OVERVIEW OF ICAR-CENTRAL MARINE FISHERIES RESEARCH INSTITUTE

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The ICAR-Central Marine Fisheries Research Institute (CMFRI), a globally renowned fisheries research organization, marked a momentous occasion in 2022 as it celebrated its 75th year of impactful research in the realm of marine fisheries. Originating as a marine fisheries research station on February 3rd, 1947, in Madras, presently Chennai, it became an integral part of the Indian Council of Agricultural Research (ICAR) in 1967. Transforming into a premier research establishment, CMFRI has been at the forefront of marine fisheries research in India. The institute's headquarters transitioned from Mandapam, Tamil Nadu, to its current location at Kochi, in Kerala in 1972. CMFRI stands as the leading marine fisheries research institute in India, contributing significantly to the foundation of tropical marine fisheries research in the region. Its influence extends beyond national borders, as it plays a pivotal role in providing valuable services and counsel to policy planners and developmental agencies not only within the country but also to nations around the Indian Ocean Rim. At the heart of CMFRI's mission is the commitment to advancing marine fisheries research, thereby shaping policies and strategies for sustainable development. The institute's mandate encompasses a wide spectrum of responsibilities, reflecting its dedication to promoting the welfare of marine ecosystems and the communities dependent on them. The vision, mission and mandate of CMFRI are the following.

Vision

Sustainable marine fisheries through management interventions and enhanced coastal fish production through mariculture for improved coastal livelihood.

Mission

To develop an information-based management system for changing over from open access to a regulated regime in marine fisheries, augment coastal fish production through mariculture and sea ranching and restore critical marine habitats

Mandate

- Monitor and assess the marine fisheries resources of the Exclusive Economic Zone (EEZ) including
- the impact of climate and anthropogenic activity and develop sustainable fishery management plans.
- Basic and strategic research in mariculture to enhance production.
- Act as a repository of geospatial information on marine fishery resources and habitats.
- Consultancy services; and human resource development through training, education and extension.

From the estimation of India's marine fish landings, CMFRI's research activities span diverse niche areas, including sea farming, coastal mariculture, the development of hatchery technologies for commercially

viable marine fish species, cage farming, biotechnological applications of marine resources, biodiversity studies, climate change impact assessment, marine products and bioactive compounds, and the creation of sustainable ecosystem management interventions. The institute is also actively engaged in policy studies and other related fields. In addition to its headquarters in Kochi, Kerala, CMFRI operates 11 Regional Research Centres situated at Mandapam Camp, Visakhapatnam, Veraval, Mumbai, Chennai, Calicut, Karwar, Tuticorin, Vizhinjam, Mangalore, and Digha. Furthermore, there are fifteen field centres, strategically positioned along the coastal belts of the country, along with two Krishi Vigyan Kendras at Narakkal, Ernakulum and Kavaratti, Lakshadweep. CMFRI boasts a dedicated team comprising 154 scientists, more than 100 PhD scholars, and over 600 other staff members spread across six research divisions. CMFRI's approach is inherently community-focused, with a particular emphasis on the fishing community in the country. The institute consistently strives for coordinated, demand-driven research, aligning its efforts with the needs and priorities of the fishermen community to ensure meaningful and impactful outcomes.

Major achievements and contributions

Fisheries management

CMFRI has achieved significant milestones, encompassing the compilation of fish landing statistics, the estimation of fishing fleets, and the formulation of recommendations. The institute has conducted marine fisheries censuses, tracked resources, and played a pivotal role in shaping harvest policies. CMFRI has made significant strides in advancing fisheries research through the development of a stratified multistage random sampling design tailored for estimating multispecies and multi-gear marine fish landings. This innovative approach has been incorporated into a comprehensive landing data collection and estimation program, implemented collaboratively with states including Kerala, Andaman and Nicobar Islands, Maharashtra, Tamil Nadu, and Karnataka. The institute has not only devised but also applied numerous analytical models, leading to the successful completion of stock assessments for 52 marine fish stocks. Furthermore, CMFRI has conducted a stock assessment of almost all species in its marine territorial waters, revealing that an impressive 92% of these stocks are sustainably fished. In a proactive move to streamline wild-caught seafood exports to the USA, where approximately 40% of Indian seafood is exported, CMFRI conducted a comprehensive marine mammal stock assessment within the Indian Exclusive Economic Zone (EEZ). The institute has also played a crucial role in formulating Fishery Management Plans, issuing advisories on seasonal fishing bans, and estimating potential yields to ensure sustainable practices. Recognizing the need for conservation, CMFRI has proposed Minimum Legal Sizes for commercially exploited marine finfish and shellfish resources in six maritime states. This initiative aims to safeguard the reproductive potential of the species and maintain ecological balance. The institute has been instrumental in notifying specific species under legal protection, including 58 in Kerala (notified in 2015 and 2017), 72 in Karnataka (with 19 species notified in 2019), 61 in Andhra Pradesh, 113 in Tamil Nadu, 58 in Maharashtra, and 45 in Gujarat. These conservation efforts underscore CMFRI's commitment to the long-term health and sustainability of marine ecosystems across the Indian coastline.

Marine aquaculture (Mariculture)

CMFRI has been at the forefront of aquaculture innovation, contributing significantly to the development of hatchery technologies for various species, including cobia, pompano, grouper, sea bream, shrimps, pearl oysters, edible oysters, mussels, clams, and ornamental fishes, totalling an impressive 37 species. The institute's pioneering efforts have not only resulted in technological advancements but have also translated into practical applications, benefitting both the industry and local communities. One of CMFRI's

major achievements lies in the popularization of cage farming technology in India. With the institute's technical support, more than 3,500 cages have been established, boasting a substantial production potential of 10,000 tonnes of harvested fish. This technology has proven to be economically viable, providing a boost to the aquaculture sector. CMFRI's expertise extends to the identification and mapping of potential cage farming sites along the Indian coastline, totalling 131 sites and covering 46,824 hectares. The calculated production potential of 2.11 million tonnes underscores the scale and impact of the institute's contributions to the aquaculture industry. The institute has also played a pivotal role in the establishment of commercial farming of mussels and oysters in coastal areas, yielding over 10,000 tonnes annually. This initiative has not only been economically beneficial but has empowered nearly 6,000 women self-help groups, providing a substantial increase in income. In the realm of aquaculture technology, CMFRI has developed the Integrated Multi-Trophic Aquaculture (IMTA) technology, combining the cultivation of cobia with seaweed. This innovative approach has resulted in a 56% increase in seaweed yield, demonstrating the institute's commitment to sustainable and integrated aquaculture practices. The identification of 317 potential seaweed farming sites covering 23,950 hectares using GIS-based models showcases CMFRI's forward-thinking approach. The calculated seaweed production potential of 9.58 million tonnes further emphasizes the institute's role in shaping the future of aquaculture. CMFRI's National Broodbank Facility for Cobia and Silver Pompano, with 33 million and 24 million yolk sac larvae respectively, underscores the institute's dedication to expanding mariculture in the country. Collaborations through MoUs with eight hatcheries and the Ananda Group demonstrate the institute's commitment to knowledge sharing and industry partnerships. The design and development of a Recirculatory Aquaculture System (RAS) for broodstock development and year-round spawning of marine finfishes, with a capacity of 100 tonnes and a cost of Rs. 13 lakhs, exemplify CMFRI's commitment to advancing sustainable aquaculture practices.

Marine biotechnology

CMFRI has achieved remarkable milestones in the realm of nutraceuticals, having developed and commercialized a diverse range of 12 nutraceuticals, with 11 derived from seaweeds and one from green mussels. These nutraceuticals play a crucial role in promoting human well-being and addressing lifestyle diseases such as diabetes, hypothyroidism, arthritis, obesity, hypertension, osteoporosis, and non-alcoholic liver disease (NALD). The market share of CMFRI nutraceuticals in the Indian market stands at an impressive 5%, highlighting their growing influence and acceptance among consumers. In addition to advancements in nutraceuticals, CMFRI has undertaken groundbreaking genetic research, including the identification of genetic stock structures of marine fin and shellfish species. The institute has conducted whole genome sequencing for the Indian Oil Sardine and the Green Mussel, providing valuable insights into the genetic makeup of these species. Furthermore, CMFRI has successfully mapped the complete mitogenome of 12 marine fishes, contributing to a deeper understanding of their genetic diversity. The institute's commitment to sustainable aquaculture is evident in its efforts to enhance marine finfish larvae and rotifer nutrition through the mass production of 12 copepods and *Nannochloropsis oculata* paste. This development serves as a crucial feed source for marine finfish larvae, showcasing CMFRI's dedication to supporting the aquaculture industry. Additionally, CMFRI has explored innovative solutions like utilizing Black Soldier Fly Larvae (BSFL) as a fish feed ingredient, showcasing a holistic approach to waste valorization and sustainable fish farming practices. Recognizing the importance of aquatic health, CMFRI has conducted comprehensive pathogen profiling in finfish and shellfish. This has led to the development of fish and aquatic health management protocols, additives, and diagnostic kits. These advancements contribute significantly to the prevention and management of diseases in aquatic organisms, ensuring the health and sustainability of

aquatic ecosystems. CMFRI's multifaceted research endeavours underscore its pivotal role in shaping the landscape of nutraceuticals, genetic research, and sustainable aquaculture practices in India.

Environment, climate and biodiversity

CMFRI has undertaken pioneering initiatives in marine research and conservation, exemplified by the successful sea-ranching of *Penaeus semisulcatus*, with an impressive production of 4.5 million post-larvae annually in Palk Bay and the Gulf of Mannar since 2016. This initiative has resulted in a significant 16-17% increase in shrimp catch from these regions, underlining the positive impact of sustainable practices on fisheries. In the realm of biodiversity, CMFRI has made substantial contributions by discovering a total of 243 species new to science across various taxa from 1947 to 2021. This extensive exploration reflects the institute's commitment to expanding our understanding of marine ecosystems. CMFRI's dedication to habitat restoration is evident in the development of protocols for artificial reef deployment and the facilitation of fabrication and installation of artificial fish habitat (AFH) modules in states such as Kerala, Tamil Nadu, Andhra Pradesh, and Gujarat. These efforts contribute to the preservation of marine environments and the enhancement of fishery resources. Vessel-based surveys have been instrumental in identifying and mapping new and non-conventional deep-sea marine resources. This includes the creation of abundance maps for oceanic squid resources, revealing a substantial potential of 6.3 lakh metric tonnes. Such mapping initiatives are essential for sustainable resource management and conservation. CMFRI has also delved into the societal impact of climate change, conducting studies on coastal village vulnerability assessment and producing vulnerability maps for eight districts across different coastal states. The institute has pioneered the concept of "Climate Smart Villages" and developed adoption strategies, providing a holistic approach to mitigating the impact of climate change on coastal communities. The Marine Litter Atlas is a testament to CMFRI's commitment to addressing environmental challenges. In the domain of sustainability, CMFRI conducted a Life Cycle Analysis (LCA) that revealed that Indian marine fisheries contribute to carbon and CO_2 emissions that are 17.5% lower than global estimates. This showcases the institute's dedication to sustainable practices and environmental responsibility. Lastly, CMFRI has played a crucial role in forecasting the catch of Indian oil sardines and modelling the impact of climate change on selected 29 marine fish species. These predictive models provide valuable insights for fisheries management and conservation efforts, ensuring a balanced and resilient marine ecosystem in the face of ongoing environmental changes.

Policy and outreach

CMFRI has demonstrated proactive engagement in policy development, playing a crucial role in shaping the regulatory landscape for mariculture. The institute has played a pivotal role in formulating the Draft National Mariculture Policy 2019 for the Department of Fisheries, Government of India, and provided valuable guidelines for Open Sea Cage Farming for the National Fisheries Development Board (NFDB). CMFRI in collaboration with the National Academy of Agricultural Sciences (NAAS) developed a policy document "Seaweed Culture and Utilization" in 2003. CMFRI's commitment to industry standards is evident in its contributions to Good Management Practices (GMP) and Standards for the Bureau of Indian Standards. These multifaceted policy contributions underscore CMFRI's pivotal role in advancing the aquaculture sector, promoting economic prosperity, environmental sustainability, and food security. Notably, the institute's impact is recognized globally, with its documents vetted or recommended by esteemed organizations such as FAO, BOBP, BOBLME, IOTC, SAARC, MSC, Commonwealth, and the AARDO member nations. CMFRI's commitment to knowledge dissemination is integral, as it actively imparts training at

both national and international levels, reinforcing its status as a leading authority in fisheries research and development.

Recognitions

CMFRI and its esteemed staff members have garnered a remarkable array of accolades, showcasing their commitment to excellence in fisheries research. The institute has been honoured with prestigious awards such as the Sardar Patel Outstanding ICAR Institution Award, and its Scientists have won the Norman Borlaug Award, the Rafi Ahmed Kidwai Award, and the Lal Bahadur Shastri Young Scientist Award, reflecting its institutional and individual contributions to the field. Additionally, CMFRI staff members have excelled, receiving recognition through awards like the Jawaharlal Nehru Award for Doctoral Thesis, NAAS Fellowship, and NAAS Young Scientist Award. The institute's commendable achievements extend to five Rajarshi Tandon Awards, two Indira Gandhi Rajbhasha Awards, and one Rashtriya Gaurav Award from the Government of India. CMFRI's commitment to transparency and communication is evident in its two Best Annual Report Awards. Moreover, the institute has amassed an impressive count of 53 other National Awards, solidifying its position as a leader in fisheries research and development. These accolades not only highlight the dedication of CMFRI but also underscore the significant impact it has made on a national scale.

Future interests

Our future interests and plans include promoting species diversification, large cages, and fostering entrepreneurship for heightened mariculture production. To boost growth rates, CMFRI will concentrate on genomic selection and selective breeding for finfish, shellfish, and seaweeds. Addressing gaps in knowledge related to deep-sea and unconventional resources will be a priority, with the development of suitable fishing systems on the agenda. The emphasis on responsible and sustainable fishing practices will persist, aiming for the long-term preservation of marine resources. CMFRI is gearing up to develop models for multi-species stock assessment based on the Ecosystem Approach to Fisheries Management (EAFM), customized for tropical contexts. Our research will extend to understanding the impact of climate change and extreme events, guiding the formulation of adaptive strategies. We will actively promote the use of indigenous, cost-effective feeds, diagnostics, and health supplements. Our future initiatives will include comprehensive market intelligence and gender mainstreaming research to inclusively expand the domestic market. Furthermore, we are set to explore technology for in-vitro fish meat production and investigate vegetarian alternatives to fish oils, utilizing microalgae as a sustainable source of polyunsaturated fatty acids (PUFA) for human consumption. Through these upcoming endeavors, CMFRI aims to make significant contributions to the sustainability, productivity, and inclusivity of marine fisheries and mariculture in India.