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Inside...

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CONTENTS

ADVERTISERS' INDEX

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Ratan Tata believed that businesses should not only serve shareholders, but also the society at large

ICAR-World Fish collaborative project meeting held

Sea cucumber is a soft-bodied marine echinoderm, related to starfish and sea urchin. They are known for their delicious dietary value and medicinal uses, especially in Asian cuisine. In recent years, this animal is facing various threats, including illegal trade, over exploitation, habitat destruction, climate change etc. Conservation efforts are need of the hour to avoid depletion and ensure sustainable management of this scheduled species population.

Dear Readers,

The November 2024 issue of Aqua International is in your hands. In the news section, you may find news about....

The world mourned the loss of Ratan Tata, Chairman of Tata Group and Tata Sons, an iconic business leader who shaped India's corporate landscape and left an indelible legacy through his transformative leadership at Tata Group. Born on December 28, 1937, Ratan Tata's journey from the shop floors of Tata Steel to becoming Chairman of Tata Sons is a story of vision, ethical leadership and an unrelenting commitment to societal progress.

Ratan Tata was born into the Tata family, inheriting a legacy of leadership and industrialism. Educated at Cornell University and Harvard Business School, his initial foray into business began humbly. This early exposure gave him a deep understanding of the company, helping him later steer Tata Group during critical junctures.

Beyond business success, Ratan Tata was always focused on using innovation for social good. Ratan Tata was equally dedicated to improving society through philanthropy. Ratan Tata himself believed that businesses should not only serve shareholders but also the community at large.

Throughout his life, Ratan Tata was known for his commitment to ethical leadership. He firmly believed that business should be conducted with transparency, integrity and a focus on societal welfare. Under his leadership, Tata Group became

Ratan Tata

a beacon of corporate governance and ethical business practices. He upheld the principle that companies must be socially responsible, a sentiment reflected in the group's approach to corporate social responsibility (CSR).

His belief in young entrepreneurs and his willingness to support their ventures showcased his forward-thinking mindset, even after stepping down from the daily operations of Tata Group.

Ratan Tata's life is a story of humility, leadership and vision. He received numerous accolades, including the Padma Vibhushan, India's second-highest civilian honour. Yet, despite his towering achievements, Ratan Tata remained down-to-earth, always accessible to those who sought his wisdom.

His life was dedicated not just to building a global conglomerate but to creating an ecosystem where businesses thrive on values and ethics. From global acquisitions that changed the face of Indian business to his unparalleled contributions to society, Ratan Tata's legacy will continue to inspire future generations of business leaders. His impact, both on India and the world, will be remembered as one of excellence, compassion and visionary leadership.

We will miss u Ratan Tata Sir. For the kind of life he lead and for the contributions he made to the Indian society, Ratan Tata may be considered as Bharat Ratna.

Contd on next page

NRS GROUP

Aqua International

Our Mission

Aqua International will strive to be the reliable source of information to aquaculture industry in India.

AI will give its opinion and suggest the industry what is needed in the interest of the stakeholders of the industry.

AI will strive to be The Forum to the Stakeholders of the industry for development and self-regulation.

AI will recognize the efforts and contribution of individuals, institutions and organizations for the development of aquaculture industry in the country through annual Awards presentation.

AI will strive to maintain quality and standards at all times.

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Send a letter: *Letters to the Editor must include writer's full name, address and personal telephone and mobile numbers. Letters may be edited for the purposes of clarity and space. Letters should be addressed to the Editor:*

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Aqua International organised its 40th edition of Aquaculture Expo 2024 on 27 – 28 September 2024 at Bhimavaram, Andhra Pradesh. West Godavari District Collector Ms Chadalavada Nagarani, Undi MLA, Raghurama Krishnam Raju and Former Member of Parliament, B. Masthan Rao said that they will work for the development of aquaculture farmers. This kind of events will help farmers to know latest techniques and knowledge to get better productivity in farming. Andhra Pradesh Government is ready to support aquaculture farmers and the govt is preparing plans to provide subsidy on electricity and other aspects. The industry is totally depending on Shrimp exports which is not a wise thing. There is a need of promoting domestic shrimp consumption to safeguard the industry and the farmers.

World Fish collaborative project meeting (ICAR-Window 3) was organised at ICAR-Central Inland Fisheries Research Institute, Barrackpore, from 22 - 24 October 2024. The meeting aimed to review the work done under the ongoing ICAR-W3—World Fish Collaborative project and also to discuss the potential for future collaborations and explore scientific and management interventions specific to inland fisheries. Dr Jörn Schmidt, Director, Sustainable Aquatic Food Systems, World Fish, Malaysia; Dr Arun Padiyar, World Fish Lead, India, Dr Sourabh Kumar Dubey, World Fish, and a multidisciplinary team of scientists & scholars from ICAR-CIFRI attended the meeting. Dr B. K. Das, Director, ICAR-CIFRI, emphasized new research initiatives, achievements, outreach programs, technologies and products developed, high-impact publications and infrastructure improvements. He also highlighted the institute's strong performance during both the previous and current phases of the ICAR-World Fish collaboration.

The 3-day online collaborative training programme on 'Excellence in Pearl Culture Techniques' was organized jointly by College of Fisheries Science, Chaudhary Charan Singh Haryana Agricultural University (CCS HAU), Hisar, Haryana and National Institute of Agricultural Extension Management (MANAGE), Hyderabad, Telangana during 14- 16 October 2024. The iECHO platform was used for this online programme, participants initially registered themselves on the iECHO platform.

West Bengal Fisheries Department undertakes Abhoy Pukur (Fish Sanctuary) scheme. Inland (freshwater and brackishwater) fishes in West Bengal, both cultivable and non-cultivable naturally-occurring ones, are important in the sense that they bring about food production with high nutritive value, *viz*., superior quality animal protein, minerals, micro-nutrients, omega-3 fatty acids; eradication of malnutrition in rural areas *via* consumption of locally-available less-costly fishes; sustainable income and employment generation *via* pisciculture in rural and sub-urban areas for aquapreneurs and rural youths.

Optima Life Sciences Pvt Ltd inaugurated new State-of-the-Art manufacturing facility in Jejuri, Pune, a land mark achievement that underscores their commitment to innovation, quality and community engagement in the animal sector. The company's Executive Chairman Mr Vinay Kwulkarni said that this facility represents a significant investment in their operational capabilities allowing them to scale manufacturing processes to meet the increasing demand for their products.

In the Articles section, **Promoting Scientific Fish Farming Practices in Kandhamal District: An initiative of ICAR-CIFA,** authored by SushreeSangitaRath, S. K. Mohanty, S. N. Sethi, D. P. Rath, S. K. Behera, T. K. Rout, K. Mohanty and H. K. De, stated that in Kandhamal district, Odisha, where challenging geographical and climatic conditions prevail, the ICAR-Central Institute of Freshwater Aquaculture (ICAR-CIFA) has launched a transformative initiative aimed at improving fish farming practices among Scheduled Caste (SC) communities. Funded under the Scheduled Caste Sub-Plan (SCSP) and the Department of Science and Technology (DST, Govt. of India), the program focuses on introducing scientific methods in aquaculture, particularly composite carp culture. This article explores the program's approach, methodologies, and the resulting enhancements in fish production and economic outcomes for SC fish farmers and farmwomen in the region.

The adoption of composite carp culture along with the provision of essential resources and training, has led to substantial gains in productivity, profitability and resilience within the community. The success of the program underscores the potential for replicating this model in other regions with underutilized water resources. Ongoing support, careful resource management, and continuous guidance is essential to ensure the sustainability of these gains.

Another Article titled **Turning Waste into Wealth: Sustainable Aquaculture Feeds from Industrial Food Waste,** authored by ShaikIrshad Ali, discussed that due to depletion fish stock and increased demand for fish meal has resulted in the search of alternate protein sources such as rapeseed meal, sunflower meal, palm kernel meal etc. These alternatives, derived from waste streams, offer a cost-effective and environmentally friendly solution, aligning with circular economy principles and the United Nations' Sustainable Development Goals.The future research should focus on achieving 100% fish meal substitution with a focus on optimizing feed quality, palatability and cost-effectiveness.

The cost of feed production can be effectively reduced by using alternative protein sources in place of fish meal. In future, studies should aim to 100% replacement of fish meals. Research studies should be conducted on the risk of consumption of waste-fed fishes (Sampathkumar, K et al. 2023). A consistent supply of fish feed is required to ensure food security. The use of food waste as a protein source minimizes the need to rely on traditional protein sources. Research is urgently needed to address knowledge gaps on food waste use and processing. Renewing standards and regulations in a timely manner will also assist the sector advance towards using waste materials in fish feed.

Another Article titled **An Insight about Sea Cucumbers - Special focus from Lakshadweep**, authoredby Abhilash C. P., Charan Ravi, T.T. Ajith Kumar and U.K. Sarkar, discussed that Sea Cucumber is a soft-bodied marine echinoderm, related to starfish and sea urchin. They are known for their delicious dietary value and medicinal uses, especially in Asian cuisine. Cucumbers play a vital role in marine ecosystems as key sediment bioturbators. In recent years, this animal is facing various threats, including illegal trade over exploitation, habitat destruction, climate change etc. Conservation efforts are need of the hour to avoid depletion and ensure sustainable management of this scheduled species population. Lakshadweep, an Indian coral paradise is housing 21 species of cucumbers.

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ICAR-World Fish collaborative project meeting organised

22nd – 24th October 2024, Barrackpore: ICAR – World Fish collaborative project meeting (ICAR-Window 3) was organised at ICAR-Central Inland Fisheries Research Institute, Barrackpore, from 22 - 24 October 2024. The meeting aimed to review the work done under the ongoing ICAR-W3—World Fish Collaborative project and also to discuss the potential for future collaborations and explore scientific and management interventions specific to inland fisheries.

Dr Jörn Schmidt, Director, Sustainable Aquatic Food Systems, WorldFish, Malaysia; Dr Arun Padiyar, World Fish Lead, India, Dr Sourabh Kumar Dubey, World Fish, and a multidisciplinary team of scientists & scholars from ICAR-CIFRI attended the meeting.

Dr B. K. Das, Director, ICAR-CIFRI, emphasized new research initiatives, achievements, outreach programs, technologies and products developed, high-impact publications, and infrastructure improvements. He also highlighted the institute's strong performance during both the previous and current phases of the ICAR-World Fish collaboration.

Dr Padiyar urged the scientists of the Institute to play a pivotal role in providing technical guidance and management plans in the context of increasing focus on inland fisheries for production enhancement and to prioritize the research activities in the context of emerging challenges.

On the second day, the team visited the ongoing project site at Chamta Wetland in North-24-Parganas, West Bengal. They observed the harvesting of Ompok pabda from the HDPE-Pen system, attended by Dr Schmidt, followed by an interactive meeting with stakeholders.

The future work plan for the project was discussed during the programme. Dr Schmidt and Dr Padiyar emphasized the importance of knowledge-sharing sessions for capacity building among scientists, aiming to promote sustainable development for stakeholders and serve as a model for other developing countries. The meeting's outcomes will assist the Institute in shaping its research programs and prioritizing focus areas to achieve national goals and enhance its impact.

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

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Probiotics for water treatment

1. WATER QUALITY CONDITIONING

Best choice of *Bacillus* spp. that rapidly decompose uneaten feed, feces and other organic substances in pond water, keeps water quality optimal

2. HIGH ACTIVITY OF SPORES

No cultivation is needed. Easily adapt to the changes of surroundings and grow fast in freshwater or seawater culture farming, even under low oxygen environment

3. DECREASE AMMONIA CONTENT

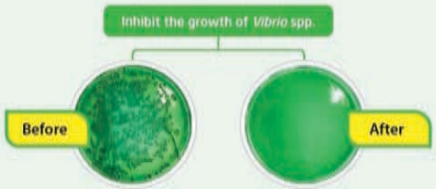
Prevent the accumulation of toxic substances such as NH_3, NO_2, etc.

4. IMPROVE WATER COLOR

Improve water color regulate the algae and bacteria balance in water, turning your pond from green to clear

5. ESTABLISH BALANCED POND BACTERIA SYSTEM

Compete nutrition with vibrio and inhibit them to grow. Provide nutrition for probiotics in the pond, to establish a well-balanced farming system.



6. INCREASE AQUACULTURE PRODUCTION

Good quality of water prevents fish/prawn infections, making high profit of production

* COMPOSITION:

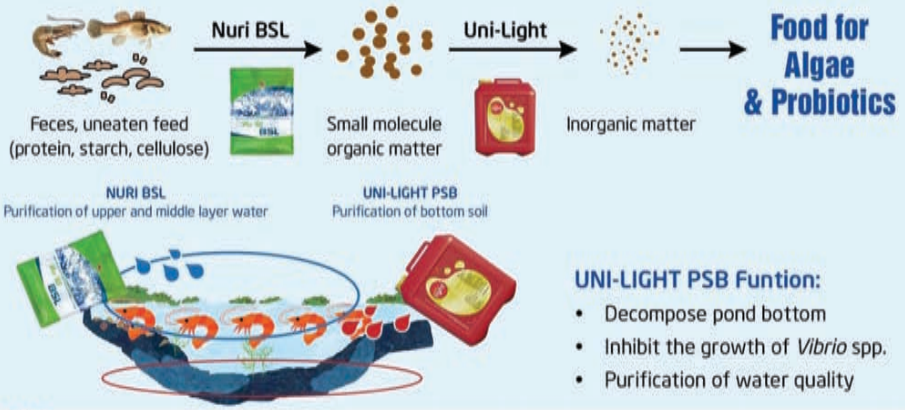
Bacillus spp. > 1x 10^{11} cfu/kg	15%
(Bacillus subtilis, Bacillus amyloliquefaciens, Bacillus licheniformis)	
Carrier (rice bran, corn gluten)	75%
Moisture	10%

* STORAGE:

Keep at dry, well-ventilated condition. Avoid direct sunlight exposure and use as soon as possible once opened for best quality.

* DIRECTION OF USE:

No cultivation is needed. Apply Nuri BSL with water-soluble bag near to the working water wheel or pour into the pond evenly. Recommend apply Uni-Light PSB together with Nuri-BSL on sunny day to achieve a clear pond more efficiently.



UNI-LIGHT PSB Funtion:

- Decompose pond bottom
- Inhibit the growth of *Vibrio* spp.
- Purification of water quality

BSL Dosage:

/10,000 m³ Quantity	10 - 30 pl/m² tiger prawn or < 80 pl/m² Vannamei	For >30 pl/m² tiger prawn or > 80 pl/m² Vannamei	For > 150 pl/m² Vannamei
7 days before stocking	800 g - 1,000 g	1,200 - 1,500 g	1,200 - 1,500 g
Day of stocking	300 g - 500 g	800 g - 1,000 g	800 g - 1,000 g
Every 7 - 10 days after stocking	300 g - 500 g	800 g - 1,000 g	3 - 5 days / use 1,000g - 2,000g

****Dosages can be adjusted according to the water conditions and practices.*

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Online Training Programme on Excellence in Pearl Culture Techniques

Kolkata: The 3-day online collaborative training programme on 'Excellence in Pearl Culture Techniques' was organized jointly by College of Fisheries Science, Chaudhary Charan Singh Haryana Agricultural University (CCS HAU), Hisar, Haryana and National Institute of Agricultural Extension Management (MANAGE), Hyderabad, Telangana during 14 - 16 October 2024. The iECHO platform was used for this online programme, participants initially registered themselves on the iECHO platform. News communicator Subrato Ghosh participated attentively in this programme. The entire programme was anchored and coordinated nicely by Dr A. Anand, Assistant Professor, Fisheries Extension, Economics and Statistics, College of Fisheries Science, CCS HAU and Dr (Smt.) Kiranmayi D., Academic Associate (ICT), MANAGE.

On the first day, in inaugural session, Hon'ble Dean, College of Fisheries Science, CCS HAU in his welcome address spoke about potential and prospect of pearl culture, an important sector in freshwater aquaculture and mariculture that provides opportunities for income generation. In 1st technical session, Dr (Smt.) R. Gulati, Professor, Aquaculture, College of Fisheries Science, CCS HAU gave Presentation (audio-visual Lecture) on 'Introduction to Pearl Culture: History, Importance, and Global Trends'. In 2nd technical session, Dr (Smt.) S. Rani, Assistant Professor, Aquaculture, College of Fisheries Science, CCS HAU gave Presentation on 'Pearl Oyster Biology and Farm Management'. In 3rd technical session, Dr Padmanabha A., Assistant Scientist, Aquatic Environment Management, College of Fisheries Science, CCS HAU gave Presentation on 'Water Quality and Environmental Management for Pearl Culture'. In 4th technical session, Dr (Smt.) K. Sharma, Assistant Professor, Fish Resource Management, College of Fisheries Science, CCS HAU gave Presentation on 'Equipment and Tools for Pearl Farming'.

On the second day, in 1st, 2nd and 3rd sessions, Mr Vikas Sharma, Progressive Pearl Farmer from Tehsil, Hansi, Dist. Hisar, Haryana discussed in detail covering three topics: 'Surgical Implantation and Nucleation Techniques', 'Post-Nucleation Care and Maintenance', 'Hatchery Techniques for Pearl Oyster Breeding'. He gave Presentation titled 'Freshwater aquaculture, pearl farming and process unit'. In 4th technical session, Dr I. Raja Khan, Assistant Scientist, Aquatic Animal Health Management, College of Fisheries Science, CCS HAU gave Presentation on 'Health Management in Pearl Culture'. On the third day, Mr M. Jagdale, Pearl Farmer from Maharashtra and Mr A. Giri, Pearl Farmer from Haryana discussed in detail on topics 'Processing and Preservation Techniques for Pearl Oysters' and 'Innovations in Post-Harvest Handling and Pearl Extraction' respectively in 1st and 2nd sessions. In 3rd technical session, Dr (Smt.) R. Gulati gave Presentation on 'Pearl Grading, Sorting, and Valuation'. In 4th technical session, Dr A. Anand gave Presentation on 'Business Development and Entrepreneurship in Pearl Culture'.

PDF copies of study material / reading material of different sessions were provided to participants for further knowledge and understanding, which will be very useful for participants. Professors and scientists from College of Fisheries Science elaborately and comprehensively explained the subject matters on respective topics, both basic and newer aspects – were informative and enriching Presentations. Skillful pearl farmers and experts lucidly elaborated on practical aspects of pearl culture, science and technology involved, their experiences, insights, new technology and method, how to obtain success, patiently gave answers to questions put up by participants – a very good interaction. Feedback of each technical session were submitted by participants online. All participants scored very well in online evaluation (examination) conducted on third day, answering 25 multiple-choice questions within time through Google Form. Freshwater pearl culture has been a subject of interest to News communicator since M.Sc Final Year, when the Abstract 'Dissemination of technology of freshwater pearl culture – a worthwhile approach of West Bengal State Fisheries Department', authored jointly with Late Dr K. K. Sengupta, the then Dy. Director of Fisheries, Govt of West Bengal, was accepted in First Indian Pearl Congress and Exposition, at ICAR-CMFRI, Cochin in February 2003. Self-authored article 'Research initiatives on cultured pearl production in India – looking back' was published in February 2014 of *Aqua International* magazine. He gained much knowledge and educated himself from discussions and explanations of this 3-day programme on pearl culture techniques.

China to host World Aquaculture 2025 at Qingdao on April 24-27

The World Aquaculture Society (WAS) and the Steering Committee of WORLD AQUACULTURE CHINA 2025 (WA2025) would like to announce that China will host the WA2025 event from April 24 to 27, 2025, at the Qingdao International Convention Centre, in Qingdao city, China. This marks the return of WA2025 to China since its successful debut in 2002.

The event is organized by WAS and the Yellow Sea Fisheries Research Institute (YSFRI) CAFS, hosted by the China Society of Fisheries (CFS), with the support from the National Fisheries Technology Extension Centre (NFTEC), the Chinese Academy of Fisheries Sciences (CAFS), and the State Key Laboratory of Mariculture Biobreeding and Sustainable Goods (BRESG).

Qingdao, located in the east of Shandong Province, is an international port city known for its significant contributions to marine science, will serve as the venue. It is a major center for marine research and education, with a strong marine economy and a rich cultural heritage. It has been awarded as one of the Most Ecologically Competitive Cities in China. The Qingdao International Convention Centre is the largest exhibition venue in Shandong Province.

WA2025 invites all aquaculture experts from organizations, institutes, companies and universities to participate in this three-day international conference and exhibition. Attendees will engage in specialized sessions, explore the latest industry products and services, network with peers, and form valuable partnerships. The conference theme, **"Aquaculture Transformation: Action towards High Quality and Food Security,"** will be explored through keynote presentations, panel discussions, interactive sessions, and an exhibition showcasing industry advancements.

Qingdao City

Aquaculture in Qingdao

Abstract submissions are due by January 31, 2025. Organizations interested in organizing or sponsoring the special sessions at WA2025, please contact us. We can arrange the meeting rooms for full or half days for the special session. Exhibitors are encouraged to book their booths early, and early registration is recommended to take advantage of reduced rates.

For more details on participation, sponsorship, or exhibiting, visit www.was.org or email apcsec@was.org.

For conference management inquiries, contact John Cooksey at worldaqua@was.org

For booth and sponsorship details, reach out to Mr MarioStael at mario@marevent.com.

He made the mother won!

Her husband neglected her when she was young. But she laid golden paths for her child's future. Making tailoring as her livelihood she provided higher education to her son.

The husband left Ms Bonthada Lakshmi of Akiveedu in West Goadavari district of Andhra Pradesh when her son was one year old. Working day and night in tailoring, she educated her child Jeevan Kumar from LKG to Fifth standard in a private convent. Though it is expensive she later joined the son in a corporate college and he scored 675 marks in NEET. The son is now doing MBBS in Rangaraya College at Kakinada.

Knowing the mother's hardships, the Loins Club Past District Governor, West Godavari, Mr Chilukuri Krishnam Raju who is also the President of Andhra Pradesh Aqua Dealers Association came forward and adopted Jeevan Kumar, and will spend Rs 85,000 annually till the boy completes his education. Some other Lions members also came forward to help the boy.

West Bengal Fisheries Department undertakes Abhoy Pukur (Fish Sanctuary) scheme

Inland (freshwater and brackishwater) fishes in West Bengal (WB), both cultivable and non-cultivable naturally-occurring ones, are important in the sense that they bring about food production with high nutritive value, *viz.*, superior quality animal protein, minerals, micro-nutrients, omega-3 fatty acids; eradication of malnutrition in rural areas *via* consumption of locally-available less-costly fishes; sustainable income and employment generation *via* pisciculture in rural and sub-urban areas for aquapreneurs and rural youths. Dr P. K. Mukhopadhyay, Retd. Principal Scientist, ICAR-CIFA mentioned that of particular relevance to future of India is to ensure access of nutritionally adequate food for improvement in quality of diet of poor persons living in the society, in article 'Fish in human health and nutrition', Souvenir of National Seminar, Visva-Bharati, February 2002.

Motsyo Abhoy-ashrom under CBFM Project, Bangladesh

Big-sized Puntius sp

Considering finfish diversity in WB and threatened fishes, according to report of 'Aquatech Popularization Society' of Association of Retired Government Fishery Officers, WB in 2003, total fish species in WB is 574nos (freshwater, brackishwater and marine), out of which total 106nos are threatened fish and 34nos endangered fish (within threatened fishes). Total endangered freshwater fish is 16nos (out of 34nos). According to records of Zoological Survey of India, total freshwater fish in WB is 239nos, of which 59nos species are threatened and 22nos within it are endangered. According to Department of Fisheries, Government of WB, 39nos local fish species (inland and marine) are likely to disappear from their natural habitat in WB in near future. Total Small Indigenous Fishes in eastern and north-eastern states (including WB) is 216nos, size not more than 22-24cm in adult stage. Total 104nos among it are highly nutritious. Indigenous freshwater ornamental fish species (also edible) in WB is 190nos and indigenous marine ornamental fish species 113nos. Total 303 species of indigenous ornamental fish found in this state (out of 574nos of finfishes in all ecosystems).

Small-sized Puntius sp

Pond for maintaining threatened fishes at JGVK, Basanti

News communicator Subrato Ghosh has read few informative and enriching write-ups, amongst many others published, authored by eminent fishery scientists. Late Dr P. Das, Founder Director, ICAR-NBFGR and Late Sri S. P. Dey, Retd. Deputy Director of Fisheries, WB discussed in detail on factors causing loss of fish biodiversity, ongoing initiatives in in-situ and ex-situ conservation, list of threatened freshwater, brackishwater and marine fishes of WB and their status/category (critically endangered, endangered, vulnerable, near threatened, lower risk, etc) in article 'Piscine biodiversity conservation with particular reference to WB', Souvenir of 6th Indian

Deshiyo chhoto maachher Abhoy-ashrom at JGVK, Basanti, South 24 Parganas

Fisheries Forum, December 2002. Padmasree and World Food Prize Laureate Dr M. Vijay Gupta discussed about decline in fish production from open waters in India in article 'Aquatic biodiversity and aquaculture in the context of global warming and climate change', Souvenir of 21st All India Congress of Zoology, December 2010. Late Dr A. Ghosh, Retd. Principal Scientist, ICAR-CIFRI gave an account of diversity of bony fishes in freshwater zone, transitional zone and low saline zone of Hooghly estuary, WB in his field guide, published by ICAR-CIFRI, 2008.

Dr K. K. Lal, Former Director, ICAR-NBFGR and Dr J. K. Jena, DDG (Fisheries Science), ICAR discussed about documentation of fish biodiversity and conservation programmes in article 'Status of fish biodiversity management research in India: ICAR-NBFGR', Souvenir of National Seminar, Rangeilunda Fisheries College, March 2017. According to Dr J. K. Jena and Dr U. K. Sarkar, Director, ICAR-NBFGR, as an approach to fish biodiversity conservation, principal elements or tasks in recovery programmes are identified as habitat and aquatic biodiversity management, habitat development, maintenance and management, native fish stocking, declaration of protected areas and fish sanctuaries (article 'Biodiversity conservation and management of fish genetic resources – current scenario and priorities', Souvenir of 21st All India Congress of Zoology). In article 'Fish population declining in the Sundarbans', Dialogue Earth, 17/12/2018, environmentalist Dr (Smt) D. Dasgupta has discussed in detail on the factors relating to human activity, in addition to the various impacts of climate change, that are putting pressure on fish density and diversity in Indian Sundarbans.

Late Prof. N. C. Datta of University of Calcutta also mentioned about establishment of protected areas if conserving biodiversity in-situ, *i.e.*, in natural habitats in article 'Aquatic biodiversity – text, context and conflicts', Diversification in Aquaculture, NPH Publishing, 2012. In this book, Dr Dilip Kumar, Former Director, ICAR-CIFE has nicely explained about 'Why we need these indigenous fish species'. One of the main actions of Community Based Fisheries Management-2 Project in 22 out of 64 districts in Bangladesh has been to establish fish sanctuaries – no fishing zones where fishes (disappearing and very rarely found in nature) in the water body are allowed to stay safely even when surrounding water levels are at their lowest. In floodplain wetland areas, these are excavated ditches whereas in beels and rivers, it is demarcated section with red flags, accompanied by signboard that fishing is completely banned here. In local language, these are the 'Motsyo Abhoy-ashram'. Scientists from ICAR-CIFRI, ICAR-CIFA, ICAR-NBFGR, dignitaries and experts have very well written on different aspects concerning the main theme 'Small indigenous freshwater fish species: their role in poverty alleviation, food security and conservation of biodiversity', Compendium of Workshop, ICAR-CIFRI and ICSF, February 2010.

News communicator came across some important write-ups in Bengali version on fish biodiversity depletion in WB - causes and conservation needs, that include '*Jeebo boichitrey motsyo-sompoder obosthan o khoy*', authored by Late Sri S. P. Dey, Motsyo Samachar, February 2002; '*Sovyotaar ogrogoti o biponno motsyo projatee*', by S. Sarkar,

Tanks for maintaining small indigenous fishes at Sargachhi RK Ashram

Souvenir, FFDA Employees Association, West Bengal; '*Bangaleer ei motsyobiplob – kholse, punti e ekhon elite*', Dr S. Bhattacharya, People's Biodiversity Register Methodology Manual, 2000; '*Jolongi noditey mosari, chot jaaley hariye jacchhey khorke, bata, nados*', Bengali Newspaper, 24/01/2007; '*Borjo-misrito nodir joley machh chasher khoti*', Anandabazar Patrika,

28/06/2023; '*Leta, punti, foluider rokkhhay chesta*', Anandabazar Patrika, 18/11/2017; '*Lupto hocchhey bohu rokomer kucho machh – dushonkei duschhen bigyaneera*', Anandabazar Patrika, 16/08/2024; '*Chhoto maccher abhoy-ashrom – banglaar chhoto machhder banchiye rakhtey*', Bengali Newspaper, 04/11/2023; '*Gongaay bhese uttchhey mora maccher jhhank – prosney karkhanaay dushon*', Anandabazar Patrika, 02/09/2023.

In order to sensitize people of WB on the importance of freshwater wetlands, inhabiting valuable and vital natural-occurring small- and medium-sized fishes therein and the need of their conservation, since 1987, WB Fisheries Department decided to observe 1st Ashar or 16th June of every year as 'Wetland Day' throughout WB. As one of the developmental programmes, the 'River ranching' ('*Noditey motsyo sonchar prokolpo*') scheme has been implemented by WB Fisheries Department at specific points (river banks) in river Bhagirathi (Hooghly) and other river stretches in different districts of WB in every financial year to supplement natural fish stock, particularly threatened less-available species. By virtue of stocking rivers with advanced fry and fish fingerlings obtained from fish hatcheries and fish seed production units, fish wealth of rivers will be restored and rejuvenated – it is rehabilitation and re-establishment of riverine fish stock.

Stocking carp fingerlings in a beel at Dakshin Dinajpur

In West Bengal Fisheries Policy, publication of WB Fisheries Department, 2015, it is mentioned about 'Encouragement for growing small indigenous fish species (supplementary nutrition to rural poor)' – importance of developing and demonstrating low-cost culture technologies of nutrient-rich small fish species in backyard ponds, composite fish culture ponds, rice fields, and other aspects. To conserve indigenous local fish species and ensure the propagation of indigenous fish species in-situ, since 2011-2012, steps have been taken by WB Fisheries Department each year to liberate indigenous fish in the beels, baors (large natural lentic freshwater bodies) under which indigenous fish species of five such species, 200nos of each, preferably common to the respective water bodies are released in each water body.

In order to conserve and restore local fish biodiversity using habitat restoration programme followed by ecosystem management strategy, the scheme namely 'Abhoy Pukur' or fish sanctuary has been undertaken by WB Fisheries Department in collaboration with WB Biodiversity Board, Department of Environment, WB, initiated in June 2024. Costs involved in pond preparation (for conservation purpose) and repairing of embankment, culture cost in the form of fish seed of different indigenous species, fish feed ingredients, lime, prophylactics, labour, accessories have been specified. Unit area of water body is specified, culture duration 12 months. Fishes include bacha *Eutropichthys vacha*, pabda *Ompak pabda*, nados *Nandus nandus*, phesa *Setipinna phasa*, sarpunti *Puntius sarana*, tor *Tor tor*, pankal *Mastacembelus pancalus*, kankley *Xenentodon cancila*, sona tengra *Mystus vittatus*. This scheme will be implemented during 2024-2025 in six fish farms of Fisheries Department, Government of WB throughout the state for restoration of indigenous less-abundant freshwater fishes with two units in each farm. In the 'Abhoy pukur' ponds, 25 - 30% area are to be kept covered purposefully with freshwater wetland-type aquatic vegetation (submerged, floating, emergent types, land-water edge plants) and maintained. In addition to above, other local indigenous fishes that will be taken up include danria, mourola, titpunti, reba, ghora danria, singi, magur, folui, koi, sal, shol, leta, chang, beley, batasi tengra, sutafuli tengra, guri kholse, pata kholse, guntey, goje pankal, raj pankal, chela, kuche, bhuto beley, ranga chanda, paat chanda.

Few years ago at Joygopalpur Gram Bikash Kendra campus, Basanti Block, Dist. South 24 Parganas, News communicator Subrato Ghosh noticed one freshwater pond about 20dec earmarked as '*Deshiyo chhoto maachher abhoy-ashram*' (place for shelter, protection and maintenance of small indigenous fishes) in signboard. Also noticed some cement-constructed tanks at Ramkrishna Mission Ashram, Sargachhi, Beldanga-I Block, Dist. Murshidabad where culture and maintenance of few small indigenous freshwater fish species (brooders and young ones) are done. He saw the Aquaculture and Biodiversity Centre, having stocking ponds and nursery ponds in Gauhati University campus, Assam for pursuing research in Zoology Department on indigenous ornamental fishes, aquaculture and fish biodiversity.

Gassen Plus

Bon Ammonia and obnoxious Gasses

Shrimp / Fish performs all their body functions and growth in water. Good quality water and proper D.O. levels determines the success or failure. Good quality water, optimum D.O. level is of prime importance for health and growth of Shrimp / Fish.

Irregular water exchange, excess and leftout feed, dead algae, fecal matter, increases the organic load at the pond bottom. Accumulation of such waste absorbs available oxygen, creating anaerobic condition which leads to pollution of pond bottom. Polluted pond bottom and unhealthy environmental conditions triggers the release of toxic gasses like Ammonia, H_2S, Methane, etc, The toxicity of Ammonia, Hydrogen Sulphide, Methane attributed mainly due to unionized form. As the concentration in water increases, ammonia excretion by aquatic organism diminishes and the level of ammonia in blood and in other tissues increases. Ammonia increases oxygen consumption by tissues, damage gills and reduces the ability of blood to transport oxygen, and increases the disease susceptibility. To eliminate / overcome the above problems 'GASSEN PLUS' Yucca Schidigera, it contains Steroidal"Saponin" which help to reduce ammonia and other noxious gasses such as H_2S, Methane, etc., Microbial enzyme "Urease' Production inhibited by Saponin which leads to an increases D.O. and reduction of BODand COD levels.

Bacterial strains such as Bacillus Subtilis, Nitrobactor, Nitrasomonas, rapidly converts ammonia into Nitrates, Nitrites and finally non-toxic Nitrogen. Hydrogen Sulphide converts into Sulphates, Sulphites and finally non-toxic Sulphur, Methane into Non-toxic carbon. This conversion reduces the obnoxious gasses in the pond bottom. Reduction of this gasses improve the D.O. level in the water and bottom.

COMPOSITION:
YUCCA SCHIDIGERA
ALOEVERA
BACILLUS SUBTILIS
BACILLUS POLYMIXA
BACILLUS LICHENIFORMIS
NITRASOMONAS
NITROBACTOR
STABILIZERS

DOSAGE : 1 Kg per Acre or consult your Aqua Technician For Specific Usage & Dosage

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In need of Water Soluble Bags ? Now is a Great Time to Order!

Normally when we look for packaging materials, we don't want something that will fall apart and empty all its contents when it gets wet. But in some cases, that is exactly what we need to make life better! With that in mind and the best season for manufacturing water-soluble film coming soon to Cortec Advanced Films (CAF), now is a great time to revisit the benefits of EcoSol. EcoSol is a water-soluble PVOH (polyvinyl alcohol) film that dissolves in water in a matter of minutes. It can be made into bags, pouches, and sachets of many different sizes to create an efficient delivery system for a wide range of products:

- Detergents
- Concrete additives
- Water treatment chemicals
- Agricultural treatments
- Bathing products

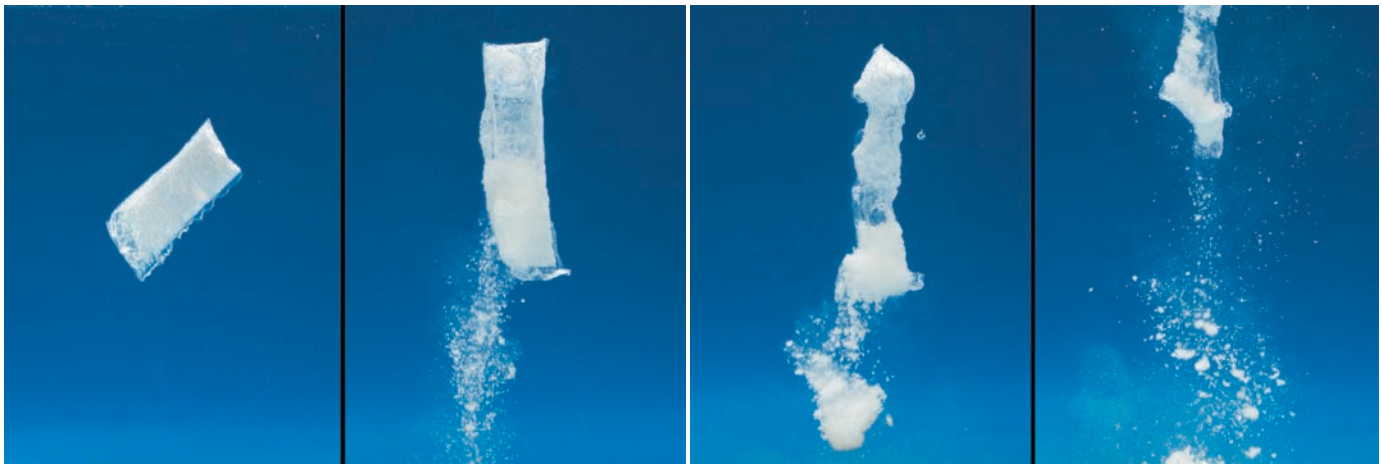
Packaging items like these in EcoSol pouches allows precise dosing and avoids the messiness associated with trying to measure and apply powder products—especially in windy conditions. EcoSol is especially beneficial for packaging chemicals because it eliminates the need for direct handling. This same benefit extends to hospitals and care facilities when laundry bags are made out of EcoSol, allowing workers to throw an entire bag of dirty laundry into the washing machine without touching the soiled linens. Although EcoSol is designed to break down in contact with water, it can be stored for two years if kept in dry conditions at room temperature in the original barrier bags.

However, CAF's favorite time to produce water-soluble film is during Minnesota winters, when the low humidity that has most people reaching for hand lotion makes it much easier to work with EcoSol on the extrusion line. Ideal EcoSol production weather is already on its way, so now is a great time to evaluate your needs for the year ahead. European customers can order EcoSol from Cortec's European manufacturing plant, EcoCortec, located in Croatia.

After few minutes of immersion at the specified temperature, EcoSol dissolves in water leaving a harmless, non-toxic, aqueous solution of polyvinyl alcohol releasing

the packaged product to do its work. Once the liquid solution of PVOH comes into contact with common microorganisms, such as those found in water-treatment plants, conversion to carbon dioxide and water takes place within about 30 days.

Mechanical properties of EcoSol packaging conform the normative of ASTM D 882-02 for Braking factor, Tensile Strength of break, Elongation and Yield Strength; It's Tear Strength is tested according ASTM D 1922-06a and Dart Drop Impact resistance - per ASTM D 1709-04.



After immersion EcoSol dissolves in water leaving a harmless, non-toxic, aqueous solution of polyvinyl alcohol. Microorganisms will degrade the solution to carbon dioxide and water within about 30 days.

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CAA/OCT22/PRO/04169

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Prevents entry of opportunistic pathogens and safeguards health of this high value asset.

Artemia:
Reduces the *Vibrio sp.* load in Artemia tank.

Zoea & Mysis:
Helps in better conversion and survival.

Post Larvae:
Stagewise control of *Vibrio sp.* results in remarkable reduction of *Vibrio sp.* load in post larval tanks. This results in high health seeds.

Works as an Alternative to Antibiotics and complies with International Seafood export regulations.

BEST APPROACH TO CONTROL PATHOGENIC VIBRIOS

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PROBIOTIC ✓
SANITISER ✗
DISINFECTANT ✗✗
ANTIBIOTICS ✗✗✗

One Health unified approach for balanced welfare of people, animals and ecosystems.

ONE HEALTH APPROACH

BACTERI THERAPY T PATHOGEN

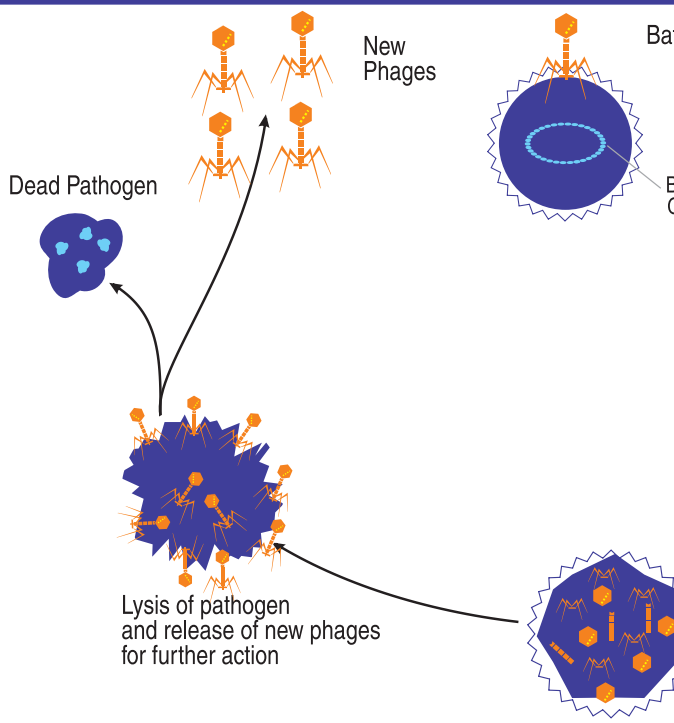
V PHAGES HATCHERY & V PHAGES GROWOUT are a c
they are safe on aquatic animals, people and ecosystem
resistant to antibiotics and incr

"V PHAGES" cocktail targets against most common pathog

• ***Vibrio parahaemolyticus*** • ***Vibrio alginolyticus*** • ***Vibrio h***

100 % Natural | Pathogen specific approach | V
Easy & Safe to use | Do

ILLUSTRATION OF ACTION OF PHA



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enic *Vibrio species* in Shrimp Hatchery & Farming

arveyi • ***Vibrio campbellii and other pathogenic Vibrio sp.***

Very Fast action | Enhances Probiotic performance
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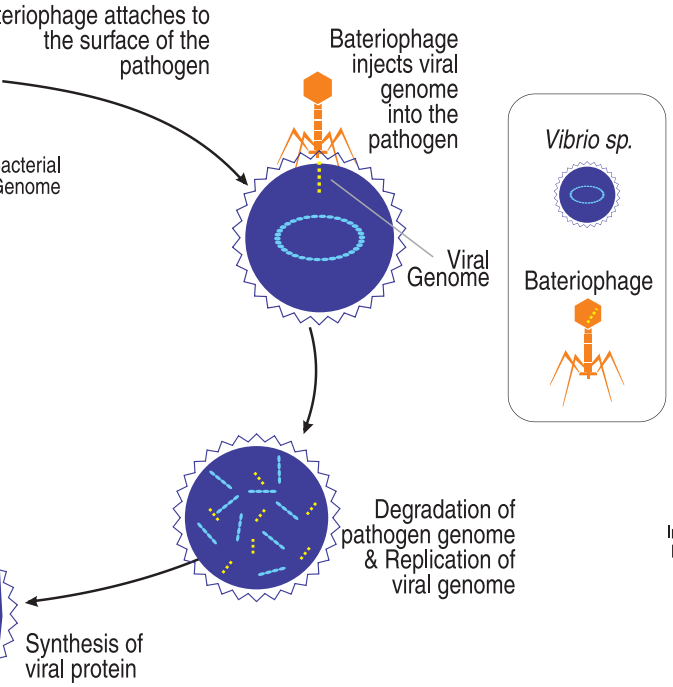
GE ON A TARGET VIBRIO BACTERIA



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BENEFITS

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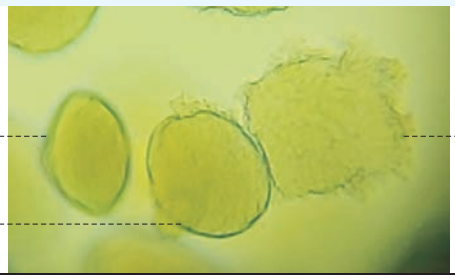
- Effectively prevents Gut Infections and Improves feeding.
- Prevents sudden crop loss and extends Life of Pond during critical profit-making period.
- Enhances Probiotic performance.

Works as an Alternative to Antibiotics and complies with International Seafood export regulations.

Stages of *Vibrio sp.* colonies infected with Bacteriophages & Progressive Lysis observed on an Agar plate, under Stereo Microscope

Colony 1 in Stage 1: Intact Colony may be infected or yet to get infected.

Colony 2 in Stage 2: Phage infected Colony showing Partial lysis.



Colony 3 in Stage 3: Phage infected Colony Completely lysed, cell contents with multiplied phages spreads out in search of their host.

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Optima Life Sciences inaugurates new State-of-the-Art Manufacturing Facility in Jejuri, Pune

Pune: Optima Life Sciences proudly announces the inauguration of its new manufacturing facility in Jejuri, a land mark achievement that under scores our commitment to innovation, quality and community engagement in the animal sector, said Mr Vinay Kulkarni, Executive Chairman, Optima Life Sciences Pvt Ltd. The facility was officially opened on 16 October 2024 in a ceremony attended by industry leaders, local government officials and valued business partners.

Vinay Kulkarni,
Executive Chairman,
Optima Life Sciences Pvt Ltd

Optima Life Sciences proudly announces the inauguration of its new manufacturing facility in Jejuri, a land mark achievement that underscores our commitment to innovation, quality and community engagement in the animal sector. This facility represents a significant investment in our operational capabilities, allowing us to scale our manufacturing processes to meet the increasing demand for our products, said Mr Vinay Kulkarni, Executive Chairman, Optima Life Sciences Pvt Ltd in an exclusive interview by Aqua International Editor M.A. Nazeer.

Expanding Production Capacity

The newly inaugurated facility spans 4.5 acres area and is equipped with cutting-edge technology designed to enhance production efficiency and quality. This facility represents a significant investment in our operational capabilities, allowing us to scale our manufacturing processes to meet the increasing demand for our products, he stated.

"Our new plant in Jejuri is a game changer for Optima Life Sciences, With advanced manufacturing capabilities and a commitment to quality, we are well-positioned to serve our customers better and respond to market needs with agility", stated Mr Vinay Kulkarni.

Advanced Technologies and Processes

The Jejuri facilities feature: **Advanced Nauta Mixer Technology:** This state-of-the-art 6 MT / Hr mixing solution enables precise ingredient integration, resulting in consistent and high-quality formulations with CV less than 0.1%.

Fully Pneumatic Transfer System

This automated system enhances efficiency by transporting materials without manual handling, minimizing contamination risks and improving safety.

Auto Bagging and Heat Sealing System

Col (Dr) Y. Sudheer Kumar, VSM, CEO of SR Group and A. Gopal Reddy, Director, Sneha Farms, unveiling the logo of Optima Life Sciences at the plant.

From Left: Vinay Kulkarni, Excecutive Chairman, Optima Life Sciences, Vijay Kulkarni (brother), Sakshi Kulkarni, (daughter), Vandana Kulkarni (mother), Aarti Kulkarni wife of Vinay Kulkarni and his sister during the inauguration of new State-of-the-Art manufacturing facilities of Optima Life Sciences in Jejuri, near Pune, Maharashtra on 16 October 2024.

Guests are given a traditional welcome at Optima's new plant inauguration.

Family and office members during the inauguration of the Plant.

This innovative packaging solution ensures accurate filling and secure sealing of products, enhancing shelf life and product integrity.

Advanced Nauta Mixer Technology

Rack Storage System

With a capacity of 750 MT, this system allows for efficient and organized storage of raw materials and finished goods streamlining inventory management.

Quality Control Systems

310 Sq. Mtr. fully equipped laboratory ensures rigorous testing and monitoring stems are in place to maintain the highest and ards of product safety and efficacy.

Research and Development Labs

Dedicated spaces for RCD will facilitate the development of new and innovative health products, driving our commitment to continuous improvement.

Commitment to Sustainability

Optima Life Sciences recognizes the importance of environmental stewardship. Our Jejuri facility incorporates several sustainable practices, including:

Energy Efficiency: The plant utilizes energy-efficient machinery and renewable energy sources to minimize its carbon foot print.

Auto Bagging and Heat Sealing System

Waste Management: Effluent Treatment Plant for Sewage Water Treatment with capacity of 25 KL.

Optima Life Sciences family during the inauguration of the new Plant at Jejuri, near Pune, Maharashtra on 16 October 2024

Research and Development Labs

Water Conservation: Advanced water recycling systems are in place to reduce water usage and promote sustainability in manufacturing processes.

Our Plant Certifications

GMP - Good Manufacturing Practices Certified.

HACCP - Hazard Analysis Critical Control Point Certified

ISO22000 – 2018 - Food Safety Management System Certified

FAMIQS - Feed Additives and Premixtures Quality System Certification is focused on ensuring the quality and safety of feed additives and pre mixtures throughout the production process.

Future Outlook

With the inauguration of this GMP, HACCP, ISO and FAMI QS certified facility, Optima Life Sciences is poised for growth and innovation in the animal nutrition and heal the sector. This expansion enhances our ability to develop and produce a wide range of health solutions, ultimately benefiting our customers and communities, he stated.

"As we look to the future, we are excited about the opportunities this facility presents for our company and the positive impact we can have on health and wellness globally," added Mr Vinay Kulkarni.

Aqua farmers told to learn advanced techniques in Shrimp Farming

Aqua International organizes 40th Aquaculture Expo at Bhimavaram, Andhra Pradesh

Raghurama Krishnam Raju, MLA, Undi Constituency, A.P., Ms C. Nagarani, District Collector & Magistrate, West Godavari District, A.P., B. Masthan Rao, Former Member of Parliament (RajyaSabha), M.A. Nazeer, Irrinki Surya Rao, Namburi Venkatarama Raju and others during the inauguration of 40th Aquaculture Expo held at Bhimavaram, Andhra Pradesh, on 27 September 2024.

Bhimavaram: West Godavari District Collector Ms Chadalavada Nagarani, Undi MLA, Raghurama Krishnam Raju and Former Member of Parliament, B. Masthan Rao said that they will work for the development of aquaculture farmers. They inaugurated 40th edition of ***Aquaculture Expo 2024*** organised by *Aqua International* on 27 September 2024 at Bhimavaram, Andhra Pradesh. This kind of events will help farmers to know latest techniques and knowledge to get better productivity in farming. The dignitaries visited the stalls and enquired about the products and their services in aquaculture.

Raghurama Krishnam Raju, *Member of Legislative Assembly, Undi Constituency, Andhra Pradesh*

Andhra Pradesh Government is ready to support aquaculture farmers and the govt is preparing plans to provide subsidy on electricity and other aspects, said MLA, Raghurama Krishnam Raju.

B. Masthan Rao, *Former Member of Parliament (Rajya Sabha) and Chairman – BMR Industries Ltd.*

Reduce Feed Prices

Mr B. Masthan Rao said that he will discuss with feed manufacturers on the demand to reduce feed prices in the feed manufacturers association meeting.

Dr Manoj Kumar T.G., *Deputy Director, MPEDA, Bhimavaram Region.*

Dr Manoj Kumar T.G., Deputy Director, The Marine Products Export Development Authority (MPEDA), Bhimavaram Region explained about MPEDA schemes for the development of aquaculture.

Dr Surya Rao Irrinki,
Chairman & Managing Director, Suryamitra Exim Pvt Ltd.

Dr Surya Rao Irrinki, Chairman & Managing Director, Suryamitra Exim Pvt Ltd, said that the industry is totally depending on Shrimp exports which is not a wise thing. There is a need of promoting domestic shrimp consumption to safeguard the industry and the farmers. He is trying to do his bit to promote domestic shrimp consumption.

Mr R.V.S.V. Prasad, District Fisheries Officer, West Godavari District, Department of Fisheries, Govt. of Andhra Pradesh; Mr Ch Krishnam Raju, President, Andhra Pradesh Aqua Dealers Association; Mr Namburi Venkatarama Raju, President, Andhra Pradesh Fish Farmers Association and Mr Subba Raju, Secretary, Shrimp Buying Agents also spoke on the occassion.

M.A. Nazeer,
Chief Executive, Aquaculture Expo, Editor, AquaInternational

In his welcome address Mr M.A. Nazeer, Chief Executive of the Expo and Editor, Aqua International said that the main objective of the Expo is to bring awareness among aquaculture farmers on shrimp, fish and crab culture and various products, technology and services available to get better yield and results in aquaculture farming. The Expo was a wonderful opportunity to aquaculture farmers to update their knowledge on various aspects in aquaculture. The event was an opportunity for buyers and sellers as well in the sector. Companies dealing with manufacture and supply of products and services related to aquaculture sector displayed their products in the Expo.

Dignitaries on the dias during National Anthem at Aquaculture Expo 2024 at Bhimavaram

Experts – Farmers Interaction Meet

Experts – Farmers Interaction Meet was held on the occasion in which Mr P. Govinda Rao, Mr Imran and Mr Ch Krishnam Raju interacted with the participants.

Golden Marine Harvest hosts Get-to-gether

Golden Marine Harvest hosted Get-to-gether on the evening of 27 September 2024 at

Experts - Farmers Interaction Meet

P. Govinda Rao speaking during Experts – Farmers Interaction Meet while Ch Krishnam Raju and Imran are in the Interaction Meet.

Participants in Experts – Farmers Interaction Meet.

Hotel Falcon Nest in Bhimavaram in connection with 40th edition Aquaculture Expo 2024. Exhibitors, farmers and other stakeholder of the industry took part in the dinner.

R.V.S.V. Prasad,
District Fisheries Officer, West Godavari District, Department of Fisheries, Govt. of A.P.

Namburi Venkatarama Raju,
President,
Andhra Pradesh Fish Farmers Association

CH Krishnam Raju,
President,
Andhra Pradesh Aqua Dealers Association.

A view of participants in the inaugural session of Aquaculture Expo 2024 at Bhimavaram.












Golden Marine Harvest hosts Get-Together





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A view of Aquaculture Expo 2024 held at Bhimavaram on September 27 & 28.


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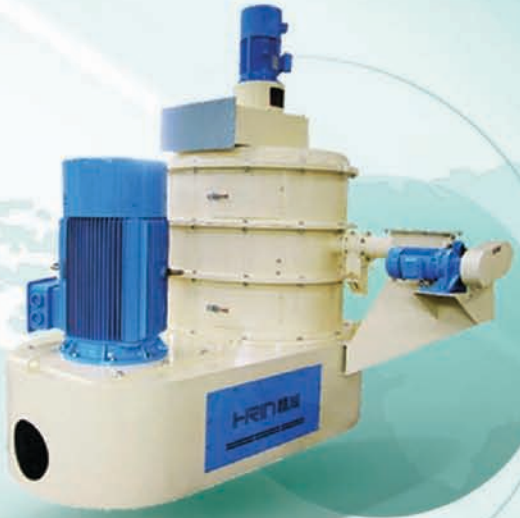

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Hengrun HRYTZ Series Vacuum Sprayer

Totally enclosed spraying space, Precision & Efficient spraying proportion widely ranged from 2%-30%.

An insight about Sea Cucumbers

- Special focus from Lakshadweep

Email: **charan.fishcol@gmail.com**

Abhilash C. P. , Charan Ravi, T.T. Ajith Kumar and U.K. Sarka

ICAR-National Bureau of Fish Genetic Resources, Lucknow, Uttar Pradesh, India.

Introduction

Sea cucumbers are fascinating marine creatures with numerous adaptations that belie their modest appearance. Belonging to the phylum Echinodermata and classified under the class Holothuroidea, sea cucumbers first appeared in the oceans around 540 million years ago. They are named for their resemblance to cucumbers, characterized by their elongated bodies and soft, gelatinous texture. The group Holothuroidea is diverse, comprising over 1,400 species found from intertidal zones to the deepest oceanic trenches. Sea cucumbers play a crucial role in marine ecosystems as key sediment bioturbators. They consume decomposing organic matter and convert it into usable nutrients, benefiting other marine life. This process prevents the accumulation of organic matter in marine sediment and helps control the effects of pathogenic agents. Remarkably, the class Holothuroidea represents 90% of the deep-sea floor biomass, making them as most dominant organisms in the world. Commercially, sea cucumbers are valued for their nutritional properties, which include high protein content, low fat levels and antioxidant molecules. They are traditionally consumed in both fresh and dried forms, with the dried form known as "bêche-de-mer" or trepan and other health products, which are exported to eastern Asian markets. Additionally, sea cucumbers are of scientific interest due to their ability to regenerate tissues and possess bioactive compounds.

Sea Cucumbers of Lakshadweep Islands

The Lakshadweep Archipelago is India's only chain of coral islands with atolls. It is a group of 36 islands, including 12 atolls, three reefs and five submerged banks, located in the Arabian Sea. The islands

- Sea cucumber is a soft-bodied marine echinoderm, related to starfish and sea urchin. They are known for their delicious dietary value and medicinal uses, especially in Asian cuisine. Cucumbers play a vital role in marine ecosystems as key sediment bioturbators.
- In recent years, this animal is facing various threats, including illegal trade, over exploitation, habitat destruction, climate change etc.
- Conservation efforts are need of the hour to avoid depletion and ensure sustainable management of this scheduled species population.
- Lakshadweep, an Indian coral paradise is housing 21 species of cucumbers.

are geographically isolated from mainland, and are separated from one another by an average distance of 40 to 60 km. It is observed that twenty-one species of sea cucumbers belonging to ten genera and four families were documented from the Lakshadweep atolls. Exceptionally high abundance was recorded in the inner reef lagoon of Chetlat and the intermediate lagoon areas of Chetlat, Kiltan and Kalpeni. Abundant species in these areas are *Holothuria atra* and *Stichopus chloronotus*. These two species, along with *Actinopyga mauritiana, Holothuria leucospilota* and *Holothuria cinerascens* are also fund rich in Lakshadweep. However, *Opheodesoma Grisea, Stichopus herrmanni,* and *Bohadschia* are among the rare and least abundant species. According to the local fishermen Perumalpar, Suheli, Cheriyapani and Valiyapani islands have rich diversity, whereas, Bangaram and Bitrahaveless population. Illegal collection of sea cucumbers is undertaken in few islands and the U. T. administration is taking very serious controlling measures to restrict illegal activities. Fishermen of Lakshadweep preferred skin-diving / free diving / snorkelling methods for sea cucumber collection. Handpicking is also adopted, while traditional boats are used for collection. Scuba diving, harpooning, and the use of mechanised boats are also used for the exploitation. As a measure towards conservation, there are three sea cucumber reserves were established in Lakshadweep islands. The first area is spread over 239 km^2 at Cheriyapani island, called Dr K. K Mohammed Koya Sea Cucumber Conservation Reserve. The second is the largest global marine conservation reserve between Amini and Pitti island, with an area of 344 km^2, declared as Attakoya Thangal Marine Conservation Reserve. The third reserve is the first Protected Area for marine birds in India, at 62 km^2 (P.M. Sayeed Marine Birds Conservation Reserve).

Sea cucumbers - Indian perspective

In India, about 200 species of sea cucumbers are reported, which is categorized into 6 orders and 16 families. Among them, 75 species are known to be found in shallow waters, the majority primarily inhabit tropical coral reefs and nearby waters. Holothurians are found in various Indian coastal states, including Andaman and Nicobar Islands, Lakshadweep, Gulf of Kutch, Gulf of Mannar and Palk Bay. All the species of sea cucumbers were listed in Schedule I of the Wildlife (Protection) Act of 1972, making their collection, trade, or use are punishable offense in India. Despite these protections, a report by TRAFFIC (2022) and WWF-India (1972) indicates that sea cucumbers in India face threats from illegal and unsustainable collection and trade.

Habitat

Holothurians inhabit diverse environments such as coral reefs, seagrass meadows, rocky shores, salt marshes, mangrove beds and even known from deepest trench. Most adults are benthic, while some larval stages are pelagic. The distribution is often patchy, with species displaying specific habitat preferences. They typically live on hard substrates, rocks, coral reefs or soft bottoms, either on the sediment surface, buried in sediment, or as epizoites on plants or invertebrates.

Morphology

Sea cucumbers have cylindrical, elongated body and reside on the sea floor. They have tube feet on their ventral side for locomotion, while their dorsal features are known with small bumps called papillae, showing secondary bilateral symmetry derived from their ancestral pentaradial symmetry. Body is divided into five ambulacral areas running longitudinally: three on the ventral (trivium) and two on the dorsal (bivium). Depending on the species, the body surface can be smooth or covered with warty bumps or papillae. Their leathery, flexible skin is supported by a dermis containing microscopic ossicles (calcareous structures), that provide rigidity and protection. Sea cucumbers exhibit various colors, from dull greys and browns to vibrant reds and oranges. Mouth, located at the front end, is surrounded by branched or simple tentacles, which are modified tube feet used for feeding. The tentacles are extensions of their water vascular system and vary in shape among species. The anus, at the rear end, is used for both excretion and respiration.

Food and feeding

Most sea cucumbers are consuming detritus, bacteria, and diatoms mixed with seabed sediments. Species on hard reef surfaces "mop up" particulate organic matter that coats rocks and benthic vegetation. A few species are suspension feeders, sweeping minute organisms, and detritus adhering to their tentacles through mucous secretion. Generally, they occupy a low trophic position in the food chain.

Reproduction

Holothurians typically spawn in the late afternoon, evening, or night. During spawning, the male releases spermatozoa first, followed by the female releasing eggs. The male lifts the anterior end and performs swaying movements, releasing sperm if a nearby female releases eggs. An adult female can release up to one million eggs, which are spherical, yellow, and about 180 to 200 microns in size. Approximately 20 to 30 minutes after fertilization, the first polar body appears.

Significance

Dietary and Medicinal uses

Sea cucumbers hold significant commercial value in dietary, medicinal, and ecological sectors. Their body parts are used to develop functional foods and nutraceutical products. Numerous commercial items, such as juice, balm, liniment oil, cream, toothpaste, gel face wash, body lotion, and soap are prepared from sea cucumber extracts. Notable brands include ArthiSea and SeaCuMax for arthritis, and Sea Jerky are more popular. In traditional Chinese medicine, sea cucumbers are used to treat body weakness, impotency, debility in the aged, constipation, and frequent urination. Recent research has identified various bioactive compounds in sea cucumbers with properties such as anti-angiogenic, anticancer, anticoagulant, anti-hypertensive, anti-inflammatory, antimicrobial,

antioxidant, antithrombotic, antitumor, and wound-healing effects. They are rich in mucopolysaccharides, like chondroitin sulfate, which helps reduce arthritis pain and inhibit viruses such as herpes and HIV.

Ecological and Environmental benefits

Nutrient Cycling: Sea cucumbers play a crucial role in nutrient cycling on the ocean floor. They help to decompose organic matter, recycle nutrients and maintain the health of marine ecosystems.

Sediment Mixing: By burrowing and feeding, sea cucumbers aerate the seafloor sediment, which enhances the habitat for other marine organisms and contributes to the overall biodiversity of the ecosystem. Sea cucumbers are integral to the coral ecosystem, digesting sand and producing calcium carbonate, a key component of coral reefs. This process helps to sustain the coral reefs.

Nutritional and Economic benefits

Sea cucumbers have culture importance due to its high nutritional content, including 82% protein, 1.7% lipid, 8.9% water, and 4.8% fibre (dry weight). They are an ideal dietary tonic, higher in protein and lower in fat, with an impressive nutrient profile of vitamins A, B1, B2, B3, essential amino acids, trace metals, and minerals like calcium, magnesium, iron, and zinc. The protein content is comparable to that of a hen's egg, and their low-fat content makes them suitable for people with high blood pressure.

Impact of climate change

Studies have shown that tropical sea cucumbers play a key role in mitigating the negative effects of global warming on coral reefs. They help counteract ocean acidification by naturally increasing the pH of the water around their reef defecation sites. The natural calcium carbonate turnover is significantly influenced by the activity of sea cucumbers and other bioeroders, which dissolve calcium carbonate sediment.The impact of climate change, global warming, and ocean acidification on biodiversity loss canbe assessed only with sustained monitoring of the sea cucumber populations as an indicator species, especially in regions like Lakshadweep atolls.

Future prospects of sea cucumber farming

India has demonstrated potential in developing research strategies for over-exploited sea cucumber resources with successful breeding and seed production techniques for species like *H. scabra* and *H. spinifexra*. Further research is needed to develop seed production techniques for other depleted and high-value unexploited species. Future efforts should focus on improving nursery rearing and grow-out techniques for holothurian juveniles, enabling cost-effective mass production through hatchery systems. India may also provide regulated permits for collecting wild animals of these threatened species for hatchery and aquaculture programs and ensure the protection of released juveniles until harvest.

Conservation measures

Sea cucumbers face various threats, including illegal trades, overharvesting, habitat destruction, climate change, destructive fishing practices, pollution, and irresponsible tourism activities. To ensure their long-term survival, conservation measures are essential. These measures include regulation in harvesting, establishing marine protected areas, conducting regular monitoring and research, involving local communities in conservation efforts, enforcing laws to deter illegal activities, protecting habitats like coral reefs and seagrass beds, and promoting captive breeding and aquaculture. Implementing these strategies helps maintain the health of marine ecosystems and protect sea cucumber populations. Organizing the awareness programmes about the importance and conservation of the sea cucumber among the islanders may act as a huge step towards the conservation of these innocent marine creatures in the wild.

Conclusion

Every organism makes a different contribution to its ecosystem, and it is no different for the sea cucumbers. Cucumbers are remarkable organisms with unique characteristics and significant ecological roles in coral reef environments. They provide food and shelter and also contribute to reef productivity. Conservation efforts, including sustainable management and public awareness, are vital for their preservation and the health of coral reefs. Protecting sea cucumbers is crucial for maintaining the delicate balance of marine environments and responsibly managing natural resources.

Acknowledgment

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References are available upon request from the corresponding author

Seacucumbers from Lakshadweep islands

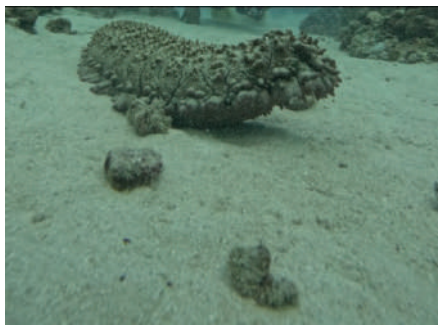
Actinopygamauritiana

Bohadschiaatra

Holothurialeucospilota

Holothuriaatra

Stichopuschloronotus



Thelenotaananus

Promoting Scientific Fish Farming Practices in Kandhamal District: An initiative of ICAR-CIFA

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In Kandhamal district, Odisha, where challenging geographical and climatic conditions prevail, the ICAR-Central Institute of Freshwater Aquaculture (ICAR-CIFA) has launched a transformative initiative aimed at improving fish farming practices among Scheduled Caste (SC) communities. Funded under the Scheduled Caste Sub-Plan (SCSP) and the Department of Science and Technology (DST, Govt. of India), the program focuses on introducing scientific methods in aquaculture, particularly composite carp culture. This article explores the program's approach, methodologies, and the resulting enhancements in fish production and economic outcomes for SC fish farmers and farmwomen in the region.

Introduction

Kandhamal district, located in the eastern state of Odisha, India, faces unique challenges in fish farming due to its hilly terrain, limited water resources and socio-economic constraints. Traditionally, the SC communities in this region have relied on subsistence farming and low- yield fish farming practices, which offer limited economic returns and fail to meet the nutritional needs of households. Recognizing the potential for aquaculture to improve livelihoods and food security, ICAR-CIFA launched an initiative aimed at promoting scientific fish farming practices among SC communities in Kandhamal. Funded under the Scheduled Caste Sub-Plan (SCSP) and supported by the Department of Science and Technology (DST, GoI), this program focused on introducing composite carp culture to utilize the local water resources and improve the socio-economic status of marginalized groups. The initiative was implemented in six villages in Kandhamal i.e., Kurtibadi, Raikia, Ratanga, Pakanagaon, Balandapada and Phiringia. The program provided specialized training, hands-on demonstrations, and essential resources such as fish seeds, feed, nets and lime to SC fish farmers and farm women. This article delves into the program methodologies, key interventions, and its impact on fish production and the socio-economic status of the beneficiaries.

The approach

The success of any developmental program lies in its alignment with the specific needs of the target community. With this principle in mind, the ICAR-CIFA initiative began with extensive consultations involving key stakeholders, including local government officials, representatives from the Krishi Vigyan Kendra (KVK) and community leaders. These discussions helped in identifying priority areas for intervention, such as use of community tanks and abandoned water bodies for scientific aquaculture practices. The initiative by ICAR-CIFA was launched during 2022.

Additionally, workshops, field days, and media coverage were organized to facilitate knowledge dissemination and encourage the replication of successful practices in other regions. The program's success was continuously evaluated through beneficiary feedback and stakeholder consultations, ensuring its relevance and adaptability to local conditions.

Pre-stocking management is a crucial phase in aquaculture, laying the ground work for successful fish farming. This phase begins with thorough pond preparation, including dewatering and desilting to enhance water quality, and the removal of aquatic weeds and predatory fish.

Kisan Mela cum Exhibition at ICAR-CIFA

Mahu a oil cake is applied @ 2,500 kg/ha/m per of water depth as a natural pesticide to eliminate unwanted predatory species. Ponds are then filled with water from nearby canals, maintaining levels between 1.5 to 1.8 meters for optimal fish growth. Liming at 200 kg/ha is done to control pH levels, enhance water clarity, and improve dissolved oxygen levels, which promotes phytoplankton growth. Manuring with cow dung @ 2,000 kg/ha, followed by single superphosphate, ensures balanced nutrient levels for plankton growth, which is essential for fish nutrition.

For stocking, fingerlings of Catla, Rohu and Mrigal were stocked one week after manuring, with a stocking density of 10,000 fish per hectare. Fingerlings were treated with potassium permanganate or salt solutions to prevent infections. The polyculture practice of IMC at 3:4:3 ratio of Catla, Rohu, and Mrigal was followed, optimizing ecological balance and resource use. The fish are raised over 8 months with a single stocking and multiple harvesting strategy to ensure steady income and prevent overstocking.

Post-stocking managment focused on tailored feeding practices, using rice bran, mustard oil cake, and occasional pellet feed @ 2.5 to 3% of the body weight was made. Organic manures like cow dung etc.

A comprehensive training module was designed, tailored to the needs of SC fish farmers and farmwomen. The training sessions covered both theoretical knowledge and practical skills, with a strong emphasis on composite carp culture. This method, which involves the cultivation of multiple species of carp - catla, rohu and mrigal - in the same pond, is known for its efficiency in maximizing space and resources while enhancing fish production.

To ensure the effectiveness of the program, a robust monitoring and evaluation system was put in place. Fish growth and program performance were tracked regularly, with periodic assessments guiding tailored technical support.

Stocking of fingerlings for grow out culture

Feeding of floating fish feed

are applied to enrich pond water for supporting plankton growth. They were guided for monthly netting and bottom raking monitor fish health, ensuring a productive and sustainable aquaculture operation.

Targeted interventions

Several training awareness programmes and demonstrations were carried out in Kandhamalas well as the campus of ICAR-CIFA, Bhubaneswar. Table 1 & 2, provide details about capacity building programmes organized in the selected region.

Table-1: Organised Awareness cum training programme on Freshwater aquaculture

Sl No.	Title of Programmes	Venue	Duration	No. of Beneficiaries
1	Awareness programme on "Scientific Aquaculture "	Phulbani, Kandhamal	28 Feb 2023	140
2	Trainingprogrammeon"Freshwater Aquaculture" for SC fish farmers	ICAR-CIFA, Bhubaneswar	24 to 26 April 2023	51
3	Farmer Scientist Interface on "Freshwater aquaculture"	Balandapada, Kandhamal	24 May 2023	150
4	"Fish Harvest Mela - cum Scientists-Farmers Interface"	Phiringia, Kandhamal	07 June 2023	150
5	Training on "Freshwater Pearl Farming for Entrepreneurship Development"	ICAR-CIFA, Bhubaneswar	17-19 October 2023	15
6	Kisan Mela-Cum-Exhibition	ICAR-CIFA, Bhubaneswar	20 Feb 2024	250

The comprehensive efforts undertaken by ICAR-CIFA yielded significant improvements infish production and economic viability for SC fish farmers and farmwomen in Kandhamal.

Fish Harvest Mela

Table-2 provides a detailed comparison of fish production before and after the intervention, highlighting the positive impact of the scientific carp culture method. The average fish production across the adopted ponds increased from 1247.2 kg/ ha/ year to 2554.5 kg/ha/year, representing a substantial gain in productivity. Moreover, the Benefit-Cost(B:C) ratio improved from 1.3 to 1.7, indicating enhanced economic returns for the beneficiaries.

Table 2: Production details of adopted ponds in Kandhamal before and after Intervention

Village Name	Pond Name	Pond Area (ha)	Fish Production	
			Before Intervention (kg/ha)	After Intervention (kg/ha)
Pankangaon	Pond 1	0.4	950 (380)	1953 (781.2)
Pankangaon	Pond 2	0.2	525 (105)	765 (153)
Phiringia	Pond 3	0.6	925 (555)	1800 (1080)
Balandapada	Pond 4	2.5	1430 (3575)	2975 (7437.5)

The program's success can be attributed to the holistic approach adopted by ICAR-CIFA, which integrated stakeholder consultations, targeted training, resource provision, andrigorous monitoring. By addressing the specific needs and challenges of the SC communities in Kandhamal, the program not only boosted fish production but also contributed to improved household nutrition and socio-economic status. The increased availability of fish for household consumption has enhanced the nutritional intake of local families, while the additional income generated from fish sales has strengthened their economic resilience.

Conclusion

ICAR-CIFA initiative in Kandhamal district represents a successful model for enhancing aquaculture practices among marginalized communities. Through a combination of scientific interventions, targeted support, and continuous monitoring, the program has significantly improved fish production and economic outcomes for SC fish farmers and farmwomen. The adoption of composite carp culture, along with the provision of essential resources and training, has led to substantial gains in productivity, profitability and resilience within the community. The success of the program underscores the potential for replicating this model in other regions with underutilized water resources. Ongoing support, careful resource management and continuous guidance is essential to ensure the sustainability of these gains. Furthermore, the program's emphasis on climate-resilient aquaculture practices contributes to food security, environmental sustainability, and the empowerment of women in these communities. As the initiative continues to evolve, it holds promise for furthering the socio-economic development of SC of rural development and poverty alleviation.

ସର୍ବସାଧାରଣ

ମତ୍ସ୍ୟ ଅମଳ ମେଳା ଓ କୃଷକ-ବୈଜ୍ଞାନିକ ଭାବ ବିନିମୟ କାର୍ଯ୍ୟକ୍ରମ

ଫୁଲବାଣୀ (କ୍ୟୁରୋ): ଭାରତୀୟ କୃଷି ଅନୁସନ୍ଧାନ ପରିଷଦ ଅନ୍ତର୍ଗତ କେନ୍ଦ୍ରୀୟ ମତ୍ସ୍ୟ ଜଳଜୀବ ପାଳନ ସଂସ୍ଥା (ସିଫା) ଓ ଓଡିଶା ସରକାରଙ୍କ ଜଳସମ୍ପଦ କୃଷି ବିଭାଗର ମିଳିତ ସହଯୋଗରେ ମାଛ ଅମଳ ମେଳା ଓ ବୈଜ୍ଞାନିକ-କୃଷକ ଭାବ ବିନିମୟ କାର୍ଯ୍ୟକ୍ରମ ଫିରିଙ୍ଗିଆ ବ୍ଲକ୍ ଅନ୍ତର୍ଗତ ରତଙ୍ଗବନ୍ଧଠାରେ ଅନୁଷ୍ଠିତ ହୋଇଯାଇଛି। ଏଥିରେ ସ୍ଥାନୀୟ ମତ୍ସ୍ୟଚାଷୀ, ବୈଜ୍ଞାନିକ ଏବଂ ସରକାରୀ କର୍ମଜର୍ତ୍ତା ଯୋଗ ଦେଇଥିଲେ। ମତ୍ସ୍ୟ ଅମଳ ମେଳାରେ କୃଷକମାନେ ଅମଳ କରିଥିବା ମାଛ ପ୍ରଦର୍ଶନ କରିଥିଲେ। ଏହି ମେଳା କୃଷକଙ୍କ ଜ୍ଞାନ ଓ ଅନୁଭୂତିକୁ ବିତରଣ, ଏକତ୍ରିତ କାର୍ଯ୍ୟ କରିବାକୁ ଆଗ୍ରହ ସୃଷ୍ଟି ଏବଂ ଜଳଜୀବ ପାଳନ ଗୋଷ୍ଠୀଙ୍କ ମଧ୍ୟରେ ଜ୍ଞାନ ଓ ଅନୁଭୂତିକୁ ବିତରଣ କରିବା ପାଇଁ ଏକ ଚମତ୍କାର ମଞ୍ଚ।

ଆଇସିଏଆର୍-ସିଫା ତତ୍ତ୍ୱାବଧାନରେ ଜାତିର କୃଷକଙ୍କ ବୈଷୟିକ ଜ୍ଞାନ କୌଶଳ ୨୦୨୧ରୁ ଯୋଗାଇ ଆସୁଛି ବୋଲି ସିଫାର ନିର୍ଦ୍ଦେଶକ ଡା ପିକେ ସାହୁ କହିଛନ୍ତି। ରତଙ୍ଗବନ୍ଧ କ୍ଷୁଦ୍ର ଜଳସେଚନ ପ୍ରକଳ୍ପରେ ମହିଳା ସ୍ୱୟଂ ସହାୟକ ଗୋଷ୍ଠୀର କୃଷକମାନେ ବୈଜ୍ଞାନିକ ପଦ୍ଧତିରେ ମାଛ ଚାଷ କରିଆସୁଛନ୍ତି। ଫିରିଙ୍ଗିଆ ମଣ୍ଡଳ ଉନ୍ନୟନ ଅଧିକାରୀ ରଶ୍ମୀରଂଜନ ମହନ୍ତ, ସିଫାର ପ୍ରଧାନ ବୈଜ୍ଞାନିକ ଡା ଏସ୍‌ଏନ୍ ସେଠୀ, ଡା ପିକେ ମିଶ୍ର, ଡା ଜିଏସ୍ ସାହା ଏବଂ ଜଳସମ୍ପଦ ଜିଲ୍ଲା ମତ୍ସ୍ୟ ଅଧିକାରୀ ପ୍ରଫୁଲ୍ଲ ଜହିର, ରତଙ୍ଗ ସରପଞ୍ଚ ପାର୍ବତୀ ମଲିକ, ସହକାରୀ ମତ୍ସ୍ୟ ଅଧିକାରୀ ଆଶାଲକ୍ଷ୍ମୀ ନେରହ, ଫିରିଙ୍ଗିଆ ବ୍ଲକ୍ ପ୍ରୋଜେକ୍ଟ କୋଡିନେଟର ବାଦଲ କିଶୋର ନାୟକ ଏହି କାର୍ଯ୍ୟକ୍ରମରେ ଯୋଗ ଦେଇଥିଲେ। ଏହି କାର୍ଯ୍ୟକ୍ରମରେ ୧୫୦ କୃଷକ ଓ ମହିଳା ମତ୍ସ୍ୟଚାଷୀ ଭାଗ ନେଇଥିଲେ।

Turning Waste into Wealth: *Sustainable Aquaculture Feeds from Industrial Food Waste*

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ABSTRACT

The increase in population and biologically decreased level of sustainable fishery stock fraction to 64.6% in 2019 which is 1.2% reduced than in 2017 has resulted in the increased demand for global food fish. As aquaculture greatly depends on high protein feeds with protein content ranging from 25% - 50%. The search for various alternative sources of protein has been a major topic of interest in fish nutrition studies to replace fish meal. The alternatives, derived from waste streams, offer a cost-effective and environmentally friendly solution, aligning with circular economy principles and the United Nations' Sustainable Development Goals. The use of food waste as protein source minimizes the need to rely on traditional protein source. Research is urgently needed to address knowledge gaps on food waste use and processing. The future research should focus on achieving 100% fish meal substitution, with a focus on optimizing feed quality, palatability and cost-effectiveness.

KEYWORDS: Alternative protein sources, Aquaculture, Waste to wealth, Fish nutrition.

INTRODUCTION:

The increase in population and biologically decreased level of sustainable fishery stock fraction to 64.6% in 2019 which is 1.2% reduced than in 2017 has resulted in the

- Due to depletion fish stock and increased demand for fish meal has resulted in the search of alternate protein sources such as rapeseed meal, sunflower meal, palm kernel meal etc.
- These alternatives, derived from waste streams, offer a cost-effective and environmentally friendly solution, aligning with circular economy principles and the United Nations' Sustainable Development Goals.
- The future research should focus on achieving 100% fish meal substitution with a focus on optimizing feed quality, palatability and cost-effectiveness.

increased demand for global food fish. The aquaculture industry has been expanded with a production of 94.4 million tonnes in the year 2022 with a total value of 296 billion USD, exceeding the capture fisheries production of 91.0 million tonnes to meet the growing demand for fish protein. Since 1950, aquaculture's share in total production has spiked from 4 - 5% to 51% in the year 2022, crossing the capture fish production for the first time in history. The Asian countries contribute 90% of the global aquaculture production. From 9.9 kg in the 1960s to a record high of 20.5 kg in 2021, the world's per capita intake of aquatic food increased although it decreased slightly to 20.2 kg in 2022 (FAO, 2024).

As aquaculture greatly depends on high protein feeds, with protein content ranging from 25% - 50% the search for various alternative sources of protein has been a major topic of interest in fish nutrition studies. In recent trends there has been increasing interest has shown towards deriving protein from industrial food waste which coincides with the12th sustainable goal "Responsible consumption and production" converting the waste to wealth (The Sustainable Development Goals Report, 2024).Examples of such include sunflower oil meal, canola meal, soybean meal, insect meal, etc. The paper explores the use of waste from the food processing industry for the production of aqua feeds.

PROBLEMS WITH EXISTING AQUACULTURE PRODUCTIVITY

In the diets of farmed fish, fish meal is the commonly used and expensive ingredient in the aqua feed industry. The fish meal has high amino acid availability and protein digestibility with a crude protein content of 60% to 80% ((Anderson et al., 1995). It also contains a high amount of essential fatty acids, minerals and trace elements. However, the availability of fish meal has been dwindling in recent years due to the over-exploitation of fisheries. Also, fish meal is a major pollutant as it may be contaminated with persistent organic pollutants (POPs),heavy metals and pesticides.

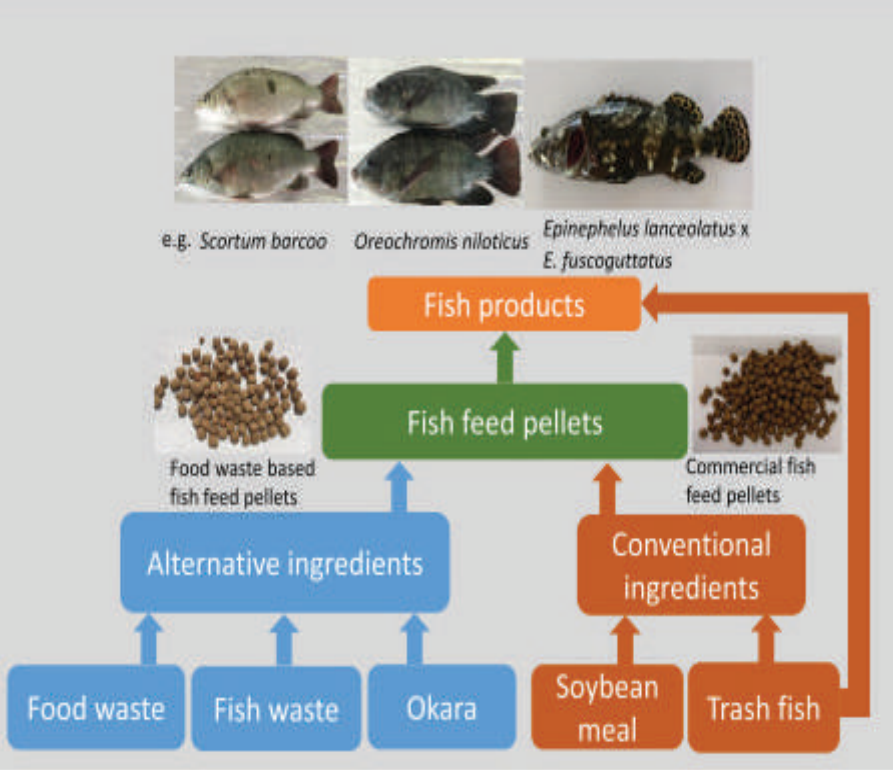

Fig No 1: Alternative and Conventional Ingredients in Aquaculture Feed Production (Mo, W. Y et al. 2018)

FOOD WASTE AS PROTEIN SUPPLEMENT IN FISH FEED

The food industry wastes ranges from agri-waste from crops, food waste including both animal and plant waste to processing waste of algae or seaweed. The reports state that nearly 24 million tonnes of waste is generated in the animal processing industry which includes livestock, poultries and fish (Martínez Alvarez et al., 2015). The animal by products have a complete nutritional requirement profile than plant-based wastes and are incorporated in both hydrolysed and raw form in aqua feeds. Both the animal waste (fish meal) and plant-based waste used in the aqua feed industry are discussed below.

ALTERNATIVES

FISH WASTE:

The tissue that is not appropriate for consumption-like intestines, heads, tails and bones can be utilized for fish meal production. The studies of Kristinsson and Rasco (2000) reveal that more than 50% of the total marine fish captured is not used for food consumption. Currently, the fish meal is produced with fish and shrimp discards. The trout intestine discards from smoking fish can be a good fatty acids source for gilthead bream (Kotzamanis et al. 2001). The fish meal produced from fish waste has a comparatively low crude protein of 58% than a high-quality fish meal of 60 to 70%. The former is still nutritious and acts as an excellent source of fat, minerals as well as mono-unsaturated fatty acids (oleic and palmitic acid).

PLANT PROCESSING WASTE

The plant processing waste that can be efficiently used to replace fish meal can be categorised as follows: oilseed cake/ meal and by-products

OILSEED CAKE

The solid residues from oil production are oilseed meals, like rapeseed meal, sunflower meal, palm kernel meal etc. They can effectively replace fish meal as they have high protein content. According to Smith et al. (2018),partial fishmeal substitution tests with high protein Sunflower meal (at just 12.5%) revealed that Arctic charr at the grow-out stage had a comparable ultimate weight increase to traditional fish feed. There were no indications of gastric irritation. Das et al. incorporated Sesame oil meal as a fish meal alternative and compared it with

commercial floating pellets with *Labeorohita* and observed similarities in feed intake and weight gain. Rapeseed meal also known as canola meal was used as a substitute for fish meal in the *Pseudobagrusussuriensis* diet resulting in no changes in survival rate and weight gain also did not affect the muscle composition of fish and crude protein level (Bu et al., 2018). Palm kernel meal (PKM) is generated as a by-product of palm oil production in countries like Malaysia and Indonesia. PKM can be effectively used in tilapia diet as they can easily digest the proteins (Yossa et al., 2021).

BY-PRODUCTS

The solid residues remaining post-food production are called by-products which include soybean meal/ okara and brewer's spent yeast. Taking their abundant production and high nutritional value into consideration. These have great appeal for aquaculture. The residue produced from soybean milk or tofu production is called soybean meal (SBM), also identified as okara. Most research studies are focused on SBM because of its high protein content ranging between 16.1% to 33.4%. Studies have been done on SBM inclusion in various fishes from 20% for Nibeamiichthioides (Huynh and Nugegoda 2011), 75% for Nile tilapia (Huynh and Nugegoda 2011), to 100% for channel catfish (Kamble, and Salin 2017) where no hindrancewas found on their growth. Brewing industry by-products both Brewer's spent grain (BSG) and spent yeast are used in the aqua feed industry. The grain contains lignocellulosic components like cellulose, hemicellulose, and lignin also it contains 15% to 24% of protein whereas the spent yeast contains a high protein of 40% to 50% and a balanced amino acid profile. Based on the studies conducted Jayant et al. (2018) propose 50% BSG incorporation in the diet of *Pangasianodon hypophthalmus* which is beneficial on economic front without any compromise on fish growth and FCR. Similarly in studies conducted by Pongpet et al., (2016) on *Pangasianodon hypophthalmus*x *Pangasiusbocourti*has shown the best results even with a 45% substitution of the fish meal also protein levels in fish increased after feeding. All these studies suggest the benefits of converting brewing waste to actual profit in aquaculture, corresponding with the goals of the circular economy.

INSECT WASTE

This involves the use of insects to convert food waste to valuable protein sources. This method is called insect biomass conversion. The insect meal contains about 60 – 80% of crude protein. Unlike plant-based protein, insect meal does not lack major amino acids in aquaculture (methionine and leucine) and the digestibility rate is also high with 98.9% for organic matter and 66.9% for protein content (Sánchez-Muros et al., 2014).For example, the Black soldier fly has been extensively studied for years due to its quick digestion of organic food waste and high protein content. Mealworms have the benefit of digesting both food and plastic trash. Furthermore, earthworms have traditionally been employed for composting food waste.

INSECTS / WORMS	PROTEIN CONTENT %	REFERENCE
Black soldier fly (*Hermetiaillucens*) larva	50	Barragan-Fonseca et al., 2018;
Mealworm (*Tenebriomolitor*) larvae	52	Jeong et al., 2022;
Earthworm (Eiseniafetida)	54.6 73(defatted)	Tedesco et al., 2020

Table No 1: Protein content of insects

FOOD WASTE:

The uneaten or discarded food is disposed of in landfills as municipal solid waste (MSW) which produces a methane gas resulting in global warming. Hence this waste can be utilized in aquaculture feed. But this is relatively new concept in the aquafeed industry and the knowledge is limited. Orange-spotted grouper (*Epinephelus coioides*) diets containing 10% to 20% have shown no changes in growth comparison with feed with 0% food waste (Hsieh,2010). The studies reveal that sufficient levels of essential amino acids, carbohydrates, lipids and phosphates and proteins can be fed to grey mullet, tilapia, grass carp and bighead carp (Mo et al. 2014).

CHALLENGES

Apart from the above-mentioned benefits, every waste has its own disadvantages, which are as follows:

1. **Plant-based waste:** They contain incomplete amino acid profile, lack specific fatty acids, poor palatability and presence of antinutritional factors (ANF) and mycotoxin.
2. **Insect-based waste:** High levels of chitin affect the protein digestibility; it does not have good fatty acid profile as fish oil. It also rather increases the cost of production.
3. **Food waste:** Highly heterogeneous in nature, difficulty in feed formulation, pre-treatment is required before further processing.

FUTURE PERSPECTIVES

Stillto date, 100% substitution of fishmeal is not possible. The industry

food waste like PKM, SBM, BSG, SOM and SFM has shown promising results with less than 50% replacement. Also, certain food waste incorporation affects palatability and digestibility when fed to carnivorous fishes. The cost of feed production can be effectively reduced by using alternative protein sources in place of fish meal. In future, studies should aim to 100% replacement of fish meals. Research studies should be conducted on the risk of consumption of waste-fed fishes (Sampathkumar, K et al. 2023).

CONCLUSION

A consistent supply of fish feed is required to ensure food security. The use of food waste as a protein source minimizes the need to rely on traditional protein sources. Research is urgently needed to address knowledge gaps on food waste use and processing. Renewing standards and regulations in a timely manner will also assist the sector advance towards using waste materials in fish feed.

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