant contributions by the faculty, staff members and students of the institute to reward talent and promote team spirit, provide encouragement and inspiration for improved performances, ICAR-CIFE released annual institutional awards and list of winners are as following in various categories.

S.No	Awards	Awardee Names
1	Best Scientist Award	Dr. Ajit Kumar Verma, Senior Scientist
2	Best Young Scientist	Dr. Saurav Kumar, Scientist
3	Best Extension Scientist	Mr. Dhalong Saih Reang, Scientist
4	Best Young Scientist for Field Oriented Work	Dr. Pankaj Kumar, Scientist
5	Best Division Award	Aquatic Environment & Health Management Division (AEHMD)
6	Best Technical Staff	Mr Prakash Kumar Behera, Technical Officer
7	Best Administrative staff award	Mrs. Anu Grower, UDC
8	Award for Institutional Building	Dr. Annam Pavan Kumar, Senior Scientist
9	Award for overall Best M.F.Sc. Dissertation	Ms. Venisza Cathy John
10	Award for Best Hindi Publication	Dr. Arpita Sharma, Principal Scientist
11	Award for Best School-going Child X	Master Shreyansh Gupta S/o Dr. Subodh Gupta
12	Award for Best School-going Child Xll	Ms. Shruti Gupta D/o Dr. Subodh Gupta
13	Best Supporting Staff	Mr Vinod Kumar Yadav, SSS
14	Best Publication of the Year Award	Dr. Saurav Kumar, Scientist
15	Award for Overall Best Ph.D. Thesis	Dr. Avinash Talukdar

ICAR - Zonal Sports tournament staffs 2022

ICAR-Central Institute of Fisheries Education bagged 18 medals in the ICAR - Zonal tournament held in NRCC Bikaner, Rajasthan between 22-26 November, 2022.

Chief de Mission : Dr. Megha Kadam Bedekar
Manager : Mr. B. L. Kokkula

Medal tally

Men

1. Mr. Kondala Rao	:	Silver- Long jump
2.Mr. Abuthagir Iburahim	:	Bronze -Long jump
3.Mr. Kondala Rao	:	Silver - 100m Running
4.Mr. Kondala Rao	:	Silver- 800 m Running
5. Mr. Abuthagir Iburahim Mr. Suraj Gupta Mr. Ninad Kandalgaonkar Mr. Kondala Rao	:	Bronze - Relay men

Women

Best Women Athlete	**:**	**Dr. Jeena K.**
1. Dr. Jeena K.	:	Gold - 100 m
2. Dr. Jeena K.	:	Gold - 200 m
3. Dr. Jeena K.	:	Gold - Javelin Throw
4. Dr. Jeena K.	:	Gold - Shot Put
5. Ms. Shobha Rawat	:	Gold - 400 m Running
6. Dr. Jeena K.	:	Silver - Long Jump
7. Dr. Jeena K.	:	Silver- Discus
8. Dr. Nalini Poojari	:	Silver- High Jump
9. Mrs. Vidhya. V	:	Silver- Shot Put
10. Ms. Shobha Rawat	:	Bronze- 200 m Running
11. Dr. Megha Bedekar Mrs. Chandrarekha Khundool	:	Silver - Table Tennis
12. Mrs. Swati Koli Mrs. Reshma Raje Ms. Shobha Rawat Dr. Jeena K.	:	Silver - Women's Relay
13. Mrs. Shobha Rawat	:	Bronze- High Jump

Letter of Appreciation

Dr. Babitha Rani. A.M, Senior Scientist, OIC, Rohtak Centre received an Appreciation Letter from National Fisheries Development Board, Hyderabad for handling a technical session on Prospects and problems of high intensive aquaculture during World Fisheries Day celebration at Dhanute, Daman.

डॉ. यल. नरसिम्हा मूर्ति, एआर एस
वरिष्ठ कार्यकारी निदेशक
Dr. L. Narasimha Murthy, ARS
Senior Executive Director

NFDB
राष्ट्रीय मात्स्यिकी विकास बोर्ड
National Fisheries Development Board
मत्स्य पालन विभाग
Department of Fisheries
मत्स्यपालन, पशुपालन एवं डेयरी मंत्रालय, भारत सरकार
Ministry of Fisheries, Animal Husbandry and Dairying, Govt. of India
स्तम्भ संख्या - 235, पी.वी.एन.आर. एक्सप्रेस वे, डाक - एस.वी.पी. एन.पी.ए, हैदराबाद - 500 052
Pillar No. 235, PVNR Expressway, SVP NPA Post, Hyderabad-500 052
फोन/Phone No. 040-24000104, ईमेल/email: senior-ed@nfdb.gov.in;
वेबसाइट/website: nfdb.gov.in

Date:25.11.2022/1643

To

The Director
ICAR- Central Institute of Fisheries Education
Indian Council of Agricultural Research
Panch Marg, Off. Yari Road,
Versova, Andheri (West),
Mumbai 400 061.

Sub : Appreciation Letter for Technical Session-reg.

Sir,

I am writing this letter to show my heartfelt appreciation for your institute's contribution during the technical session on the occasion of World Fisheries Day 2022-Daman on the topic "Prospects and problems of high intensive aquaculture systems viz. RAS, Biofloc, aquaponics, etc." The presentation and discussion helped the farmers/entrepreneur and officials to have a better concept and a clear direction for fisheries development in the country.

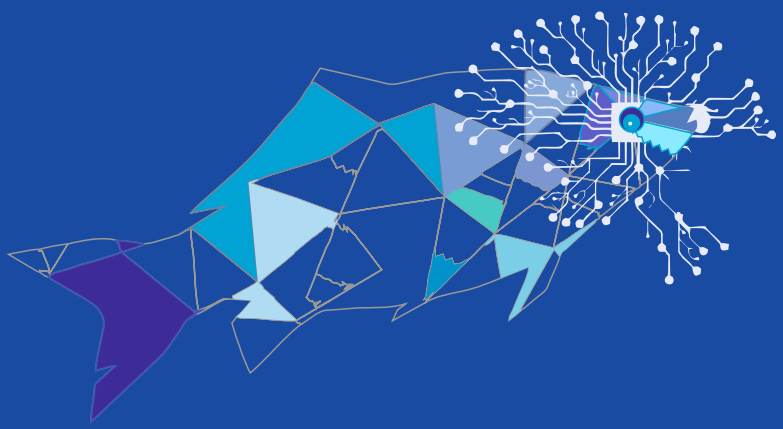
We hope the information disseminated by your organization will help in materializing into reality. The speaker, Dr. Babitha Rani, Senior Scientist of your institute patiently listened to challenges, understood them and mitigated them by providing explanations to farmers/entrepreneurs and officials. We are elated that the lecture brought lots of appreciation to NFDB. We wish you all the best and appreciate your contribution to the fisheries sector in India.

Thanking you.

25/11/22

Dr.L.Narasimha Murthy
Senior Executive Director,
National Fisheries Development Board

08 Linkages and Collaborations



8.1. Linkages

The Institute maintains linkages and collaborations with various national and international institutions and agencies for education, research and development.

Government of India Organizations

- Fishery Survey of India, Mumbai
- Central Institute of Fisheries Nautical and Engineering Training, Kochi
- Marine Products Export Development Authority, Kochi
- Zoological Survey of India, Kolkata
- Indian Institute of Technology, Kharagpur
- Department of Earth Sciences, New Delhi
- Department of Science and Technology, New Delhi
- Department of Biotechnology, New Delhi
- Indian National Center for Ocean Information Services, Hyderabad
- Satellite Application Centre, Ahmedabad
- Bhabha Atomic Research Centre, Mumbai
- Tata Cancer Research Center, Mumbai
- Indian Institute of Foreign Trade, Kolkata
- Tata Institute of Fundamental Research, Mumbai
- Krishi Vigyan Kendra, Banswara, Rajasthan
- Nuclear Power Corporation of India Limited, Mumbai
- National Bank for Agriculture and Rural Development, Mumbai

ICAR Institutes

- ICAR-Central Marine Fisheries Research Institute, Kochi
- ICAR-Central Institute of Brackishwater Aquaculture, Chennai
- ICAR-Central Institute of Freshwater Aquaculture, Bhubaneshwar
- ICAR-Central Inland Fisheries Research Institute, Barrackpore
- ICAR-Central Institute of Fisheries Technology, Kochi
- ICAR-National Bureau of Fish Gentic Resources, Lucknow
- ICAR-Directorate of Coldwater Fisheries Research, Bhimtal
- ICAR - Central Coastal Agricultural Research Institute, Goa
- ICAR Research Complex for Eastern Region, Patna
- ICAR Research Complex for North-Eastern Hill Region, Barapani
- ICAR-Indian Agricultural Research Institute, New Delhi
- ICAR-Central Institute of Agricultural Engineering, Bhopal

CSIR Institutes

- Central Drug Research Institute, Lucknow
- Central Institute of Medicinal and Aromatic Plants, Lucknow
- Central Food Technological Research Institute, Mysore
- National Institute of Oceanography, Goa
- Centre for Cellular and Molecular Biology, Hyderabad
- Institute of Genomics and Integrative Biology, New Delhi
- Indian Institute of Integrative Medicine, Jammu
- Indian Institute of Chemical Biology, Kolkata

International

- University of Idaho, Idaho, USA
- University of Kentucky, Lexington, KY, USA
- Curtin University, Australia

Universities

- Cochin University of Science and Technology, Kochi
- Annamalai University, Chidambaram
- Acharya N. G. Ranga University, Guntur
- B. S. Konkan Krishi Vidyapeeth, Dapoli
- Maharana Pratap University of Agriculture and Technology, Udaipur
- Jawaharlal Nehru University, New Delhi
- Mangalore University, Mangalore
- Bhartiyar University, Coimbatore
- West Bengal University of Animal & Fishery Sciences, Kolkata
- Mumbai University, Mumbai
- Bidhan Chardra Krishi Viswa Vidyalaya, Nadia, West Bengal
- Kalyani University, Kalyani, West Bengal
- Barkatullah University, Bhopal
- Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur
- Chhattisgarh Kamdhenu Vishwavidyalya, Chhattishgarh
- Babasaheb Bhimrao Ambedkar University, Lucknow
- Centre of Agriculture University, Imphal

State Governments

Department of Fisheries of the following states:
Maharashtra, Haryana, Uttar Pradesh, Bihar, Tamil Nadu, Andhra Pradesh,Tripura, Arunachal Pradesh, Madhya Pradesh, Meghalaya, Nagaland, Assam, Manipur, Mizoram, Sikkim, Punjab and Telangana

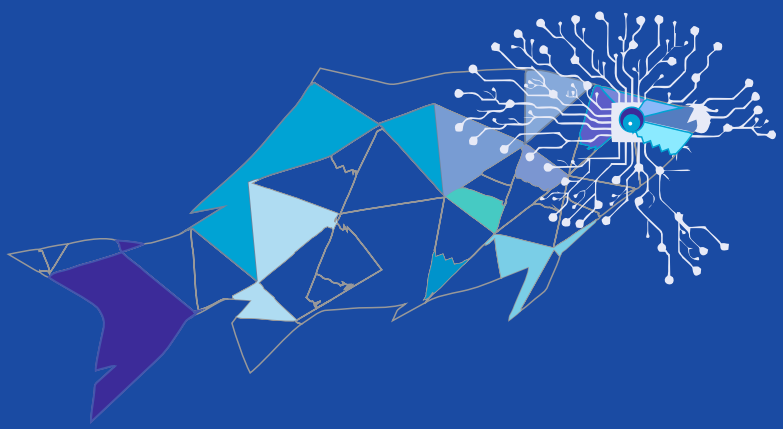
NGOs:

- Yusuf Meherally Centre, Kutch, Gujarat
- United Artists' Association, Ganjam, Odisha

Other Organizations r

- Haryana Kishan Ayog, Chandigarh
- State Institute of Fisheries Technology, Kakinada
- Action Aid International, Port Blair
- M. S. Swaminathan Research Foundation, Chennai
- The Seafood Exporters Association of India, Kolkata
- Nezami Rekha Sea Foods Pvt. Ltd., Kolkata
- IFB Agro Industries Ltd., Aquatic & Marine Products Div., Kolkata
- Shimpo Exports, Kolkata
- Coreline Exports, Kolkata
- Digha Sea Food Exports, Kolkata
- NSZA Sea Food Pvt. Ltd, Kolkata
- Central Calcutta Science and Culture Organization for Youth, Kolkata
- APC Nutrient, Mumbai
- Godrej Agrovet Pvt. Ltd., Vijayawada
- Maharashtra Machimar Kriti Samiti, Mumbai
- Akhil Bhartiya Machimar Sanghatna, Mumbai
- Madhya Pradesh Fish Federation
- CPWD, Bhopal, M.P.
- CPWD, Hoshanagabad, M.P.
- Telecom Department, M.P.
- State Electricity Board, M.P.
- Saguna Baugh Farm, Neral
- Tata Power Co. Mahseer Farm, Lonavla
- Govt. Fish Farm, Khopoli
- Arrey Fish Farm, Mumbai
- Shramajivi Janata Sahayyak Mandal, Mahad, Raigarh, Maharashtra

3.9 Events and Meetings



ICAR-CIFE Awards Distribution Ceremony & International Women's Day

A ceremony was held to distribute the Annual Institute Awards, Director's Appreciation Awards for the years 2019-2020 and 2020-21 on 8 March 2022 on the occasion of International Women's Day. The Student Endowment Awards for the year 2020-21 were also distributed on this occasion. These awards had been announced earlier in an online function held on the occasion of CIFE's Foundation Day, 6 June 2021. The awards were distributed by Dr. Ravishankar C. N., Director & Vice Chancellor, ICAR-CIFE, Mumbai & the Chief Guest of the function Dr. Geetanjali Sachdeva, Director, ICMR-National Institute of Research in Reproductive and Child Health (NIRRH), Mumbai. Dr. Gopal Krishna, former Director, ICAR-CIFE was also present. In her remarks the Chief Guest requested women to take good care of their health in order to lead a personally and professionally fulfilling life. She informed everyone about outreach programs conducted by NIRRH for this purpose. Dr. Ravishankar C. N., congratulated the award winners and hoped that this would motivate others to excel. Dr. Aparna Chaudhari, Chairperson, Staff Institute Awards Committee and Dr. A. K. Verma, Chairperson, Student Endowment Awards Committee organised the function with guidance from Director & V.C., CIFE. The students and staff also organized a cultural program that provided an opportunity to showcase their talent. Dr. Megha Bedekar and Dr. Asha T. Landge supervised the arrangements of the cultural program.

Celebration of 8th International Yoga Day (IDY-2022)

ICAR-Central Institute of Fisheries Education, Mumbai celebrated the 8th International Day of Yoga-2022 (IDY-2022) on 21 June, 2022. Total 134 participants including Head of Departments, Scientists, Technical officers, Administrative staff and students of ICAR-CIFE participated in the Celebration of 8th IDY-2022 on the theme of 'Yoga for Humanity'. Scientists and staff form CMFRI Regional Centre at Mumbai also joined the celebration. Dr. N. S. Nagpure, Nodal Officer, IDY-2022, welcomed the guests and the participants of the program. Dr. N.P. Sahu, Joint Director, ICAR-CIFE, briefed about the importance of the Yoga for physical and mental health. The Program was inaugurated with address by Dr. Ravishankar C.N., Director and Vice Chancellor, ICAR-CIFE, who emphasized on practicing yoga for the benefit of individual and eventually for the entire society and humanity. This was followed by Yoga session by Mrs. Sayali Jadhav, Yoga Guru from Kalyan. The program started with a prayer asper Common Yoga Protocol given by Ministry of AYUSH, Government of India. The instructor explained the importance of yoga to rectify the stress from day-to-day life especially focusing onthe daily routines of working people and students. Brahma Kumari Kreena, Raj Yoga Teacher, from Brahma Kumaris, Vile Parle Branch Mumbai took a session on Raj Yoga. The team of Brahma Kumaris also took session Chakra activation. Prizes to winners of e-poster competition organized on 28th May 2022 for students on theme “Yoga for wellbeing" and essay competition organized on 18th June on theme “Yoga for Youth: An Empowerment tool" were also distributed The program ended with formal vote of thanks by Dr. A. Pavan Kumar, Senior Scientist. The program was coordinated by Dr. N.S. Nagpure, Dr. Megha K. Bedekar, Dr. A. Pavan Kumar and Dr. Nalini Poojary.

ICAR-CIFE, Kolkata Centre

The 8th International Yoga Day was observed with great enthusiasm on 21 June, 2022 at ICAR-CIFE, Kolkata Centre. All the officials, staff members and students participated in the programme. The inauguration session of the programme started am at Committee Room of the Centre. Dr. G. H. Pailan, OIC welcomed all participants and Yoga Guru Mr. Dilip Kumar Das, Medicare Yoga & Physiotherapy Centre, Kestopur. Mr. Das enlightened the audience with a lecture on importance of Yoga in our daily life. The positive effects of yoga on physical, mental and spiritual health were highlighted. After the lecture all participants practice different Asanas for their benefit.

ICAR-CIFE, Powarkheda Centre

The 8th International Yoga Day, 2022, was celebrated at ICAR-Central Institute of Fisheries Education, Powarkheda centre, Madhya Pradesh. The program was attended by 47 participants, including scientists, technical officers, students, farmers and contractual staff. The theme of the program this year is “Yoga for Humanity". The program was started by remembering Yog Guru Patanjali. Discussions on various Asanas were done during the program. Various asanas were practised during the session. The program ended with a vote of thanks by OIC, Powarkheda centre.

ICAR-CIFE, Kakinada Centre

The 8th International Yoga Day, 2022 was observed on 21st June, 2022 at ICAR-CIFE, Kakinada Centre. All the officials, staff members and students participated in the programme. The inauguration session of the programme started at 11.00 AM in the Lecture Hall of the Centre. Dr. Muralidhar P. Ande, Senior Scientist & OIC welcomed all the participants and Yoga Guru Sri Krishna Phanendra. The theme of the program for this year is “Yoga for Humanity”. Yoga Guru Shri. Phanendra practiced various asanas and explained their health benefits to the participants during the session. He also emphasised the positive effects of yoga on physical, mental and spiritual health. The program ended with a formal vote of thanks.

Celebrations of the 75th Independence Day of India

ICAR – Central institute of Fisheries Education celebrated the 75th Independence Day, on 15 August, 2022 with great gaiety, enthusiasm and full participation of students, staff and their family members at the Mumbai Headquarters and five Regional Centres at Kolkata, Kakinada, Powarkheda, Rohtak and Motipur. About 500 people participated in the program. Ghar Tiranga Campaign: The Indian flag was hoisted on all the buildings located in CIFE campuses from the 13 to 16 August 2022. Banners were displayed on the main gates and a standee was prepared for selfies. Students and staff were advised to upload photos with the flags on social media.

Literary competitions: Speech Contest, Self-written Poetry Recitation Contest, Group Song Competition and Drawing Competitions were held for students, staff and staff children keeping Bharat ka Amrit Mahotsav as the theme. The First Prize winners of the Speech Contest and Poetry Recitation spoke in the 15th Aug function.

Independence Day Celebrations: On 15 August, 2022 special caps printed with the 75th Independence Day logo were distributed. Director, CIFE, Dr. Ravishankar C. N. hoisted the Indian national flag and delivered the Independence Day address wherein he recounted the various achievements of India and CIFE in the past, and threw light on needs of the future. The Director distributed prizes for various competitions and. gave flags to children.

Special Cultural Program: Patriotic group songs by staff, children, Ladies' Club of

CIFE, speeches and poems students enlivened the day's celebrations.

Flag Hoisting and Plantation Drive at the CIFE Regional Centres: The flag hoisting ceremony was followed by planting of 75 saplings at each of the five regional centres.

हिन्दी पखवाड़ा -2022

संस्थान में हिन्दी पखवाड़ा -2022 काउद्घाटन 14 सितंबर 2022 को 3.00 बजे सभागृह में आयोजित कियागया। कार्यक्रम का शुभारंभ संयुक्त निदेशक एन.पी.साहू, संयुक्त सचिव श्री राजीव लाल एवं मुख्य तकनीकी अधिकारी श्री प्रताप कुमार दास के कर कमलों से दीप प्रज्ज्वलित कर हुआ।

कार्यक्रम के अध्यक्ष डा.एन.पी.साहू ने अपने उद्बोधन में हिन्दी के बढ़ते कद, प्रसार-प्रचार, बाजार व्यव साय, सिनेमा, साहित्यिक उत्थान, शिक्षा सभी विषयों पर हिन्दी की वर्तमान स्थिति पर प्रकाश डाला। सभा को अवगत कराया कि हिन्दी आज विश्व के 176विश्व विद्यालयों में भाषा एवं साहित्य के रुप में पढ़ाया एवं सिखाया जा रहा है। भारतीय सिनेमा के कुछ चुनिंदा फिल्म भारत से अधिक विदेशों में राजस्व की कमाई किया है। इस से हिन्दी की लोक प्रिय तास मझीजासकती है। आपने आंकड़ों के जरिए हिन्दी के विकास की यात्रा प्रस्तुत की। राजभाषा विभाग द्वारा संचालित पुरस्कार योजना ओंत था हिन्दी टूल्स काभी विस्तार से जानकारी प्रस्तुत की। संस्थान की हिन्दी उपलब्धि यों पर प्रसन्नता व्यक्तकर ते हुआ यह भी सला हदि याकि विगत कई वर्षों से संस्थान को हिन्दी को हिन्दी के क्षेत्र में कोई राष्ट्रीय स्तर का पुरस्कार प्राप्तन हीं हुआ है। अत:इस का र्यहे तु प्रयास कि एजाएं। वैज्ञानिकों से मौलिक हिन्दी पुस्तक लेखन काभी आहवान किया। आप ने जलचरी पत्रिका हेतु ISBN प्राप्त करने काभी उल्लेख किया जिस से वैज्ञानिकों कोइ समें हिन्दी लेख का लाभ मिल सके।

हिन्दी पखवाड़ा के अंतर्गत आशु भाषण, सायंसक्लब के अंतर्गतप्रो. शेर अली, प्रो. लखन ऊवि श्व विद्यालय का"मानव स्वास्थ्य एवं व्यक्ति विशेष उपचार"विषय पर व्याख्यान, निबंध प्रति योगिता, छात्रों हेतु भाषण प्रतियोगिता, स्वर चितगीत एवं कविता पठन प्रतियोगिता, महिलादिवस, शुध्द लेखन प्रतियोगिता, हिन्दी टिप्पण/ आलेखन, बच्चों के लिए चित्रकला प्रतियोगिता, छात्र - छात्रा ओंहेतु लेखन - प्रतियोगिता, प्रश्नोत्तरी प्रतियोगिता आदिका आयोजन किया।

बृहस्पतिवार, दिनांक 29 सितंबर, 2022 को प्रात:11.00 बजे समापन समारोह का आयोजन किया गया।इस अवसर पर निदेशक डा.रवि शंकरसी.एन.के कर-कमलों से सभी विजयी प्रति भागियों को नकद पुरस्कार एवं प्रमाण पत्र वितरित किए गए। इस के बाद मंच पर उपस्थित संयुक्त सचिव श्री राजीव लाल ने विशेष उद्बोधन प्रस्तुत किया। पुरस्कार विजेता ओंको बधाई देते हुए साल भर हिन्दी का प्रयोग, हिन्दी में काम करने की प्रेरणादी। संयुक्त निदेशक डा.एन.पी.साहू ने अपने विशेष उद्बोधन में हिन्दी पुस्तक लेखन, गृहमंत्रा लय एवं परिषद द्वारा संचालित विभिन्न पुरस्कार योजना ओं में भाग लेने की सलाह दी। कर्मचारि यों से हिन्दी का अधिकाधि कप्र योग बढ़ा ने की बातें कही।

कार्यक्रम के अध्यक्ष एवं संस्थान के निदेशक डा.रवि शंकरसी.एन.ने भाषा की महत्ता पर प्रकाश डाल ते हुए राजभाषा हिन्दी के अनुप्रयोग पर बलदिया। आपने समस्त कर्मचारियों से इस संवैधानिकदायित्व के निर्वहन में समुचित योग दानदेने की बात कही।आपने संसदीय राजभाषा समिति के निरीक्षण का संदर्भ देते हुए कहा किह में निर्धारित लक्ष्य (90%)की प्राप्ति हेतु संभव प्रयास करना चाहिए। आपने प्रशासन से जारी किए जानेवाले पत्र/परिपत्र/सूचना/अधिासूचना/धारा3(3)के अंतर्गत सभी कागजात अनिवार्य रुप सेद्वि भाषी मंही जारी किए जाने का निदेशदिया और कहा कि इस में किसी भी प्रकार की नियमों का उल्लंघन नहीं किया जाए।

निदेशक महोदयने प्रतियोगिता ओं में भाग लेने वाले सभी कर्मचारियों एवं छात्र-छात्रा ओंको बधाई दिया। राष्ट्रगान के साथ कार्यक्रम को समाप्त किया गया।

Agripreneurship Orientation Programme

The 'Agripreneurship orientation programme' was conducted at ICAR CIFE, Mumbai on 28 September, 2022. It was organized by ABI, ICAR- CIFE & ICAR-CIRCOT, Mumbai for ABI incubatees and students of CIFE. A totalof 45 participants attended the orientation program. Director & Vice Chancellor Dr. Ravishankar C. N. presided over the function.

The CO-PI CIRCOT-R-ABI Mrs. Prachi Mhatre welcomed the delegates and Dr. B. B. Nayak, HoD& PS, FRHPHM & PI, ABI described the program detailsand the importance of the RAFTAAR support. Mr.Hemant Ladgaonkar, Business Manager, CIRCOT-R-ABI described about RKVY-RAFTAAR scheme of Ministry ofAgriculture and Farmers Welfare and CIRCOT RKVY RAFTAAR-ABI, Mumbaiactivities. Dr. Sheshrao Kautkar, Scientist and CO-PI CIRCOT-R-ABI explain do'sand don'ts & general guidelines for CIRCOT-R-ABI applicants. Dr. A. K. Balange, PS, FRHPHM & Co-PI, ABI presented activities of ABI Centre and technologies available with ICAR-CIFE. Mr. Arvind Ghadge presented his 'water maker model' developed under RAFTAAR Uday scheme. Dr. N. P. Sahu, in his remark stressedmore on entrepreneurship development in fisheries and cited the changing scenariotechnology landscape in India. Dr. Ravishankar C. N. urged the students to develop technologies through their Masters and Ph. D. work and also suggested students to bean entrepreneur and job givers. Dr. B. B. Nayak highlighted about the studentincubation programs in ABI at CIFE, Mumbai. After an interactive session, programme was concluded with the vote of thanks from Dr. A. K. Balange.

Cleanliness Campaign and Swachhta Pakhwada

The institute flagged off the Cleanliness Campaign and Swachhta Pakhwada with Swachhta Pledge and display of banners at its HQ and Centers. The function was organized under the guidance of Dr. Ravishankar C.N., Director, CIFE and overall coordination of Dr. A.K. Verma, Nodal Officer, Swachhta Abhiyan, CIFE. The OICs of CIFE Regional Centers coordinated the activity at their respective centres. The programme on Cleanliness Campaign included several activities spread over 30 days during 02-31 October 2022 and Swachhata Pakhwada Event over 15 days from 16-31 December 2022. A march to the Versova Landing Center and Versova Beach was conducted to create awareness among the people by showing them banners and placards and cleaning up and segregation the plastic waste collected. A Workshop on “Water Management for aquaculture” was organized on the occasion of Kisan Diwas (23.12.2022) and the lectures were delivered on “Zero Water Exchange System in Aquaculture, Role of Feed on Water Management and Conservation, Recirculating Aquaculture System, and Current Status and Future Prospects in Brackishwater Aquaculture” by experts to the farmers from different parts of the country. The school children enjoyed the talk and interacted actively. They showed commitment towards cleanliness and protection of beaches from pollution and also promised to spread awareness. An e-poster-making competition for the CIFE students and a drawing competition for CIFE staff children were organized

on this occasion. Cleanliness drives were conducted in all the Divisions and Sections in addition to laboratories, library, wet laboratory facility and aquaculture hatcheries, boys hostel at the old and new campuses, girls hostel at new campus, canteen and basement, and staff quarters of CIFE. A Sanitation Campaign at surrounding areas of the campus was conducted in the surrounding areas of the Institute. All the staff members from different Divisions and Sections actively participated in cleanliness drives. Necessary steps were taken to initiate the weeding-out of old office files. Since 100% of work is now on e-office, the use of paper and printing is reduced considerably. Students cleaned their workstations, work places and the surroundings. The chemicals and equipment were arranged properly. Discarded plastic items were collected for recycling. Students and children participated enthusiastically. A waste plastic collection drive was organized at CIFE to create awareness about minimizing plastic use and promoting recycling. CIFE conducts such drives on monthly basis. On the final day of the Swachhta Pakhwada, a tree plantation drive was conducted. Flowering and fruit trees were planted by Dr. Ravishankar C.N., Director, Dr. N.P. Sahu, Joint Director, ICAR-CIFE and other scientists and officials. At the Head Quarters, plantation programme was coordinated by Chandrakant M.H., Estate Officer and his team. The plantation was also done at CIFE Centres by the OICs and staff.

Vigilance Awareness Week

Vigilance Awareness Week was observed at ICAR-Central Institute of Fisheries Education from 31 October to 6 November, 2022 on the theme "Corruption free India for a developed Nation". The banners on Vigilance Awareness Week were displayed in front of the Main Gate and the Office building. The Vigilance Awareness week commenced with administration of the integrity pledge to the staff, officials and scientists by Dr. Ravishankar C. N., Director/Vice Chancellor of ICAR-CIFE, Mumbai, followed by his enlightening address on the importance of integrity in the workplace.

In order to celebrate the Vigilance Awareness Week, following competitions were organized for the students and staff. A poster competition on the topic 'Corruption Free India 'was organized for students. A debate competition on the topic 'Corruption and Economy' was organized for students

Essay, poetry and slogan competition was organised for students and staff on the topic 'Integrity-A way of life'.

Post Procurement Review of the NAHEP, 28 February- 4 March 2022 at ICAR-CIFE

The Central Institute of Fisheries Education, Mumbai under the aegis of NAHEP-CAAST, organized the 'Post Procurement Review' meeting during 28 February - 4 March 2022. A total number of sixty-seven participants from 19 universities of west zone attended the review meeting. During inaugural session, Dr. Gopal Krishna, Principal Investigator (PI) of CIFE –NAHEP CAAST welcomed the Director and Vice-Chancellor Dr. Ravishankar, C.N., Joint Director, Dr. N. P. Sahu and Mr. K. K. Singh, procurement consultant, PIU, NAHEP. He presented the brief report and salient achievements made by the CIFE-CAAST. He appreciated the PIU for their guidance and timely help. Dr. Rupam Sharma, Purchase Point Person (PPP), Co-PI & Principal Scientist, ICAR-CIFE, Mumbai briefed the procurement report of CIFE. Mr. K. K. Singh, procurement consultant, PIU, NAHEP requested the University representatives to actively participate in auditing process. Dr. N. P. Sahu, Joint Director & Co-PI, NAHEP, ICAR - CIFE Mumbai mentioned that NAHEP-CAAST has immensely benefited and strengthen the research area 'Inland Saline Aquaculture' and improved the competency of students and faculty through its various capacity building programme. He also mentioned about the pending procurement activity and sending more students and faculties for overseas training.

Dr. Ravishankar C. N., Director/Vice Chancellor, ICAR-CIFE in his presidential address thanked the funding agency and ICAR for creating tremendous opportunities to the students as well as faculty members. He wished if the project extended, it will further benefit the students and faculty. He also complimented Dr Gopal Krishna PI, Co-PIs and all the project staff for their contribution. The inauguration session was concluded with a vote of thanks by Dr. Gayatri Tripathi, Co-PI, NAHEP.

Interaction Meet of CIFE Scientists & Students with DDG (FS), ADG (FS) and Directors of ICAR Fisheries Institutes for Collaborative Research

An interaction meet was held at CIFE Mumbai on Saturday, 28 May, 2022 between scientists and students of the Institute and Dr. J. K. Jena, DDG (FS). Dr. Pravin Puthra, ADG (FS), Dr. Bimal Mohanty ADG (FS) and Directors of all the ICAR Fisheries Institutes, Dr. A. Gopalakrishnan, Director CMFRI, Kochi, Dr. B. K. Das, Director CIFRI, Barrackpore,

Dr. Kuldeep K. Lal, Director NBFGR, Lucknow, Dr. S. K. Swain, Director CIFA, Bhubaneswar, Dr. Leela Edwin, Director CIFT, Kochi, Dr. P. K. Pandey Director DCFR, Bhimtal, Dr. K. P. Jeethendran, Director CIBA, Chennai were attended.

Dr. Ravishankar C. N., Director and Vice Chancellor, welcomed all the dignitaries and spoke about the strengths of ICAR-CIFE, Mumbai (Deemed to be University). Dr. N. P. Sahu, Joint Director CIFE, emphasized the importance of coming together, staying together and working together as a team. All the Directors highlighted the research focus and strengths of respective institutes. Ongoing collaborations between CIFE and the ICAR Fisheries Institutes were presented by Dr. Aparna Chaudhari (PME Cell I/C). Dr. K.V. Rajendran, Dean (Academics) coordinated the interaction of students with the dignitaries. Possible approaches to promote collaborative student research and scientific projects were discussed to impart the best academic experience to students, and to optimally utilize the sophisticated scientific equipment available in the institutes. Dr. J. K. Jena said that it was for the first time that Directors of all the Fisheries Institutes were gathered at one place for discussions. He encouraged everyone to take concrete steps to take the deliberations forward. The meeting ended with a formal vote of thanks by Dr. Rupam Sharma (Boys' Hostel Warden).

Directors Conclave: Energising Pathways for Fisheries Development

ICAR-CIFE, Mumbai, jointly with National Fisheries Development Board (NFDB), brought together Directors and representatives of as many as 25 State/UT DoF on a single platform to discuss developmental challenges and identify actionable strategies. The two-day consultative meeting 'Directors Conclave: Energising Pathways for Fisheries Development' held at ICAR-CIFE during 4-5th November 2022 reignited the leaders and senior executives of the state fisheries departments as well as the R&D community. Calling it a path breaking meeting, Shri Jatindra Nath Swain, Secretary, DoF, GoI who was the Chief Guest on the second day, urged the Directors and their representatives of State Fisheries Departments present to strengthen the extension system and reorient the development support to achieve the ambitious targets set under Pradhan Mantri Matsya Sampada Yojana (PMSSY) by 2025. The summary of the Conclave proceedings is given below.

The two-day meeting was held around three themes namely (i) Professional Development of Human Resources in State Department of Fisheries (DoF); (ii) Strengthening Development Support & PMMSY

Implementation in States; and (iii) Enabling policy and governance framework in States. Dr. Ravishankar C.N., Director / Vice-Chancellor, ICAR-CIFE highlighted the indispensable nature of partnership among research-academia-developmental agencies, and the long history of CIFE working closely with State Departments in building capacities, policy advocacy, and customised R&D support. Dr. J.K Jena, DDG (Fy.), ICAR, Chief Guest on the first day, underscored the key role of R&D in bridging the development gap, showcased the strength of ICAR fisheries institutions, and invited the state DoFs for regular dialogue assuring ICAR's continued support.

Dr. N.P. Sahu, Joint Director, ICAR-CIFE made a lead presentation and set the stage for discussion. Dr. L. Narasimh Murthy briefed about NFDB's recent initiatives to promote biofloc, RAS and ornamental fish units, National Seed Action Plan and the establishment of GIFT tilapia and Pangasius hatcheries, river ranching program, mapping of fisheries cooperatives, etc. Invited experts Dr. Dilip Kumar, Former Director, ICAR-CIFE, Dr. Pravin Putra, Former ADG, (FS), ICAR, and Dr. M. M. Bazaz, Former JD, DoF, J&K, underscored the uniqueness of this meeting wherein CIFE, along with NFDB, has brought together all the heads of state DoF to interact, network and enrich each other's development experience.

Many Directors and Joint Directors of State DoFs namely Mr. Ishwar Singh (Haryana), Dr. Ramacharya (Karnataka), Mr. D.B. Kharwanlang (Megalaya), Mr. Balkrishna Singh (Manipur), Mr. I. A. Shah (Jammu & Kashmir), Mr. Bharat Singh (Madhya Pradesh), Mr. Rongsennungba (Nagaland). Mr. N.S. Rahamani (Uttar Pradesh), Mr. Gurupreet Singh (Punjab), Dr.H. N. Dwivedi (Jharkhand), and Mr. Nishat Ahmad (Bihar), Dr. Ramacharya (Karnataka), Dr. Adeela Abdulla (Kerala), Dr. C.P. Juyal (Rajasthan), Dr. Shamila Monteiro (Goa), Mr. Narayan Singh Nag (Chattisgarh), Mr. M. Raiza (Ladakh) and Mr. Janardhanan (Tamil Nadu) and Mr. Nitin Sangwan (Gujarat) shared their experience and spoke about their expectations. State representatives were made into three parallel focus groups (HRD Group, Extension/PMMSY Group, and Policy Group) to deliberate upon the identified themes, facilitated by the experts and CIFE faculty. The Group identified state representative presented the highlights from each FGD in the joint session and further inputs were taken from other group.

On the second day, Mr. J.N. Swain, Secretary, DoF was the Chief Guest and Dr. J.K. Jena, DDG (Fy.), ICAR was the Guest of Honour. Dr. Ananthan P.S., ICAR-CIFE presented the summary of the first day deliberations under three identified themes in the form of issues and options within the context of present scenario of human resources in state DoF, less than optimal budgetary performance of PMMSY in states, weak extension system, and policy/governance related challenges. Dr. Dilip Kumar called for a rethink on the support/subsidy-driven development to one in which empowering farmers and fishers with

information, training, credit mobilisation and market facilitation gets the centre stage in order to make the sector self-sustaining. Responding to the key issues and challenges identified one by one, Mr. J. N. Swain in his address drew upon his rich swathe of experience in development departments to drive home a central message: the need to strengthen the extension system (what he termed as the 'software' part) in state fisheries departments for effective delivery of development support. Drawing parallels from Bangladesh model of cost-effective development, he stressed upon the advantages of having a generalist village level worker (VLW) for grassroots convergence of developmental efforts. He positively assured the States that many of the PMMSY implementation related challenges will be immediately addressed. Citing Andhra's experience, he urged the states to identify key aggregators and facilitate them in driving the development engine particularly in strengthening cold storage and market infra for fisheries. He desired that states organise exposure visits, with NFDB/DoF support, to sites of success stories for replication across the country, while urging the R&D system to work together with DoFs to identify innovative practices farmers and practices and validate them for larger adoption. He asked CIFE and NFDB to come out with points to be acted upon by the DoF (GoI), respective State DoFs, and CIFE/ICAR. Pleased with the overwhelming participation from states and the quality of interaction, he termed this a 'path breaking' event and expressed the desirability of conducting such meetings annually to share and enrich the development journey.

The meeting was attended by 28 State/UT DoF Directors / their official Representatives from Bihar, Chhattisgarh, Goa, Gujarat, Haryana, J&K, Jharkhand, Karnataka, Kerala, Ladakh, Madhya Pradesh, Maharashtra, Manipur, Meghalaya, Mizoram, Nagaland, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh. In addition, Senior Officers from NFDB, representatives from FSI, two industry representatives, three invited experts, and 42 Scientists from ICAR-CIFE and ICAR-CMFRI Mumbai Centre also attended the meeting. The technical program was coordinated by Dr. Ananthan P.S., Dr. Neha Qureshi, Dr. Shivaji Argade, Dr. N. Shamna, Dr. Saurav Kumar, Dr. Kapil Sukdhane and Mr. Abuthagir I.S. The meeting ended with a formal vote of thanks by the Joint Director, CIFE.

भा.कृ.अनु.प.-केन्द्रीय मात्स्यिकी शिक्षा संस्थान, मुंबई का वार्षिक हिन्दी प्रतिवेदन - 2022

शैक्षणिक हिन्दी जलवाणी पाठयक्रम – संस्थान में स्नातकोत्तर (एम.एफ.एस.सी.) सत्र 2021-2023 के प्रथम वर्ष के छात्र हेतु हिन्दी जलवाणी HB-501 की कक्षाएं नियमित रुप से संचालित की गई।

राजभाषा कार्यान्वयन समिति की बैठक का आयोजन

संस्थान की राजभाषा कार्यान्वयन समिति की 99 वीं, 100 वीं, विशेष बैठक एवं 101 वीं बैठक दिनांक 17 मार्च, 2022, 11 अप्रैल, 2022, 13 जुलाई, 2022, 14 नवम्बर, 2022 को निदेशक डा. रविशंकर सी. एन. की अध्यक्षता में संपन्न हुई।बैठक में लिए गए निर्णयों परअनुवर्ती कार्रवाई की गई।

हिन्दी कार्यशाला का आयोजन

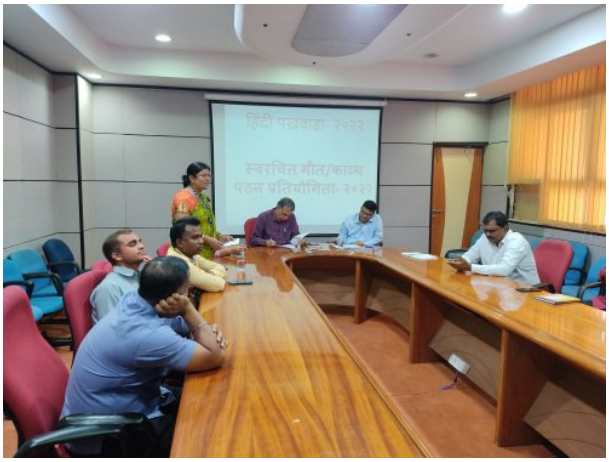
संस्थान मुख्यालय एवं उपकेन्द्रों के वैज्ञानिकों, तकनीकी एवं प्रशासनिक कर्मचारियों हेतु दिनांक 26 मार्च, 2022, 28 जून, 2022 को क्रमश: राजभाषा नीति, कार्यान्वयन एवं दायित्वतथा यूनिकोड विषय पर ऑनलाइन कार्यशाला आयोजित की गई।

पारंगत प्रशिक्षण पाठयक्रम

हिन्दी शिक्षण योजना, क्षेत्रीय कार्यालय, मुंबई द्वारा संस्थान के अधिकारियों / कर्मचारियों हेतु ऑनलाइन पारंगत पाठयक्रम के दोसत्रों काआयोजन किया गया जिस के अंतिम परीक्षा मेंसमस्तपरिक्षणार्थीउत्तीर्णहुए।

नगर राजभाषा कार्यान्वयन समिति

नगर राजभाषा कार्यान्वयन समिति, उत्तर मुंबई के अध्यक्षीय कार्यालयनौ वहन महानिदेशालय एवं अवर सचिव भारत सरकार की अध्यक्षता में 17 जून, 2022 एवं 23 दिसंबर, 2022 की छमा ही



बैठक में संस्थान के निदेशक डा.रविशंकर सी.एन. एवं मुख्य तकनीकी अधिकारी श्री प्रताप कुमार दास ने भागलिया।
इसी के साथ, नराकास द्वारा दिनांक 25 मई, 2022 को आयोजित कार्यशाला में मुख्य तकनीकी अधिकारी पी.के.दास एवं श्रीमती रेखा नायर ने भाग लिया।

हिन्दी पखवाड़ा का आयोजन

संस्थान में दिनांक 14 से 29 सितम्बर, 2022 तक हिन्दी पखवाड़ा आयोजित कियागया। इस के अंतर्गत विभिन्न प्रतियोगिता ओं एवं कार्यक्रमों का आयोजन किया गया तथा विजयी प्रति भागियों को नकद पुरस्कार एवं प्रमाण पत्र से सम्मानित किया गया।

संगोष्ठी में प्रतिनिधित्व एवं लेख प्रस्तुति

संस्थान के मुख्य तकनीकी अधिकारी श्री प्रताप कुमार दास नेदिनांक 7-8 मार्च, 2022 को जबल पुर में परिषद एवं खरपत वार अनुसंधान संस्थान के संयुक्त तत्वावधान में आजा दी के अमृतम होत्सव एवं राजभाषा हिन्दी विषय पर आयो जित संगोष्ठी में भाग लिया।

दिनांक 13-14 सितम्बर, 2022 को सूरत में आयोजित राजभाषा सम्मेलन में श्रीमती रेखा नायर, सहायक मु.तक.अधिकारी ने भाग लिया । इस कार्यक्रम का उद्घाटन केन्द्रीय गृहमंत्री श्री अमित शाह के कर–कमलों से किया गया।

श्री प्रताप कुमार दास, मुख्य तक.अधिकारी द्वारा प्रस्तुत लेख्स आत्मनिर्भर भारत, परिषद की वार्षि का पत्रिका 'राजभाषा आलोक' में प्रकाशित की गई।

संसदीय राजभाषा समिति निरीक्षण

माननीय संसदीय राजभाषा समिति द्वारा संस्थान का 17 जनवरी, 2023 को निरीक्षण किया गया। इस निरीक्षण हेतु 'निरीक्षण प्रश्नावली' को भरकर 28 दिसंबर, 2022 को संसदीय राजभाषा सविचालय में जमा किया गया।

ICAR-CIFE HQ & Centres

Kolkata Centre

32, G. N. Block, Sector-V,
Salt Lake City, Kolkata,
West Bengal – 700 091
kolkata@cife.edu.in
Ph.: 033 - 2357 3893
Fax: +91 033-2357 5269

Kakinada Centre

Near Old Burma Shell,
Beach Road,
Kakinada, Andhra Pradesh
Pin 533 007
kakinada@cife.edu.in
Ph.: 0884-2376746
Fax: +91 0884-2373602

Rohtak Centre

Lahli, Via Anawal,
Rohtak – 124 411, Haryana
rohtak@cife.edu.in
Ph.: 01258 – 253595 / 253506
Fax: +91 01258-253506

Powarkheda Centre

Powarkheda, Dist. Hoshangabad,
Madhya Pradesh- 461 110
powarkheda@cife.edu.in
Ph.: 07574-227280
Fax: +917574 227208

Motipur Centre

C/o Regional Centre of Indian Institute
of Sugarcane Research
Motipur, Distt. Muzaffarapur, Bihar
Pin 843 111,
motipur@cife.edu.edu.in
Ph.: 9004864708

ICAR-CENTRAL INSTITUTE OF FISHERIES EDUCATION
(University under Sec.3 UGC Act, 1956)
Indian Council of Agricultural Research
Panch Marg, Off Yari Road,
Mumbai - 400 061
+91 22 263636404 / 26374306
www.cife.edu.in