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42nd Edition



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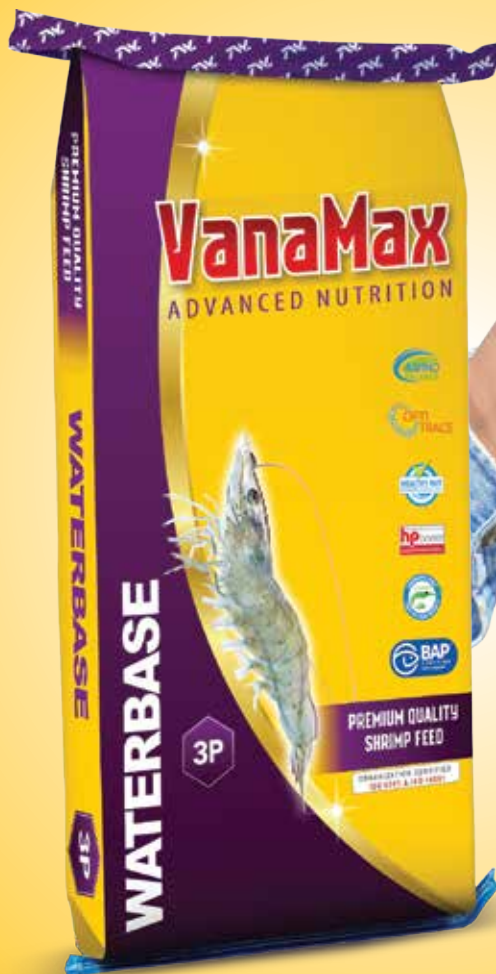
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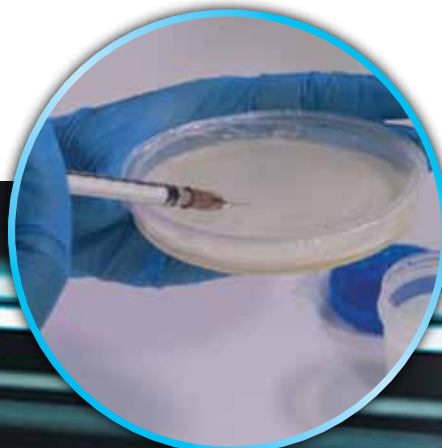
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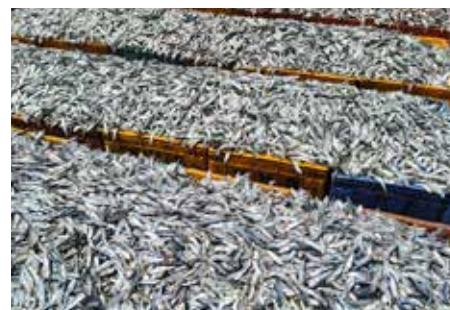
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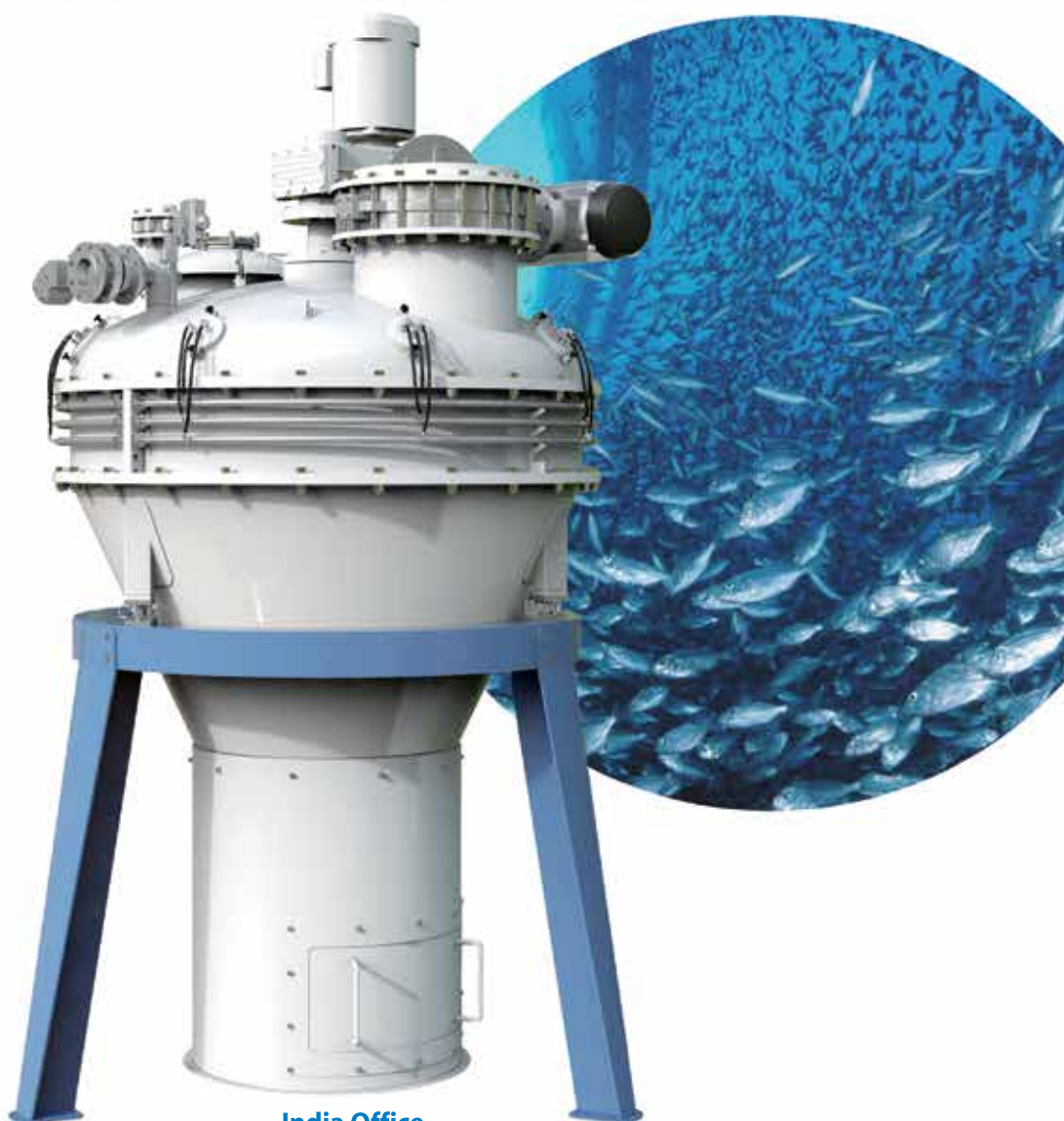
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BMR Blue Genetics export its Skyline broodstock to Aquilia Imports in Bangladesh; Its a pride thing to Indian Aquaculture sector

Climate change has emerged as one of the most critical challenges affecting global aquaculture and fisheries production, primarily driven by the increasing concentration of greenhouse gases. The integration of climate-resilient technologies and biotechnological interventions in aquaculture can effectively address these challenges and promote sustainable and secure food production systems.



Dear Readers,

The November 2025 issue of Aqua International is in your hands. In the news section, you may find news about...

We congratulate BMR Blue Genetics Pvt Ltd,

a joint venture between BMR Group, India, and Blue Genetics, Mexico, a subsidiary of Groupe Grimaud, France that their Broodstock Multiplication Centre located at Kavali, India has successfully exported 500 Skyline broodstock to Aquilia Imports, Bangladesh. To reduce reliance on imported broodstock, the Government of India encouraged the establishment of Broodstock Multiplication Centres (BMCs). In response, BMR partnered with Blue Genetics Mexico—a subsidiary of Groupe Grimaud, France—and launched India's first private-sector BMC in 2019 under BMR Blue Genetics Pvt Ltd. BMR BLUE GENETICS BMC facility is located in a remote, bio-secure zone near Kavali Town in SPSR Nellore District, Andhra Pradesh. The facility is India's first and only BMC with Bio-floc Technology for producing SPF P. vannamei broodstock under Indian conditions. This milestone reaffirms India's evolving role—not just as an importer but as a trusted global exporter of high-quality SPF broodstock. It reflects our unwavering commitment to innovation, quality and global partnerships, and strengthens our dedication to the Make in India initiative. BMR Blue Genetics informed that they produce two strains - **Golden Line G4**, engineered for enhanced disease resistance and survival and **Skyline**, a balanced strain offering exceptional survival, growth and low FCR—validated through rigorous challenge tests.

We need atleast 30 to 40% land to have proper growth of aquaculture in Gujarat state though 89,000 hectares of land is available in Gujarat

coastline, the land in use for aquaculture in the state is only 9,400 hectares which comes to 10%. The main obstacle for the progress and development of Shrimp culture in Gujarat state is non allotment of land though 89,000 hectares of land is available in Gujarat coastline. The land in use for aquaculture in Gujarat is only 9,400 hectares which comes to 10 per cent. We need atleast 30 to 40 per cent land to have proper growth of aquaculture in Gujarat state, said Mr Naresh Tambada, Deputy Director for Gujarat region of The Marine Products Export Development Authority speaking to Aqua International Editor Mr M.A. Nazeer here on September 9. Tiger Shrimp production: Tiger Shrimp production became strong in Gujarat. In 2024 – 2025 out of 42,700 metric tonnes of shrimp production, Tiger shrimp production was 32,000 tonnes (76%) from 9,400 hectares of land, while Vannamai production was on 11,000 tonnes (around 30%). Officially, over 1,450 farmers are doing brackish water shrimp farming in the state. The state government allots land for aquaculture farming on lease, mostly 5 hectares per person. There is a lack of significant fish farming activity in Gujarat.

Fisheries sector hopes to beat U.S. curbs with sustainability About 10 Indian marine and saline fish and shrimp varieties are set to get the global Marine Stewardship Council (MSC) certification soon. The first batch is set to be submitted for the certification in 2026. According to experts, the certification is likely to increase the revenue of the fisheries sector by 30% and help fishermen and traders find new markets other than the US, in the event of further trade restrictions due to the higher tariffs. The certification will also help fishing communities begin ecologically sustainable fishing, practices and ensure steady incomes. Fisheries Development Commissioner K. Mohammed Koya told that the Union Government, under the Pradhan Mantri Matsya Sampada Yojana (PMMSY), would subsidise the certification process, which is done



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.

Contd on next page

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by third party auditors. Mr Koya said that global affluent markets such as European and Japanese ones, are looking for sustainably sourced fish. "Sustainability is part of our fisheries. Some of our fish varieties may not immediately qualify for sustainable segregations, but many of the varieties are amenable to certification. Once we recertify the fish, the advantages that we get include access to the best markets. It is a way of certifying the fish so that it gets a better price," he said.

MPEDA holds marine sector Stakeholder Awareness Meetings on India-UK CETA at Chennai and Vizag. MPEDA Chairman, D.V. Swamy, said that the recently signed India-UK Comprehensive Economic and Trade Agreement marks a significant milestone in India's seafood export sector, and there is an imperative need to adopt strategies for availing the opportunities like value addition and upskilling offered by it. He highlighted this issue during the Marine Products Export Development Authority's Stakeholders Awareness Meetings on the benefits and opportunities of the agreement for the marine sector in Chennai and Vizag on October 16 and 17, respectively. Mr Anil Kumar P., Joint Director, MPEDA, presented the salient features of CETA and opportunities for the marine products export sector. Mr Alex Paul Menon, Development Commissioner, MPEZ-SEZ, discussed the possibilities for the development of Marine Aqua Parks SEZ in Tamil Nadu during the meeting in Chennai. The stakeholders shared their perceptions about the opportunities for India's marine products export sector. Under the agreement, 99 per cent of tariff lines will now enjoy zero-duty access, enhancing the competitiveness of Indian seafood in the UK market. Key export items, such as Vannamei shrimp, frozen squid, lobsters, frozen pomfret, and black tiger shrimp, will benefit from duty-free access.

A skill development training programme on "Lobster and Mud Crab Fattening" funded by Tamil Nadu Skill Development Corporation under the Naan Mudhalvan Vetri Nichayam Scheme was conducted from 17 September to 4 October 2025 at Dr MGR Fisheries College and Research Institute, Tamil Nadu Dr J. Jayalalithaa Fisheries University, Ponneri, Thiruvallur District, Tamil Nadu. The training aimed to impart theoretical and practical knowledge on different aspects of lobster and mud crab fattening to enhance skill proficiency and employability among the Pazhaverkadu fisherfolks including surrounding regions like Minjur and Ponneri areas. A total of 23 participants have completed the training programme. Dr S. Balasundari, Dean, Dr MGR. FC&RI, Ponneri gave a special address to the participants and encouraged to learn the techniques of lobster and mud crab fattening.

PM lays foundation stones for ₹160-crore fishery projects in Odisha. Prime Minister Narendra Modi on October 11, 2025 virtually laid the foundation stones for two fishery projects worth around ₹160 crore in Odisha. He laid the foundation stones for the fishery projects while launching the ₹24,000 crore Pradhan Mantri Dhan Dhaanya Krishi Yojana (PMDDKY) and a ₹11,440 crore Mission for Aatmanirbharta in Pulses in Delhi. The fishery projects included a ₹100 crore integrated aqua park at Basantapur in Sambalpur district and a ₹59.13 crore fish market at Pandara in Bhubaneswar. Chief Minister Mohan Charan Majhi, his Deputy K.V. Singh Deo and others joined the event virtually from a State level function on OUAT premises in Bhubaneswar. Majhi said the fish market project in Bhubaneswar is another important initiative under the Pradhan Mantri Matsya Sampada Yojana. The chief minister said that of the ₹59.13 crore, ₹30 crore will be given by the Centre and remaining amount by the state.

The higher tariffs imposed on Indian goods by American President Donald Trump would have a long-term impact, especially for India's marine exports, officials of the Union Ministry of Commerce told the Public Accounts Committee headed by senior Congress leader K.C. Venugopal. The PAC met to deliberate the 'Performance audit report on the Export Promotion Capital Goods Scheme. There were several questions on the impact of U.S. tariffs on Indian exports. There were several questions on India's marine exports from both sides of the aisle, including from the PAC Chairperson, Mr Venugopal. Several members pointed out that many of India's coastal towns would be directly impacted if shrimp exports declined drastically.

In the Articles section, **"Management practices in *Litopenaeus vannamei* farming in simplified form"**, authored by Mr Balai Jana and Mr Subrato Ghosh, says in last one decade, increased numbers of fish farmers in three coastal districts of West Bengal have adopted *Litopenaeus vannamei* farming in brackishwater ponds on a commercial scale as means of self employment and income generation. Since 2017, the first author, aged 52 years, has visited 90 to 100 nos of *L. vannamei* farms in private sector in these districts on requests to give necessary advice for protecting the growing *L. vannamei* from diseases and keep pond and water conditions healthy all throughout culture period.

Another article titled, **"Mysterious life cycle of Indian Mottled Eel"**, authored by Swapnil Ghatge, Dr Balaji Kharatmol, Krishna Patil, Dr Rajiv Rathod, The freshwater eel, *Anguilla bengalensis* (Gray, 1831), commonly referred to as the Indian mottled eel, is a significant species belonging to the family Anguillidae. It is widely distributed across India, including states like Kerala, Andhra Pradesh, Arunachal Pradesh, Manipur, Meghalaya, Odisha, Tamil Nadu, Assam and Nagaland. Its range extends to neighbouring countries such as Pakistan, Bangladesh, Nepal, Sri Lanka, Myanmar and even as far as South Africa. In the Marathwada and Vidarbha regions of Maharashtra, it is locally known as 'Tambhu.' As a tropical species, the Indian mottled eel is the most prevalent freshwater eel in the inland waters of India.

Another article titled, **"Climate Resilient Aquaculture Technologies for Sustainable Aquaculture Production: A Way towards Combating the Climate Change Effects on Aquaculture"** authored by Gajjela Maheshwari, discussed that Climate change has emerged as one of the most critical challenges affecting global aquaculture and fisheries production, primarily driven by the increasing concentration of greenhouse gases. To mitigate these impacts, it is essential to adopt and implement climate-resilient technologies and adaptive management practices in aquaculture. The integration of climate-resilient technologies and biotechnological interventions in aquaculture can effectively address these challenges and promote sustainable and secure food production systems.

Readers are invited to send their views and comments on the news, special feature and articles published in the magazine which would be published under "Readers Column". Time to time, we shall try to update you on various aspects of Aquaculture sector. Keep reading the magazine Aqua International regularly and update yourself. Wish you all fruitful results in your efforts.

M.A.Nazeer
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BMR Blue Genetics exports 500 Skyline broodstock to Aquilia Imports in Bangladesh

BMR Blue Genetics Broodstock Multiplication Centre –
Pioneering India's Aquaculture Future



Chairman, B. Masthan Rao with the BMC Team Ladislao (Mexico), Marianne (Mexico) and V. Ravikumar, GM-Technical and others

Kavali, A.P: Since the early 1990s, the BMR Group has proudly contributed to the evolution of India's shrimp farming industry. In its early days, the sector faced challenges with Tiger shrimp with national production stagnating at just few tons per annum

Between 2003 and 2007, BMR played a pioneering role in introducing Specific Pathogen-Free (SPF) *Penaeus vannamei* (commonly known as Pacific White Shrimp)

broodstock, seed production and culture. Culminating in its official launch in 2009, through collective passion and perseverance, India's shrimp production soared to 1 million tons annually by 2022.

To reduce reliance on imported broodstock, the Government of India encouraged the establishment of Broodstock Multiplication Centers (BMCs). In response, BMR partnered

with Blue Genetics Mexico a subsidiary of Groupe Grimaud, France, and launched India's first private sector BMC in 2019 under BMR Blue Genetics Pvt Ltd, informed Mr V. Ravikumar, General Manager – Technical, BMR Blue Genetics Pvt Ltd.

However, since 2022, shrimp production has declined due to disease outbreaks such as Running Mortality Syndrome (RMS) and White Fecal Syndrome, which have influenced



Brooders ready to pack for export

survival rates, growth and feed conversion ratios. To address these challenges, Blue Genetics developed two new broodstock strains 1) Golden Line G4 and 2) Skyline under BMR BLUE GENETICS joint venture.

A Jewel in the Crown

The BMR Blue Genetics Broodstock Multiplication Centre stands as the most prestigious jewel in the crown of the BMR Group. Conceived by Dr B. Masthan Rao, the facility reflects his vision for a sustainable aquaculture industry in India. It fulfills the dream of supplying healthy, resilient, domestically produced broodstock directly to hatcheries across the country.

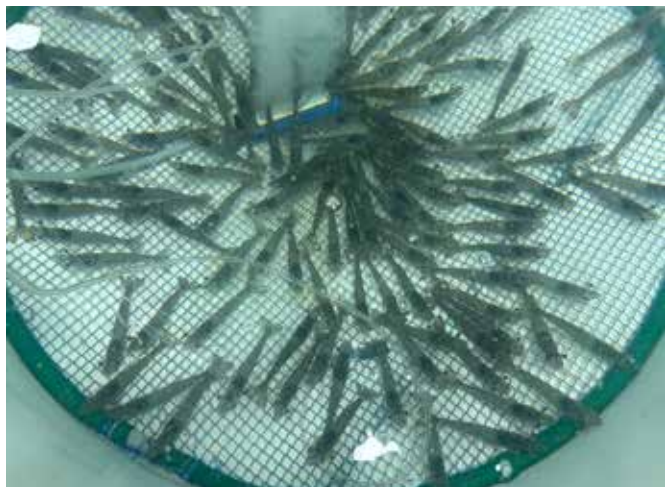
The facility is located in a remote, bio-secure zone near Kavali Town in SPSR Nellore District, Andhra Pradesh. The facility is India's first and only BMC with Bio-floc Technology for producing SPF *P. vannamei* broodstock under Indian conditions.

World-Class Infrastructure and Expertise

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Aerial view of the biosecured BMC facility



Acclimatizing the brooders for shipping

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Advantages of Local BMCs

- High survival and growth performance.
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- Superior tolerance to climatic and local salinity conditions.
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- Proven performance under diverse farm conditions.

Commitment to Quality

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- Hand-picked broodstock selection for optimal performance.
- Supplied over 73,760 broodstock to the industry to date.
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- Competitive pricing compared to imported stocks.
- Proudly aligned with the Make in India initiative.



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Breakthrough Strains

- **Golden Line G4:** Engineered for enhanced disease resistance and survival
- **Skyline:** A balanced strain offering exceptional survival, growth, and low FCR—validated through rigorous challenge tests.

A Historic Milestone

We are proud to announce a landmark achievement that BMR BLUE GENETICS BMC has successfully exported 500 Skyline broodstock to Aquilia Imports, Plot No. 10, Niribili Orchid, Kolatoli Road, Cox's Bazar – 4700, Bangladesh, said the General Manager.

This marks India's first BMC-certified broodstock export and the country's first-ever shrimp broodstock export with its inaugural shipment.

This milestone reaffirms India's evolving role – not just as an importer but as a trusted global exporter of high-quality SPF broodstock. It reflects our unwavering commitment to innovation, quality, and global partnerships, and strengthens our dedication to the Make in India initiative, he stated.



Technical team with brooder boxes ready to export

We need atleast 30 to 40% land to have proper growth of aquaculture in Gujarat state

Though 89,000 hectares of land is available in Gujarat coastline, the land in use for aquaculture in the state is only 9,400 hectares which comes to 10%.

Valsad: The main obstacle for the progress and development of Shrimp culture in Gujarat state is non allotment of land though 89,000 hectares of land is available in Gujarat coastline. The land in use for aquaculture in Gujarat is only 9,400 hectares which comes to 10 per cent. We need atleast 30 to 40 per cent land to have proper growth of aquaculture in Gujarat state, said Mr Naresh Tambada, Deputy Director for Gujarat region of The Marine Products Export Development Authority speaking to Aqua International Editor Mr M.A. Nazeer here on September 9.

Tiger Shrimp production: Tiger Shrimp production became strong in Gujarat. In 2024 – 2025 out of 42,700 metric tonnes of shrimp production, Tiger shrimp production was 32,000 tonnes (76%) from 9,400 hectares of land, while Vannamai production was on 11,000 tonnes (around 30%). Officially, over 1,450 farmers are doing brackish water shrimp farming in the state.

The state government allots land for aquaculture farming on lease, mostly 5 hectares



*Naresh Tambada,
Deputy Director, MPEDA, Valsad*

per person. There is a lack of significant fish farming activity in Gujarat.

Shifting from Vannamai to Tiger

Farmers in Gujarat are shifting from L.Vannamai to specific pathogen free Tiger shrimp farming. Now farmers are going for low stocking density with Tiger and are getting better production results.

Academic and Research Institutes

The sector in west coast has three research institutes on aquaculture / fisheries like CIBA at Navsari, CIFT & CMFRI at Veraval, and Fisheries Colleges at Navsari and Veraval.

3 Shrimp Feed Plants

Gujarat has 11 Hatcheries but only 3 are functioning. The state has 3 shrimp feed plants such as Avanti Feeds, Skretting India and Ishi Marine.

Shrimp Producing Districts

The prominent shrimp producing districts in Gujarat state are Valsad, Navsari, Surat, Bharuch, Anand, Bhavnagar, Girisomnath, Porbandar and Junaghad.

Four Processing Plants

Gujarat has 4 shrimp processing plants from the industry stakeholders, like West Coast Frozen Foods Pvt Ltd, Zeal Aqua Pvt Ltd, Mindholla Foods LLP and Shree Datt Aquaculture Farms Pvt Ltd.

Essential Products Suppliers

About 20 Feed companies, 25 Hatcheries, 100 Nutrition and Healthcare products manufacturing companies, 10 Aerator companies, 10 Disinfectant and Water treatment products supplying companies, 5 Geomembrane products supplying companies and Equipment & Machinery supplying companies are supplying there products and services in Gujarat, Maharashtra, Rajasthan etc in the West Coast of the country.

The aquaculture sector in Gujarat has about 25 active dealers and over 80 technicians serving the

needs of farmers.

Mr Naresh Tambada did his B.Tech (Agriculture Engineering) from Maharashtra, then M.Tech from IIT, Kharagpur, West Bengal. Naresh started his career as aquaculture engineering at Karwar, Karnataka in 2009 in MPEDA and got promoted as assistant director in 2013. In 2021, he got elevated as deputy director at Bhubaneswar, Odisha. Presently, he is the deputy director for MPEDA at Valsad.

He has been working with MPEDA's Sub-Regional Division in Valsad and involved in initiatives related to sustainable aquaculture such as antibiotic free farming, and has participated in training programs and awareness campaigns including species diversification and market trends. He has participated in meetings with officials from the Department of Fisheries to promote antibiotic free aquaculture.

Valsad Sub-Regional Division is assisted by other staff like Bhavin Gheravara, Junior Technical Officer (aquaculture production) and Namdev Bhoinkar, Junior Technical Officer, (exports promotion). MPEDA has two Analysts Ms Amisha Patel and Ms Chaya Patel working in Elisa Lab.



Team Work: Bhavin Gheravara, Junior Technical Officer; Namdev Bhoinkar, Junior Technical Officer; Ms Amisha Patel, Analyst, Elisa Lab; Ms Chaya Patel, Analyst, Elisa Lab with Deputy Director; MPEDA, Gujarat, Naresh Tambada.



Get-together: Aqua International Editor M.A. Nazeer with Pradip Navik and other Executive at Zingalala Restaurant in Surat on October 17 during dinner.



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Eliminate undesirable algae



Improve water color

* COMPOSITION:

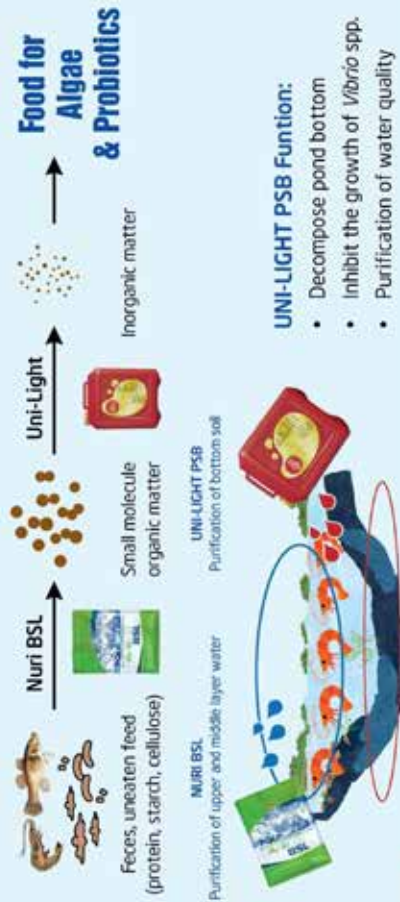
Bacillus spp. > 1×10^{11} cfu/kg
(*Bacillus subtilis*, *Bacillus amyloliquefaciens*, *Bacillus licheniformis*)
Carrier (rice bran, corn gluten)
Moisture

* STORAGE:

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* 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.



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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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Fisheries sector hopes to beat U.S. curbs with sustainability label



Affluent markets such as the European and Japanese markets are looking for sustainability certified seafood

The Hindu, New Delhi, 7 October 2025:

About 10 Indian marine and saline fish and shrimp varieties are set to get the global Marine Stewardship Council (MSC) certification soon. The first batch is set to be submitted for the certification in 2026

According to experts, the certification is likely to increase the revenue of the fisheries sector by 30% and help fishermen and traders find new markets other than the US, in the event of further trade restrictions due to the higher tariffs.

The certification will also help fishing communities begin ecologically sustainable fishing, practices and ensure steady incomes.

Fisheries Development Commissioner K. Mohammed Koya told The Hindu that the Union Government, under the Pradhan Mantri Matsya Sampada Yojana (PMMSY), would subsidise the certification process, which is done by third party auditors.

Mr Koya said that global affluent markets, such as European and Japanese ones, are looking for sustainably sourced fish.

"Sustainability is part of our fisheries. Some of

our fish varieties may not immediately qualify for sustain-able segregations, but many of the varieties are amenable to certification. Once we recertify the fish, the advantages that we get include access to the best markets. It is a way of certifying the fish so that it gets a better price," he said.

Experts said the certification process is in its final stages and they are addressing the technical gaps, including stock assessments for shrimp, squid, cuttlefish and octopus, which are part of the varieties that await MSC certification.

It is primarily based on the Food and Agriculture Organisation's (FAO) Code of Conduct for Responsible Fishing and Guidelines for the Eco-labelling of Fish and Fishery Products from Marine Capture Fisheries.

Advanced Stages

Speaking recently at a technical session jointly hosted by the MSC and the Sustainable Seafood Network India (SSNI) and the Seafood Exporters Association of India (SEAI), MSC India head Ranjit Suseelan said the prioritised fisheries are in the advanced stages of assessment, raising expectations of MSC certification in the next year.

DFFTA aims to improve livelihood of marine fishermen of Digha, West Bengal



As a part of 15-day In-Service Training Programme of newly-appointed Fishery Extension Officers (Directorate of Fisheries, West Bengal) at Government Fish Technological Station, Junput, Purba Medinipur, that begun on 15 September 2025, participants visited Digha Mohona fish market on 22 September 2025. It is one of very important marine fish wholesale markets in Asia, located just adjacent to office of Digha Fishermen and Fish Traders Association (DFFTA) at Digha Mohona in same district. It is a noisy place full of activity in dawn and morning hours, meant for commercial auction & sale of various kinds economically-important marine finfishes and shellfishes having high market demand. It is brought in fresh condition by local marine fishermen, who operate in mechanized-motorized and motorized fishing trawlers in 12 Nautical mile zone

(22km from coast into open sea) and beyond it. DFFTA oversee all the activities daily.

Sri S. S. Das, Secretary, DFFTA welcomed all FEOs and elaborated that DFFTA, established in 1989 and 100% non-political organization, is working to cause socio-economic development of small-scale marine fishermen in the region. Earlier fishermen used to get only a small amount after selling marine fishes. But now DFFTA takes care so that they become self-sufficient after selling captured fishes and get fair price (that they deserve) for it, also applicable for associated labours (in fish landing, icing, sorting, cleaning, weighing, ice making, etc). Now fish sale isn't done directly via auctioneers. DFFTA has built up necessary infrastructure, 10000-12000 nos fishermen stay at this market permanently. It has given 5 acre land to Department of Fisheries, WB where a new construction



Surat, Gujarat to host Aquaculture Expo 2025 on December 5 - 6

Surat: We would like to inform the stakeholders of aquaculture sector that **Aquaculture Expo 2025** scheduled to be held on 19 - 20 November 2025 at Daman, India, has been rescheduled to 5 - 6 December 2025 and the expo will be held at Surat, Gujarat instead of Daman due to circumstances.

42nd Edition



This decision of relocating the venue from Daman to Surat is taken for the better success of the expo. We sincerely regret for the inconvenience caused

to the stakeholders with the change of date and the venue, said Mr M.A. Nazeer, Chief Executive of the Expo and Editor, Aqua International. He requested the stakeholders to kindly understand the circumstances and cooperate with their active participation in the Expo at Surat.

The venue for the expo is Surat International Exhibition & Convention Centre (SIECC), Sarsana, Khajod Chokdi, Sachin Magdalla Road, Surat, Gujarat.

The event consists of Exhibition on both the days of December 5 & 6, and Interaction Meet between Experts and Farmers in the afternoon of December 5. Aqua International sofar organised the expo for 14 years continuously at Surat.

**5 - 6 December 2025
Surat, Gujarat, India**

*An Exhibition & Experts - Farmers Interaction Meet
on Aquaculture Sector to Update Knowledge and
for Better Business Opportunities*



Organised By **NRS EVENTS**
Aqua International
English Monthly, since 1993

**5 - 6 December 2025
Surat, Gujarat, India**

Venue: Surat International Exhibition & Convention Centre (SIECC), Sarsana, Khajod Chokdi, Sachin Magdalla Road, Surat, Gujarat

Programme: Exhibition: 10 am to 6 pm
Experts - Farmers Interaction Meet
from 3 pm to 5 pm on 5th December 2025

Aquaculture Experts and Consultants are invited to take part in Interaction Meet and answer to the queries and issues of the farmers during the meet from 3 pm to 5 pm on 5 December 2025

ENTRY FREE INTO EXHIBITION

Advantages of Farmers' Participation in the Expo

Farmers can directly meet and talk to the companies, who exhibit their products & services in the stalls and know about the products and their usefulness in shrimp and fish culture.

Companies (Exhibitors) can meet farmer-customers and get their feedback on their products and performance as well as services. This will enable the companies / manufacturers to know farmers' feed back and suggestions to further improve the quality of their products and services.

Every product displayed in Aquaculture Expo and every word spoken in the inaugural session and during the technical interaction are meant for farmers and the culture.

Farmers can also interact with experts on various aspects and get solutions for various problems in Aquaculture. We are creating a **Lounge for Experts - Farmers Interaction** during the exhibition time in the venue.

This Expo is also a very good opportunity to the enterprising people who would like to take up Aquaculture as a profession.



Exhibition Timings: 10:00 am to 6:00 pm on December 5 - 6
Inaugural Session : 10:30 am on December 5.

**Experts - Farmers Interaction Lounge
open during the Expo timings in the venue**

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(marine fish landing and auction centre) is ongoing with improved facilities. Modernization is needed, that will support upliftment of life and livelihood of marine fishermen. Earlier they used to go for 2-3 days at a stretch into open sea but now going for 10-12 days continuing period, venturing farther into deep sea. Amount of fish production (catch) increased per operation. Use of Transponder has helped in two-way communication with fishermen at sea, their safety and security is ensured. DFFTA understands its importance.

Sri Das said that in 2024-2025, the quantum of captured marine finfishes, shellfishes and farmed brackishwater shrimps that were exported from WB had worth Rs 4.5 thousand crores. It was Rs 60 thousand crores from entire country. Presently about 70 lakh fishermen and fish farmers in WB are engaged in this profession. Marine and inland fishermen will get benefit from the Fishermen Registration Card scheme introduced by the Department. Scientific pisciculture must be initiated in more number of big inland freshwater bodies like beels in different districts – that will lead to prosperity of small-scale fishermen by profession.

We can increase price of marine finfishes by means of modification and value addition. DFFTA has introduced Insurance policy first time in WB for marine fishermen with a minimum premium – nominee of deceased fishermen (died due to natural disaster at sea) can claim an amount of Rs 5 lakh.

DFFTA provides services and financial support for a long time period to meritorious son and daughter of old, infirm and poor marine fishermen. It provides food and relief to fishermen in inundated fishermen village affected during flood caused by Subarnarekha river, takes care of improving infrastructure of local hospital at Digha where injured/seriously sick marine fishermen are admitted. It organizes weeklong 'Gangotsov' or Sea Food Festival during mid-January every year where, in addition to other activities, proper identification, acceptance and nutritional importance (benefits of eating) of over 50 species of marine finfishes (100% organic) are made known to visitors, which are displayed as formalin preserved specimens. Food values of some low-priced fishes are also made known.

DFFTA strictly observes '2-month' long ban period

in marine fishing every year for conservation and preventing resource depletion of important marine finfishes in days to come - will be good if increased to 90 days, Sri Das said. Proper conservation measures are followed by fishermen here for *Hilsa ilisha* fishery; also for 3 species of pomfrets (sold at Rs 450-500/- kg). Fishermen operating trawl nets were advised to stop indiscriminate exploitation of unintended juvenile & sub-adults of important fishes – only those of targeted size must be caught. Lessening the extent of operation of trawl nets will help in saving fuel cost on fishermen's part, Sri Das opined. Special square-size meshes newly introduced by DFFTA in bag nets and made effective, so that small-sized fishes can escape and aren't caught. DFFTA prepared and issued Identity Card to bonafide marine fishermen so that no clash occurs in between fishermen during fishing. DAT, Wireless system installed in fishing trawlers, communication can be made with trawler drivers at sea in times of super-cyclones and heavy rain, rescue operation is initiated quickly.

In 1993, DFFTA has introduced Marine Fishing Regulation and Licensing process, and fishing isn't allowed to boat/trawler owners without it. It promotes rural socio-economic upliftment in fishing villages, welfare and day-to-day activities of professional marine fishermen so they become self-reliant, don't get disconnected from this profession, that will

give livelihood security sustainably; will encourage others to get involved into it. Rs 15000-16000/- is given by DFFTA to each of sea-faring fisherman per month. Sri Das also spoke about future plan of activities, to stand beside the fishermen, cooperate with them, fulfill their needs. On an average, transaction of Rs 4 crores occurs every day at this Digha Mohona fish market. He mentioned that upto 12 N miles is State territorial zone for WB and 12-200 N mile is EEZ. Beyond 200 N mile is high sea where any country is allowed for marine fishing. Now we are exploiting upto 70-80 N miles and 80-200 N mile region remains unexploited. Deep Sea fishing policy is expected to be implemented so that worth of India's net export of captured marine finfishes, shellfishes and farmed brackishwater shrimps may be increased from Rs 60 thousand crores (2024-2025) to Rs 65 thousand crores per year. Our country's marine fishermen will be promoted, trained, financially supported and necessary technology disseminated so that we may reach this target.

Towards the end, Sri P. K. Poyra, Vice-President, DFFTA and Sri S. Saha, Assistant Director of Fisheries (Marine), Purba Medinipur expressed their best wishes to newly appointed FEOs and believed that development schemes of Department of Fisheries concerning marine and inland fishermen as beneficiaries will be implemented effectively at Block-level. News communicator Subrato Ghosh was present in this short programme at DFFTA.



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MPEDA holds marine sector Stakeholder Awareness Meetings on India–UK CETA at Chennai and Vizag

Kochi, October 18: The recently signed India–UK Comprehensive Economic and Trade Agreement (CETA) marks a significant milestone in India's seafood export sector, and there is an imperative need to adopt strategies for availing the opportunities like value addition and upskilling offered by it, MPEDA Chairman D.V. Swamy, IAS, has said.

Mr Swamy highlighted this issue during the Marine Products Export Development Authority (MPEDA)'s Stakeholder Awareness Meetings on the benefits and opportunities of the agreement for the marine sector in Chennai and Vizag on October 16 and 17, respectively.

Mr Anil Kumar P., Joint Director, MPEDA, presented the salient features of CETA and opportunities for the marine products export sector.

Mr Alex Paul Menon, Development Commissioner, MPEZ-SEZ, discussed the possibilities for the development of Marine Aquaparks SEZ in Tamil Nadu during the meeting in Chennai. The stakeholders shared their perceptions about the opportunities for India's marine products export sector.

Under the agreement, 99 per cent of tariff lines will now enjoy zero-duty access, enhancing the

competitiveness of Indian seafood in the UK market. Key export items, such as Vannamei shrimp, frozen squid, lobsters, frozen pomfret, and black tiger shrimp, will benefit from duty-free access.

The meetings at Chennai, where the MPEDA team was headed the Chairman, were attended by Mr Devasenapathy, Secretary, Coastal Aquaculture Authority (CAA); Mr Praveen Kumar, Director, Department of Commerce, Ministry of Commerce and Industry (MoCI); Dr Ram Mohan M.K., Director, MPEDA; Ms. Sunanda Tewari, Professor & Head of Trade & Investment Law, CTIL; and Dr Nilesh Anil Pawar, Deputy Director, Department of Fisheries, Govt. of India.

The other attendees were Mr K.V. V. Mohanan, National Vice President, SEAI; representatives of EIA, Chennai; and 55 seafood exporters from Tamil Nadu and Nellore region of Andhra Pradesh.

The stakeholder meeting at Visakhapatnam, which was also chaired by the MPEDA Chairman, was attended by Mr Praveen Kumar, Director, Department of Commerce, MoCI, Mr S. Kishore IAS (Retd.), Dr Ram Mohan M.K., Director, MPEDA; Mr G. Pawan Kumar, National President, Seafood Exporters Association of India (SEAI); Mr Kondragunta Anand Kumar, Regional President,

SEAI, Andhra Pradesh; representatives of Export Inspection Agency (EIA), Vizag, and 37 exporters from Andhra Pradesh and Odisha.

India exported marine products worth USD 7.45 billion in 2024–25, with shrimp, fish, and cuttlefish among the top categories. The exports to the UK in 2024-25 were 16,082 MT worth US\$104.43 million.

The UK has a high demand for Indian frozen seafood, driven by the large Indian diaspora and the demand for processed seafood, particularly shrimp, fish, and squid. Frozen shrimp contributed 77% of total exports to the UK, with

an export value of \$80.05 million, followed by frozen fish, which contributed to eight per cent of total exports, with \$8.35 million in exports in 2024-25.

The India-UK CETA, a comprehensive economic and trade agreement signed in July this year, is expected to facilitate doubling of Indian exports to the UK in the coming years, and will enhance the competitiveness of Indian seafood, increasing the scope for value addition, upskilling, and better employment opportunities for skilled labour. This agreement boosts economic growth, job creation, innovation, and sustainable practices.

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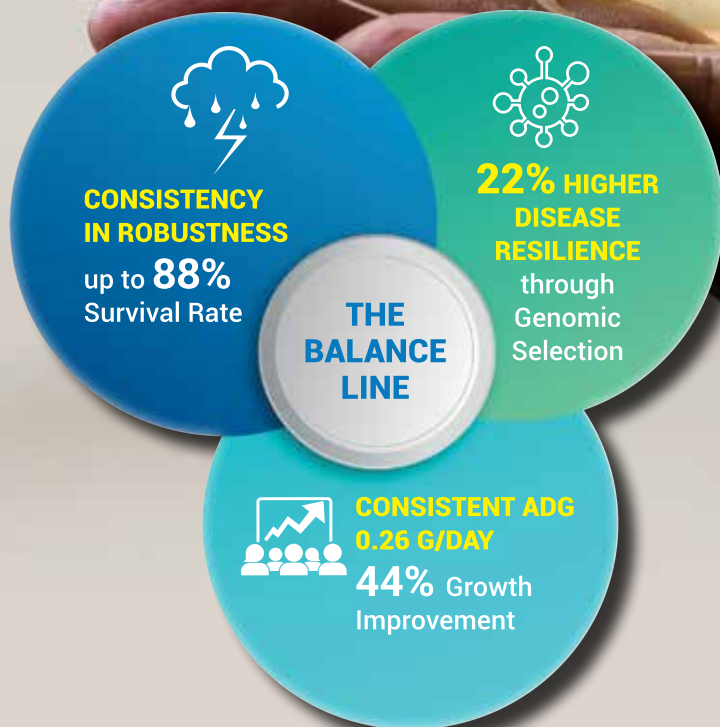
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Report on Skill Development Training Programme at TNJFU - Dr MGR FC&RI, Ponneri



A skill development training programme on “Lobster and Mud crab Fattening” funded by Tamil Nadu Skill Development Corporation under the Naan Mudhalvan Vetri Nichayam Scheme was conducted from 17th September to 4th October 2025 at Dr MGR Fisheries College and Research Institute, Tamil Nadu Dr J Jayalalithaa Fisheries University, Ponneri, Thiruvallur District, Tamil nadu. The training aimed to impart theoretical and

the Pazhaverkadu fisherfolks including surrounding regions like Minjur and Ponneri areas. A total of 23 participants have successfully completed the training programme. Dr S. Balasundari, Dean, Dr MGR. FC&RI, Ponneri gave a special address to the participants and encouraged to learn the techniques of lobster and mud crab fattening. The programme was inaugurated by Th. Ajay Anand, Assistant Director



practical knowledge on different aspects of lobster and mud crab fattening to enhance skill proficiency and employability among

of Fisheries, Thiruvallur District on the first day of training programme. The training programme activities were coordinated



by Dr S. Selvaraj, Assistant Professor and Head i/c, Department of Aquaculture.

The following topics were covered by different faculty members, farm managers and PG/PhD students of Dr MGR FC&RI, Ponneri: Day 1 - Dr S. Selvaraj: Overview of mud crab fattening practices and experience of mud crab fattening trials in Pazhaverkadu; Th. P. Pavinkumar, Assistant

Day 3 – Field visit to Pazhaverkadu; Day 4 – Mr H. Manimaran, PhD student and Hatchery Manager: Mud crab hatchery operation and fattening trials in Pazhaverkadu; Dr S. Selvaraj, Visit to water quality testing laboratories; Mr Rohith, Sharing of ELP experiences of mud crab fattening in FRP tanks.

Day 5 – Dr C. Kalidass, Principal Scientist and SIC, Karwar Regional Station of



Professor and Head i/c, Department of Fisheries Resource Management: Biology of Mud crabs; Miss. K. Kiruthisha, M.F.Sc. student: Cannibalism in mud crab culture and methods to overcome; Day 2 – Th. Vetri, Astro Aquaculture, Ponneri: Indoor mud crab fattening systems and their operation; Mrs. N. Ramya, Farm Manager: Mud crab fattening techniques and trials in Pazhaverkadu;

CMFRI: Lobster fattening systems and experience from Thoothukudi trials; Dr S. Aruna, Assistant Professor and Head i/c, Department of Fisheries Environment Management, Bottom soil management in mud crab fattening; Day 6 – Miss. Indhu, PG Student: Comparative evaluation of mud crab fattening systems; Mr Manickavasagam, Assistant Professor, Department of Fisheries Environment





Management: Soil and water quality management in lobster fattening; Dr C. Sudhan, Assistant Professor, Department of Fisheries Environment Management: Cultivable lobsters, their distribution and biology; Day 7 – Dr Kaviarasu, Assistant Professor, Department of Aquatic Animal Health Management: Diseases in mud crab fattening; Miss. Santhiya, Assistant Professor, Department of Aquatic Animal Health Management: Diseases in lobster fattening; Miss. Nimish Mol Stephen, Assistant Professor and Head i/c, Department of Fish Processing Technology: Post harvest handling of mud crabs and lobsters; Day 8 – Dr L. Surulivel, Assistant Professor, Department of Fisheries Extension, Economics and Statistics: Economics of lobster and mud crab fattening and their marketing strategies;

Dr Agnes Daney Angela, Assistant Professor and Head i/c, Department of Fisheries Extension, Economics and Statistics: Government schemes for aquaculture activities with a special note on PMMSY scheme of Govt. of India; Dr S. Selvaraj: Reproductive biology of mud crabs; Day 9 – Dr S. Saravanan, Assistant Professor and Head i/c, Department of Aquatic Animal Health Management: Chemotherapy in lobster and mud crab fattening; Dr L. Vinoth, Assistant Professor, Department of Fish Processing Technology: Utilization of crab shell and lobster shell wastes for chitin/chitosan preparation; Day 10 – Dr S. Selvaraj: Utilization of Chaaru mussel as feed for mud crab fattening; group discussion on preparation of DPR for obtaining bank loan was done and participants were demonstrated on the



installation of FRP boxes in ponds and tanks for mud crab fattening

Day 11 – Miss. Jothika, PG Student: Recent advances in mud crab fattening; Miss. Vanathi, PG Student: Recent advances in lobster fattening; Mr R. Velmurugan, Assistant Professor and Head i/c, Department of Fishing Technology and Fisheries Engineering: Harvesting of mud crab and lobster and design of cages for fattening; participants visited the laboratory of Fishing Technology for viewing the crafts and gears; Day 12 – Mrs. Usha Myelraj, Manager, Canara Bank, Ponneri: Availing loans for lobster and mud crab fattening; Dr C. Lloyd Chrispin, Assistant Professor, Department of Fisheries Extension, Economics and Statistics: Block chain technology for lobster and mud crab fattening; Day 13 – Dr P. Ruby, Farm Manager: Feeds and feeding management in lobster and mud crab fattening; Dr C. Anand, Assistant Professor and Head, Mandapam CeSA: Lobster fattening and sharing the experience of Mandapam trials; Day 14 – Dr S. Selvaraj, Practical design and installation of FRP boxes in ponds for mud crab fattening.

Field visits included visit to different mud crab fattening practices and systems in Pazhaverkadu and surrounding regions. On third day of the training programme, all participants were taken to Kolathumedu fishing village where mud crab fattening is undertaken in earthen ponds. Mr Murugesan, mud crab fattening farmer



explained the practices of earthen mud crab fattening to the trainees. Trainees interacted with the farmer and clarified their doubts. Subsequently, trainees were shown different fattening facilities and mud crab hatchery at Pulicut Research Farm Facility of Department of Aquaculture, Dr MGR FC&RI, Pazhaverkadu. The trainees were shown and explained use of FRP tanks, cement tanks, FRP boxes, FRP cages and earthen ponds for mud crab fattening. Recent trials of mud crab fattening in FRP tanks were shown and the live crabs maintained in the centre were shown to the participants. Mud crab hatchery established under PMMSY scheme “Empowerment of artisanal fisherfolks of Pazhaverkadu area through mud crab culture technology” was shown to all the participants. Participants viewed the mud crab broodstock maintained in the hatchery and interacted with the hatchery manager and the staffs. The different stages in hatchery operation were shown to the participants.

Another field visit on 9th day of training was undertaken through visit to Indoor mud crab fattening unit at Kollumedu of Ponneri Taluk. Mr Balaji, Unit Manager explained different activities and management of the indoor mud crab fattening unit.

Boom-and-bust cycles of sardine linked to monsoon and oceanographic changes, reveals CMFRI study



Kochi, September 29: Monsoon rainfall trends caused the sudden surge of juvenile Indian Oil sardines along Kerala's coast in 2024 and the subsequent ecological and economic fallout, according to a news study by ICAR-Central Marine Fisheries Research Institute (CMFRI).

The study, published in *Current Science* highlights how climate-driven oceanographic changes have been shaping the boom-and-bust cycles of this vital fishery, underscoring the urgent need for dynamic fishery forecast models and harvest rules.

A lifeline for Kerala's fishing communities and a major contributor to India's marine landings, Oil sardine had witnessed a steep decline from a record catch of four lakh tonnes in 2012 to just 3,500 tonnes in 2021. However, in 2024, an unusual influx of



young sardines, averaging 10 cm in size, was reported across Kerala's coast, with instances of mass beaching in districts like Kozhikode and Thrissur.

With an eco-regional approach, CMFRI study integrated fisheries biology and oceanographic data from Kochi, Vizhinjam, and Kozhikode. According to the study, the phenomenon was triggered by positive monsoon rainfall trends coupled with nutrient-rich upwelling that boosted microplankton growth — the primary food source for sardine larvae. This spike in microplankton enhanced larval survival, leading to an unprecedented surge in recruitment.

"Later, this condition also increased competition for food resources among the recruits leading to poorly fed fish and lower weight gains for the zero year-class fishes. The economic impact was felt in massive crash of the market prices for the sardine and led to suspension of fishing for juveniles", said U Ganga, Principal Scientist who led the study.

The study also pointed out that ecosystem

productivity indicators — especially the microplankton component of chlorophyll-a — played a stronger role in sardine recruitment than the traditionally emphasized spawning stock biomass. The marine heatwaves phenomenon varied in intensity and duration in the three eco-regions and likely affected maturation and distribution trends of oil sardine spawners.

With climate change intensifying these



fluctuations, CMFRI researchers have called for the development of species-specific, short-term fishery forecast models and dynamic local harvest rules to ensure sustainability.

"Within a broader fisheries management framework, dynamic local harvest control approaches for the highly environment driven sardine fishery are also important for safeguarding livelihoods and food security", Dr Ganga said.

Indian Aqua Farmers must adhere to Best Management practices, GMP

Indian aquaculture farmers must strictly adhere to Best Management Practices (BMP) and Good Manufacturing Practices (GMP). Unfortunately, many are yet to evolve toward advanced technologies and modern management systems, continuing instead with outdated methods.

Adding to the concern, several medicine input suppliers mask poor-quality products with attractive packaging and branding, often sourcing from satellite manufacturers who follow unethical practices. Antibiotics are discreetly introduced under the guise of biotechnology, leaving farmers unaware of the risks involved.

To safeguard the industry, processors must enforce strict vigilance. Harvests should be pre-tested at

the farm level, and if not, then rejected at the gate by Quality Control teams using Six Sigma standards. Even a few rejections will set a powerful precedent, compelling the entire industry to discipline itself.

Equally important, so-called "technical consultants" must act with integrity—placing farmers' interests above revenue targets—and provide genuine solutions rather than pushing profit-driven products.

In short, rejections, rejections, and more rejections at pre-harvest or at the gate by processors are essential to drive accountability and restore credibility.

I share these thoughts purely out of deep concern for our beautiful, promising, and profit-oriented aquaculture industry.

PM lays foundation stones for ₹160-crore fishery projects in Odisha

The fishery projects included a ₹100-crore integrated aqua park at Basantapur in Sambalpur district and a Rs 59.13-crore fish market at Pandara in Bhubaneswar

October 11, 2025: Prime Minister Narendra Modi on Saturday (October 11, 2025) virtually laid the foundation stones for two fishery projects worth around ₹160 crore in Odisha.

He laid the foundation stones for the fishery projects while launching the ₹24,000-crore Pradhan Mantri Dhan Dhaanya Krishi Yojana (PM-DDKY) and a ₹11,440-crore Mission for Aatmanirbharta in Pulses in Delhi.

The fishery projects included a ₹100-crore integrated aqua park at Basantapur in Sambalpur district and a ₹59.13-crore fish market at Pandara in Bhubaneswar.

Chief Minister M.ohan Charan Majhi, his Deputy K.V. Singh Deo and others joined the event virtually from a State-level function on OUAT premises in Bhubaneswar.

Majhi said the fish market project in Bhubaneswar is another important initiative under the Pradhan Mantri Matsya Sampada Yojana (PMMSY).

"Of the ₹59.13 crore, ₹30 crore will be given by the Centre and remaining amount by the State," the chief minister said.

The project will be implemented in collaboration with the state government's

Fisheries and Animal Resources Department and the Bhubaneswar Municipal Corporation (BMC), and it will directly benefit 143 traders and generate indirect employment for more than 2,000 people, he said.

The chief minister said the fish market will meet the demand of consumers in Bhubaneswar and Cuttack.

A memorandum of understanding has been signed with the BMC to implement the project and the work will be completed by November 2027, he said.

The Chief Minister said that the integrated aqua park at Hirakud, which will be built over 95.47 acres of government land, will further develop modern fish farming.

Of the ₹100 crore investment to be made in the project, the central government will contribute ₹60 crore while the remaining ₹40 crore will be spent by the state government.

"This will be the first aqua park project in eastern India. The project, which will be completed by January 2027, will transform Sambalpur into a centre of excellence in modern fish farming," Mr Majhi said.

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Majhi said PM-DDKY is being implemented in 100 districts across the nation, including four in Odisha — Kandhamal, Malkangiri, Sundergarh and Nuapada.

The Chief Minister said that the Modi government has been implementing new initiatives for farmers since it came to power in 2014.

"In the last 11 years, our country has become self-reliant in many fields. The country needs to become self-reliant in the production of major food

grains, oilseeds and pulses. Even today, our country is dependent on foreign countries for pulses and edible oil. We have to reduce this dependency," the Chief Minister said.

Majhi also highlighted the State BJP government's initiatives in the last 15 months.

He said the implementation of PM-DDKY and Mission for Aatmanirbharta in Pulses will bring prosperity to the farmers.

The chief minister said that through this scheme, Odisha's farmers will not depend only on paddy cultivation, but can also

diversify to cultivate pulses, oilseeds and other cash crops and earn more money.

Mr Singh Deo said Odisha has already become self-reliant in rice production, and the time has come to achieve it in pulses and oilseeds as well.

To counter trade ban, fisheries sector eyes new markets with eco-friendly label

About ten fish varieties soon to get MSC certification, another seven under process



About 10 Indian marine and saline fish and shrimp varieties are set to get the global Marine Stewardship Council (MSC) certification soon.

The Hindu, October 07, 2025: About 10 Indian marine and saline fish and shrimp varieties are set to get the global Marine Stewardship Council (MSC) certification soon. The first batch is set to be submitted for the certification in 2026.

According to experts, the certification is likely to increase the revenue of the fisheries sector by 30% and help fishermen and traders find new markets other than the U.S. in the event of further trade restrictions due to the higher tariffs. The certification will also help

fishing communities begin ecologically sustainable fishing practices and ensure steady incomes.

Fisheries Development Commissioner K. Mohammed Koya told The Hindu that the Union Government, under the Pradhan Mantri Matsya Sampada Yojana (PMMSY), would subsidise the certification process, which is done by third-party auditors.

Mr Koya said that global affluent markets, such as European and Japanese ones, are looking for

sustainably sourced fish.

"Sustainability is part of our fisheries. Some of our fish varieties may not immediately qualify for sustainable segregations, but many of the varieties are amenable to certification. Once we re-certify the fish, the advantages that we get include access to the best markets. It is a way of certifying the fish so that it gets a better price," he said.

Experts said the certification process is in its final stages and they are addressing the technical

gaps, including stock assessments for shrimp, squid, cuttlefish and octopus, which are part of the new varieties that await MSC certification. It is primarily based on the Food and Agriculture Organisation's (FAO) Code of Conduct for Responsible Fishing and Guidelines for the Eco-labelling of Fish and Fishery Products from Marine Capture Fisheries.

Speaking recently at a technical session jointly hosted by the MSC and the Sustainable Seafood Network India (SSNI) and the Seafood Exporters Association of India (SEAI), MSC's India head Ranjit Suseelan said the prioritised fisheries are in the advanced stages of assessment, raising expectations of MSC certification in the next year.

Gillnet-caught blue swimming crab, trawl-caught karikadi shrimp, trawl-caught Indian nylon shrimp (Deep Sea Shrimp), trawl-caught Indian nylon shrimp (two types), trawl-caught Indian squid, trawl-caught poovalan shrimp, trawl-caught pharaoh cuttlefish, trawl-caught webfoot octopus, trawl-caught flower shrimp, and thread fin bream fishery

are the varieties currently under the fisheries improvement project of the MSC.

Other than this, six species of Grouper fish from Kanyakumari, pole-and-line-caught skipjack tuna from Lakshadweep Islands, trap-caught spiny lobster from Kanyakumari, trawl-caught flower shrimp from the Gulf of Mannar, gillnet-caught oil sardine from Kollam, Kerala, Ashtamudi clam from Kerala and gillnet-caught Mud crab and scylla serrata from Odisha's Chilka Lake are the new fisheries aiming for certification.

Mr Suseelan said MSC-certified products often fetch a price premium of up to 30% in international markets, boosting India's seafood export potential. Seafood exporters feel that such certifications will help India overcome trade barriers in global markets. "Eco-labels and sustainability certifications help enhance acceptance among consumers with a strong market penetration. This will boost India's bargaining power in the global trade of seafood", Abraham Tharakan of SEAI said.

Dr Sunil Mohamed, Chairman of the SSNI, said it is a market-driven label certification, known as an eco-label which is voluntary and ensures sustainability in the sector. "20% of global fisheries are MSC certified at present. Ashtamudi clam was the first variety to get MSC certification and it was lapsed. It's going to be re-certified now. This certification will ensure that there is sufficient stock of the fish so that the fishery can be continued," he said.

U.S. tariffs will have long-term effect on trade: Commerce Ministry to PAC

Tariffs will significantly impact India's marine exports, especially shrimp; Centre working on market diversification pushing for registration of more export units in the EU, and engaging in discussions with other countries, says Special Secretary

The Hindu Bureau, September 30, 2025: The higher tariffs imposed on Indian goods by American President Donald Trump would have a long-term impact, especially for India's marine exports, officials of the Union Ministry of Commerce told the Public Accounts Committee (PAC) headed by senior Congress leader K.C. Venugopal.

The PAC met to deliberate the 'Performance audit report on the Export Promotion Capital Goods Scheme.

There were several questions on the impact of U.S. tariffs on Indian exports. Rajesh Agarwal, Special Secretary, Department of Commerce, maintained that anxiety over the adverse impact on the Indian pharmaceutical sector was unfounded, since India's key competitor in this sector was China, which was also reeling under similar tariffs, sources said. He acknowledged that the high tariffs will have a negative long-term effect on trade.

There were several questions on India's marine exports from both sides of the aisle, including from the PAC Chairperson, Mr Venugopal. Several members pointed out that many of India's coastal towns would be directly impacted if shrimp exports declined drastically.

The U.S. has imposed high tariffs, notably a

50% duty implemented in August 2025, which significantly impact India's marine exports, especially of shrimp, with shrimp exports facing an effective levy exceeding 58% when combined with existing duties. Mr Agarwal, sources said, conceded that the high tariff barrier had placed India at a disadvantage when compared with its competitors.

Mr Agarwal, sources said, informed the panel that India was actively working on opening up new markets via Free Trade Agreements with other regions, including the European Free Trade Association (EFTA) bloc (comprising Iceland, Liechtenstein, Norway, and Switzerland), and the U.K., which would "eliminate existing duties".

EU negotiators were recently in India to discuss these agreements, Mr

Agarwal told the panel, according to sources, and he went on to add that India was focusing on market diversification by successfully pushing for the registration of more marine export units in the EU, and engaging in discussions with other countries, including Russia.

The committee expressed dissatisfaction over the lack of clear outcomes from the Export Promotion Capital Goods Scheme, a policy aimed at facilitating the import of capital goods for producing quality goods and services to enhance India's manufacturing competitiveness. Under the scheme, duties worth ₹42,714 crore were forgone between financial years 2018-19 to 2020-21. The panel has directed the government to come up with clear answers on how it has helped growth in the manufacturing sector.

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English Monthly from Hyderabad, India

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English Monthly from Hyderabad, India

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AISHA Organising Hatch India conference at Vizag on October 30, 31



Seeding the Future of Indian Shrimp Farming

2nd edition of the biennial event of AISHA for Shrimp hatchery fraternity of India
30 & 31 October, 2025, Radisson Blu, Visakhapatnam

Ravikumar Yellanki, AISHA Hatcheries Association

Moderator



David Leong, Shrimp Improvement Systems

Improvements in Shrimp Breeding



Carlos Lozano, Benchmark Genetics

Scientific Breeding Strategies backed by Performance Data



Naomi Duijvesteijn, Hendrix Genetics

Genetic pathways to Resilient and Profitable Shrimp



Manavendra Rao, Aquanima

Long-Term Shrimp Breeding and Species Strategies for India



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October 30, 2025 Session 2: Shrimp Larval Nutrition, Health and Husbandry

D. Ramraj, AISHA Hatcheries Association

Moderator



Dr Olivier de Camp & Mr Stefano Calloni, INVE Aquaculture

Broodstock Nutrition and its Impact on Nauplii and Larval Quality



Dr Eamonn O' Brien, Skretting Global

Optimising Larval Nutrition and Feed Rations



Prof. Dr Andrew Shin, INVE Aquaculture

Shrimp Larval Diseases and their Management



Dr Natthinee Munkongwongsiri, Sykqua Siam Co., Ltd.

Smart Hatchery Practices: Practical Approaches to Improve PL Quality and Survival



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October 31, 2025 Session 3: Innovations in Hatcheries & Farming

Chandrasekar Sankaranarayanan, Invid Consultant for Aquaculture

Moderator



Dr Dan Fegan, I&V Bio

The Importance of Early Nutrition on shrimp grow out performance



Dr C R Subashini, Aristogene Biosciences

Harnessing bacteriophages for sustainable bacterial management in shrimp hatcheries



Sunkaranam Hari Narayana Rao, Aquaculture Consultant

Count with confidence: Digital shrimp seed counting for a transparent value chain



Dr A Palavesam, Manonmaniam Sundaranar University

Disclosing the pathogens behind shrimp hatchery and a postbiotic solution



Pham Minh Anh, ADM Animal Nutrition

Innovative nursery technology for production improvement in Litopenaeus



Seeding the Future of Indian Shrimp Farming

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October 31, 2025 Session 4: Farming Improvements

Dr Manoj Sharma, Miyuki Aquaculture Pvt. Ltd.

Moderator



Saji Chacko, Society of Aquaculture Professionals

Two species, one goal: Maximizing returns



Prakan Chiarakhongman, CP group

Precision Frontiers: Addressing 2025 Shrimp disease challenges in India



Dr K P Kumaraguru Vasagam, CISA

Diversified systems for efficient operations



Soraphat Panakorn (Danny), Novozymes

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Climate Resilient Aquaculture Technologies for Sustainable Aquaculture Production: A Way towards Combating the Climate Change Effects on Aquaculture

Gajjela Maheshwari, MFSc Aquaculture, Kerala University of Fisheries and Ocean Studies, Kochi, Kerala, E: maheshwarigajjelao8@gmail.com

HIGHLIGHTS:

- ▶ Climate change has emerged as one of the most critical challenges affecting global aquaculture and fisheries production, primarily driven by the increasing concentration of greenhouse gases.
- ▶ To mitigate these impacts, it is essential to adopt and implement climate-resilient technologies and adaptive management practices in aquaculture.
- ▶ The integration of climate-resilient technologies and biotechnological interventions in aquaculture can effectively address these challenges and promote sustainable and secure food production systems.

Abstract

Aquaculture has become one of the fastest-growing sectors to meet the global food demand. However, climate change has **its significant and growing effects on aquaculture**, impacting both freshwater and marine farming systems. These changes include the shifts in water temperature, sea level rise, acidification, harmful algal blooms, alterations in monsoons, water stress, salinity, and extreme weather conditions, which can reduce productivity, increase disease risks, and threaten the sustainability of

aquaculture if not properly managed. This article highlights the several mitigation methods and adaptations that are being implemented, emphasizing future demands of affordable protein, like selective breeding, species diversification, and aquaculture systems like integrated multi-trophic aquaculture, aquaponics, recirculating aquaculture systems, and biofloc systems, which are some of the most widely accepted and adapted solutions to combat the effects of climate change on aquaculture.

Introduction

The FAO recorded the global aquaculture production of 130.9 million tonnes, valued at USD 312.8 billion, 59 percent of global fisheries and aquaculture production, which plays an important role in the world food economy (FAO, 2024). Capture fisheries production is declining, while aquaculture production is increasing, both of which must be maintained and improved. Climate change is causing rising concern in the current scenario, as it has a substantial impact on food-producing sectors, including aquaculture (Abisha et al., 2022). Climate change is a long-term shift in the statistical distribution of weather patterns. Extreme weather events are frequently occurring, with heat and cold waves, drought, tropical storms, and heavy rainfall among the most common events. Climate change is becoming more prevalent, with 2015–2019 being the hottest 5-year period due to the massive increase in carbon dioxide (CO₂) emissions (World Meteorological Organization 2019).

All ecosystems and biodiversity are threatened by climate change. Aquaculture farms are more susceptible and vulnerable to the changing climate due to the continuous exposure of the animal to varied temperatures in an enclosed structure. Aquaculture activities are carried out in various operating structures, such as ponds and tanks, and in various habitats, such as freshwater, brackish/coastal water, and inland saline waters, to meet the growing population's protein needs. Shellfish aquaculture is more vulnerable to the effects of climate change on aquaculture than finfish aquaculture. Climate change affects the rural economies, as their

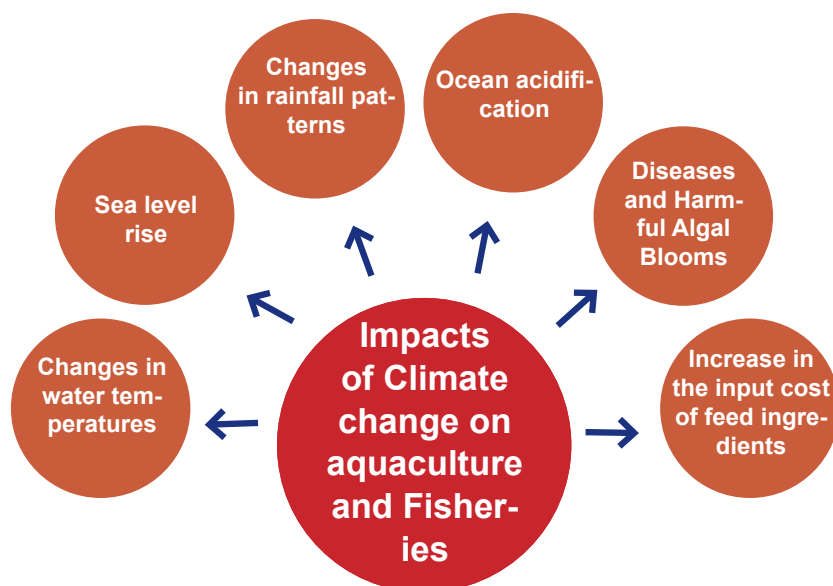


Fig: Impacts of Climate Change on Aquaculture and Fisheries

livelihood depends on aquaculture practices. Carbon emissions and other greenhouse gases are the primary cause of climate change. Temperature extremes contributing to global warming, ocean acidification, shifting precipitation, drought, flood, sea-level rise, changes in climatic variables, and so on are all climatic variables that affect aquaculture (**Ahmed & Diana, 2015; Clements & Chopin, 2017; De Silva & Soto, 2009**).

Mitigation techniques and robust adaptations must be implemented to address extreme climate variance. Climate change resilience is a combination of resistance strategies/adaptations or the ability to overcome severe disruptions and adapt to new circumstances. The practice of aquaculture is a climate-resilient adaptation in itself. In aquaculture, the term 'resilience strategy' refers to the steps taken by farmers and stakeholders to help them withstand the adverse effects of climate change on their farms. Shrimp farming, crab fattening, biofloc fish culture, recirculating aquaculture system (RAS), integrated multi-trophic aquaculture (IMTA), cage culture, monosex tilapia farming, use of natural air-breathing fishes in climate-smart aquaculture, and other modifications can all be used in aquaculture. Different strategies include erecting nets surrounding farms to prevent cultured animals such as shrimp from escaping during floods and high rainfall and increasing depth and dike heights to avoid extreme heat and storm surges. As a result, climate-smart aquaculture is preferred, in which adaptation and management strategies are used to resist the changing environment by combining mitigation, adaptation, productivity, and resilience to achieve high production and boost local economies (**Abisha et al., 2022**).

Impacts of climate change on aquaculture

Global warming is caused by increased emissions of greenhouse gas concentrations. Carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), and other greenhouse gases are among the most important,

and their concentrations have risen dramatically in recent decades. Climate change can drive changes in aquaculture through both direct and indirect factors, whether in the short- or long-term. Examples of short-term impacts may include the loss of production or infrastructure due to extreme weather events, the outbreak of diseases, the proliferation of toxic algae and parasites, and decreased productivity due to suboptimal farming conditions. Long-term impacts include the scarcity of wild seed, limited access to freshwater for farming, limited access to feed from marine and terrestrial sources, decreased productivity due to suboptimal farming conditions, eutrophication, and other perturbations (**Barange et al., 2018**).

1. Changes in water temperatures:

Temperature is a critical component that has a significant impact on the growth, survival, physiology, and reproductive cycle of fish. The rise in temperatures will have both negative and positive effects on fisheries and aquaculture. The positive impacts include the extended fish growing seasons, enabling longer and potentially more productive periods of aquaculture activity (**Handisyde et al., 2006**), and enhanced fish growth rates and feed conversion efficiency by increasing metabolic activity, thereby improving overall productivity in aquaculture systems in temperate regions (**Handisyde et al., 2006; Perry, 2011**). The negative impacts of a rise in temperature include the reduced dissolved oxygen levels in water, causing stress to fish, which creates increased susceptibility to infection and incidents of pathogens causing diseases and mortality (**De Silva & Soto, 2009**). Increased temperature may lead to increased growth of harmful algal blooms, which deteriorate water quality in aquaculture (**Kibria et al., 2013**). The hypoxic condition (low levels of dissolved oxygen of <2.8 mg/l) can impair fish reproduction, alter reproductive behaviors, and reduce fertilization and egg hatching success and can cause endocrine disruption in fish (**Wu, 2009**).

2. Sea level rise:

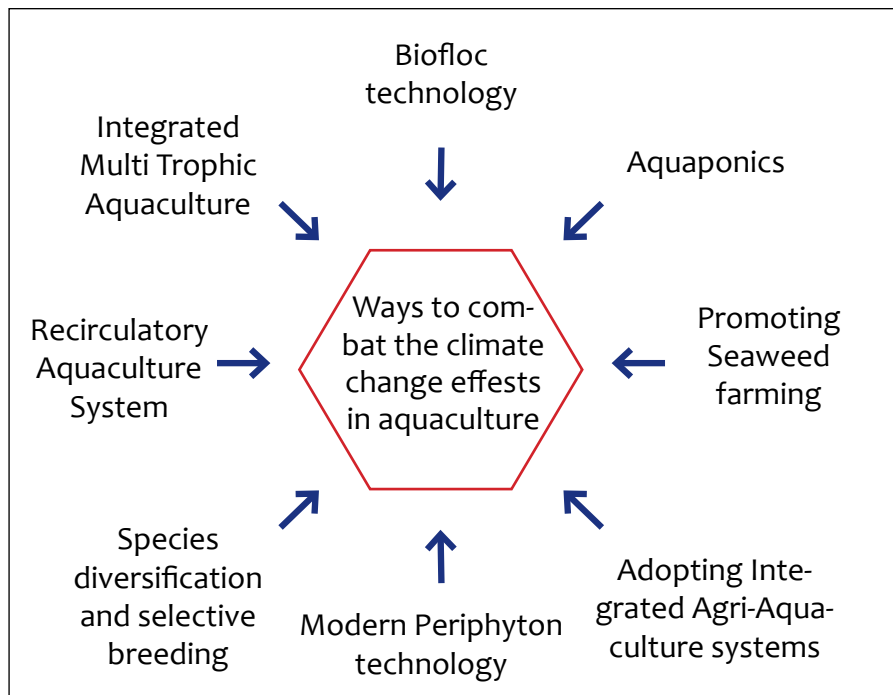
Sea level rise projections by IPCC-2018 indicate that the rise will be around 0.1 meters lower under 1.5°C global warming compared with 2°C by 2100. Sea-level rise poses considerable challenges to aquaculture, especially in lowland and deltaic regions, by causing the loss of culture areas and the intrusion of saline water into freshwater environments. This can negatively impact various aquaculture systems such as ponds, cages, tanks, and pens and lead to the salinization of essential freshwater resources, ultimately threatening the viability of freshwater aquaculture operations (**Kibria et al., 2017**). On the positive side, sea-level rise may benefit aquaculture by expanding areas suitable for brackish water species like shrimp and mud crab, offering new opportunities for sustainable production in coastal regions (**Kibria et al., 2017; Handisyde et al., 2006**).

3. Changes in rainfall patterns:

Changes in rainfall patterns will affect aquaculture production and sustainability in two directly opposite ways: increased rainfall (flooding) and periods of low or no rainfall (drought). According to the IPCC (2018), risks resulting from drought events are likely to be higher at 2°C compared with 1.5°C of global warming in a given region, while flooding event patterns are difficult to predict with certainty.

Flooding

Floods have become more common in recent years due to climate change and have significant impacts on both inland and coastal aquaculture systems. In inland aquaculture, floods can physically damage infrastructure facilities, inundate the ponds, and result in animal losses, the introduction of invasive species, and contamination of culture water. Flood-related mortalities are particularly frequent in pond culture systems and hatcheries (**Reid et al., 2019**). These mortalities may occur for several reasons but are primarily attributed to low oxygen levels in floodwaters. For example, reports from Vietnam indicate that severe floods have caused extensive damage



Adaptation and mitigation strategies towards climate-resilient aquaculture

to striped catfish farms (Nguyen et al., 2014).

Coastal aquaculture is also heavily affected by flooding, which often results from backwater effects, excessive river discharge, inadequate drainage capacity, and saltwater intrusion, all of which have negative consequences for coastal aquaculture. These factors introduce contaminants, hazardous compounds, and predatory or wild fishes into aquaculture ponds, which adversely affect farm operations (De Silva & Soto, 2009). Saltwater intrusion also poses a hazard to integrated rice-shrimp aquaculture by lowering soil fertility, preventing the system from producing. However, in some cases, saltwater intrusion has had a positive impact by enabling the cultivation of high-value shrimp in seawater-intruded rice fields (Roy et al., 2010).

Drought:

Drought is becoming an increasingly serious challenge for inland aquaculture due to climate change. Rising global temperatures accelerate water evaporation, alter rainfall patterns, and dry land surfaces, leading to more frequent and intense droughts (Dai et al., 2004). If global temperatures rise by 2°C, drought could impact up to 25% of the world by 2050 (Park et al., 2018). These

conditions increase water demand for aquaculture and can cause water stress, including shortages and deterioration in water quality, negatively affecting production (Hambal et al., 1994). Drought also lowers groundwater levels, making year-round aquaculture difficult (Ahmed & Diana, 2016), and reduces the availability of open water, hindering cage culture operations.

4. Ocean acidification (OA):

Atmospheric increases in anthropogenic carbon dioxide (CO₂) are raising the concentration of hydrogen ions in the Earth's oceans, resulting in a decrease in pH known as ocean acidification (Pörtner, 2008). The global projections show that ocean acidity (pH) has already declined across the global ocean by 30% (0.1 pH unit) and by the end of this century will decline by 100-150% (0.3-0.4 pH unit) if CO₂ emissions continue at the same rate (Sumaila et al., 2014). It is adversely affecting many organisms that use calcium carbonate for their skeletons and shells, such as molluscs, corals, and echinoderms. It has a considerable impact on mariculture, particularly the production of finfish, shellfish, and seaweed (Clements & Chopin, 2017). For example, OA significantly reduced calcification (by 40%), growth

(by 17%), and development (by 25%) in molluscs reviewed by Kroeker et al. (2013), and black lip abalone, *Haliotis rubra*, and green lip abalone, *H. laevisgata*, exposed to pH 7.78 and pH 7.39, caused 5% and 50% growth reductions, respectively (Harris et al., 1999). As a result, adverse effects on aquaculture must be addressed by combining modifications that promise a route to improved food production even in the face of adversity.

5. Diseases and Harmful Algal Blooms:

Climate change, particularly rising temperatures, increases the risk of disease outbreaks in aquaculture by causing thermal stress in cultured species, which weakens their immunity and makes them more susceptible to bacterial, viral, parasitic, and fungal infections. Warmer conditions may also facilitate the spread of exotic diseases (Collins et al., 2020). Additionally, higher temperatures promote harmful algal blooms (HABs), which deplete dissolved oxygen during die-offs, leading to fish kills (Kibria et al., 2016a). A major fish mortality event in Chile was linked to blooms of *Pseudochattonella cf. verruculosa* and *Alexandrium catenella*, triggered by climate-induced water column stratification (Trainer et al., 2020). HABs have also caused inflammation, atrophy, and necrosis in bivalve molluscs (Basti et al., 2011; Haberkorn et al., 2010; Hégaret et al., 2012). Temperature variations may further influence the metabolism and toxicity of harmful algae (Farrell et al., 2015).

Indirect impacts of climate change on aquaculture:

Aquaculture relies heavily on agriculture and capture fisheries for essential inputs, indicating strong interdependence among these sectors. While aquaculture practices resemble agriculture, it remains closely linked to capture fisheries, which currently supply most protein inputs, wild seed, and broodstock, while agriculture contributes energy-rich feed ingredients and is expected to become the main protein source in the future (Cochrane et al., 2009; Hardy, 2010). Climate change can

indirectly impact aquaculture in two key ways by causing price fluctuations in capture fishery products and by decreasing the availability of fishmeal and fish oil (**Handisyde et al., 2006**). These resources primarily come from pelagic fish species like anchovies and sardines, which are vulnerable to reduced ocean productivity and climate-related disruptions, such as El Niño and changes in ocean circulation (**De Silva & Soto, 2009**). Declining capture fish yields have increased reliance on agricultural crops like cereals and soybeans for feed (**Ytrestøyl et al., 2015**), but agricultural production is also threatened by climate change (**Khatrichhetri et al., 2020**). As a result, input availability may decrease and costs may rise, particularly impacting small-scale aquaculture. However, rising prices for fishmeal and fish oil are driving research into alternative protein and oil sources, with plant-based ingredients gaining attention to support sustainable aquaculture (**Hardy, 2010**).

ADAPTATION AND MITIGATION STRATEGIES

Aquaculture is widely regarded as one of the most effective ways for fisheries to adapt to the climate change challenges. Adaptation to dangerous climate changes is essential to achieve high fish production with minimal or no environmental damage. Climate change adaptation solutions that boost aquaculture productivity sustainably have been developed. Aquaculture, like agriculture, has adapted to changing climates through technological advancements such as rice-fish farming, pond-based integrated agri-aquaculture (IAA) systems, IMTA, RAS, aquaponics, coastal aquaculture (principally molluscs), seaweed farming, selective breeding, species diversification, etc. Aquaculture can respond to disease outbreaks by selecting the right location, vaccinating the animals, and using low- or zero-water exchange systems.

1. Development of climate-resilient smart farming technologies.

RAS (Recirculatory Aquaculture System)

Recirculating aquaculture systems (RAS) are intensive tank-based culture systems that facilitate water reuse using different treatment steps. Compared to other systems, the RAS is a technology of resilience adaptation because it has complete control over the system, as it is a fully closed system, reduces outside environmental contact, and requires less water. This system provides higher fish production as they are carried out intensively. A typical RAS unit consists of a culture tank, along with a solid removal unit followed by a nitrogen removal and disinfection unit. These units recycle the outlet water from the culture tanks and circulate it back to the culture tank, which reduces the dependence on water and gives almost complete control over the culture system. The reconditioned water circulates through the system, and no more than 10% of the total water volume of the system is replaced daily. As a result, the RAS can be used in any part of the world irrespective of the climatic condition (**Badiola et al., 2018**). This attribute helps in the reduction of CO₂ emission associated with food transport by facilitating the culture of seafood near the market areas (**Martins et al., 2010**). However, the main disadvantage of RAS is that the initial investment to start up is very high, and also, they have higher operational costs, which makes them difficult to practice for medium-level fish farmers.

IMTA (Integrated Multi-Trophic Aquaculture)

Integrated Multi-Trophic Aquaculture (IMTA) system is more environmentally friendly, sustainable, and economically rewarding as well as more resilient to changing climate compared to monoculture because it combines finfish farming with other species (**Van Osch et al., 2019**). The system integrates different trophic level species to utilize the effluents from the cages and to avoid their negative impact on the ecosystems (**Chopin et al., 2004**). The major components of this system

include commercially important cultured species or fed aquaculture species (e.g., finfish/shrimp), organic extractive aquaculture species (e.g., shellfish/herbivorous fish), and inorganic extractive aquaculture species (e.g., seaweed). Integration of these organic and inorganic extractive feeders utilizes the organic and inorganic contents of the wastes released from the marine cages, respectively (**Neori et al., 2004**). The ICAR-CMFRI has successfully demonstrated IMTA under participatory mode with a fishermen group by integrating seaweed *Kappaphycus alvarezii* with cage farming of Cobia (*Rachycentron canadum*), which increased the production of both cobia and seaweed compared to the control and also efficiently reduced both the organic and inorganic matter from unutilized feed and excreta, thereby serving as one of the significant mitigating measures of the adverse impact of climate change and earning carbon credit for our country (**Johnson et al., 2021**).

Biofloc Technology

BFT is a climate-smart aquaculture with objectives of increasing fish productivity, enhancing resilience of fish production systems, and efficient use of energy, water, and land, and reduction of greenhouse gas (GHG) emissions. Bioflocs are the association of microorganisms, micro- and macro-invertebrates, filamentous organisms, extracellular polymers, feces, and uneaten feed that are suspended in the water column. The BFT uses the principle of nutrient cycling through complex bio-pathways to produce natural food for fish. The working machines are the bacterial flocs that convert pond bio-wastes into edible nutrients for the cultured animals. This reduces feed cost by about 30% and ensures higher profitability. The BFT requires minimal water exchange in aquaculture systems to maintain the flocs and allows high stocking densities and increased fish productivity (**Kuhn and Lawrence, 2012; Ogello et al., 2021**).

Aquaponics

Aquaponics is a climate-smart

aquaculture approach that combines fish culture with hydroponic vegetable production in a climate-controlled greenhouse setting, resulting in increased food production efficiency. Climate change, water scarcity, waste discharge, irregular weather patterns, and soil degradation are all addressed by this system (Haridas et al., 2021).

Modern Periphyton Technology (PPT)

Periphyton is an amalgamation of bacteria, fungi, algae, and inorganic and organic detritus that attach and grow on submerged substrates using a mucopolysaccharide matrix. The concept was deduced from traditional fishing methods in Africa and Asia used to promote fisheries in coastal lagoons. Periphyton productivity ranges between 1 and 3 g/m² substrate per day worked under the synergism of two main principles, i.e., the introduction of vertical substrates for the attachment of the biofilms and adjustment of the C/N ratio. This improves water quality and provides supplementary fish food by enhancing the heterotrophic pathway, which is activated by adding carbon sources like molasses to promote the growth of heterotrophic bacteria. These bacteria absorb inorganic nitrogen, helping control ammonia levels, especially when the carbon-to-nitrogen (C/N) ratio is maintained at 15 to 20. They colonize uneaten feed and waste, forming bacterial biomass on substrates that fish can consume. This process rapidly reduces total ammonia nitrogen (TAN) levels within 1–3 days and boosts fish growth, feed efficiency, and cost-effectiveness (Ogello et al., 2024).

2. Development of climate-resilient fish species, species diversification, and selective breeding

Diversification of species is a critical aspect in coping with climate change. According to a study done by Nadarajah & Eide (2020), shrimp species are more adaptable to climate change, such as seawater intrusion, warmth, and lower fish meal availability, than other fishes,

including tilapia, carp, and catfish. For the viability of inland saline aquaculture, the euryhaline and eurythermal species like tilapia, carps, murels, catfishes, and shrimps could be ideal. *P. vannamei* is a powerful hyper-osmoregulator that retains necessary ions by active transport by raising the Na⁺–K⁺ ATPase enzyme activity to tolerate low salinities (Abisha et al., 2022).

Selective fish breeding is another climate change-resistance adaptation in aquaculture to improve traits like tolerance to temperature extremes, stress, disease resistance, and others that can be developed. The primary goal of selective breeding is to create a disease-free fish population, which has mostly been done on bivalves and shrimps. The study conducted by Fitzer et al. (2019), in which oysters were selectively bred for faster growth, found that traits such as disease resistance altered their calcite biomineralization mechanisms, potentially increasing their resilience to ocean acidification and contributing to more sustainable oyster farming under climate change.

The prevalence of diseases in salmon and trout aquaculture increases as the water temperature rises in coldwater aquaculture. Rainbow trout (*Oncorhynchus mykiss*) have been deliberately developed to resist the bacterial coldwater disease *Flavobacterium psychrophilum*, employing genetic improvement (Wiens et al., 2013). Salmon are selectively bred for thermal tolerance.

For most cultured species, next-generation sequencing, genotyping, and phenotyping enable quick discovery of desirable features. Research into improved tolerances on numerous variables like temperature, salinity, and disease resistance is required to choose lines that will perform better under permanently changing growing conditions.

3. Adopting Integrated Agri-Aquaculture systems (IAA)

The IAA system renders farmers an improved option for livelihood and nutrition during drought. In this type of integration, the culture water

can be supplied to the agriculture crops to sustain them, and also this aquaculture water containing nutrients improves productivity when drought occurs. Aquaculture efficiency may be significantly improved by implementing integrated farming strategies that include many components such as cattle, poultry, and crops in addition to fish farming.

4. Promoting seaweed farming

The challenges due to ocean acidification can be addressed by the culture of photosynthetic organisms such as seaweeds and seagrasses. Photosynthesis and growth rates of red seaweeds, *Porphyra yezoensis*, were enhanced under higher CO₂ concentrations (concentrations of 1,000 and 1,600 ppm). Similarly, enhancement of growth with increasing CO₂ is also reported in *Gracilaria* spp. (red algae) species (Roleda and Hurd, 2012). In light of climate change, seaweeds and their extracts are becoming more popular as functional feeds. The Central Marine Fisheries Research Institute (ICAR-CMFRI) has embraced climate-resilient seaweed farming techniques in India, which has resulted in significant earnings for the farmers while also lowering carbon emissions (Manojkumar et al. 2019).

Conclusion:

As climate variability intensifies, aquaculture systems are increasingly exposed to both direct and indirect stresses—from altered water temperatures and sea-level rise to input shortages and disease proliferation. These multifaceted impacts demand a shift from reactive to proactive management. Strengthening adaptive capacity through climate-smart technologies, diversification of species and systems, new feeding technologies, feed formulation, and integration of environmentally restorative practices like IMTA and seaweed farming will be critical. Moreover, investment in research, policy support, and farmer training must align with climate resilience goals to safeguard livelihoods and ensure sustainable aquaculture growth. A collaborative, science-driven approach will be

essential to future-proof aquaculture against climate risks while enhancing its role in global food security.

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Mysterious life cycle of Indian Mottled Eel

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The freshwater eel, *Anguilla bengalensis* (Gray, 1831), commonly referred to as the Indian mottled eel, is a significant species belonging to the family Anguillidae. It is widely distributed across India, including states like Kerala, Andhra Pradesh, Arunachal Pradesh, Manipur, Meghalaya, Odisha, Tamil Nadu, Assam, and Nagaland. Its range extends to neighboring countries such as Pakistan, Bangladesh, Nepal (notably in the Gandaki, Koshi, Karnali, and Mahakali rivers), Sri Lanka, Myanmar, and even as far as South Africa (Fig. 1).

In the Marathwada and Vidarbha regions of Maharashtra, it is locally known as 'Tambhu.' As a tropical species, the Indian mottled eel is the most prevalent freshwater eel in the inland waters of India. Renowned for its high nutritional value and purported medicinal properties, this eel is highly prized as a food fish. Beyond its commercial significance, it holds cultural and

Highlight Points

- ▶ *Anguilla bengalensis* is a catadromous freshwater eel with a complex migratory life cycle involving long-distance spawning migrations to the sea.
- ▶ The species is facing population decline due to habitat fragmentation (dams/weirs), overfishing, and pollution.
- ▶ It holds significant ecological, nutritional, and cultural value across South and Southeast Asia.
- ▶ Classified as 'Near Threatened' in India, urgent conservation measures are needed to restore migratory routes and regulate exploitation.
- ▶ The article calls for enhanced research, sustainable management, and habitat connectivity to ensure long-term species viability.

religious importance, often preserved in temple ponds, particularly in the Himalayan drainage, where it is regarded as a "pristine rare ornamental species."

Morphological and Ecological Traits:

The freshwater eel (*Anguilla bengalensis*) features an elongated body and a conical head that is dorsally flattened, giving it a snake-like appearance. This resemblance often leads to misidentification among locals, particularly as the eel exhibits snake-like crawling behaviour on land during heavy rains or in moist grass. However, the presence of fins distinctly identifies it as a fish (Fig. 2).

Freshwater eels are catadromous species, spending most of their lives in freshwater environments before migrating to the sea to breed. Their life cycle consists of distinct stages: the yellow eel, silver eel, leptocephalus, glass eel, and elver (Fig. 3). These eels have remarkable

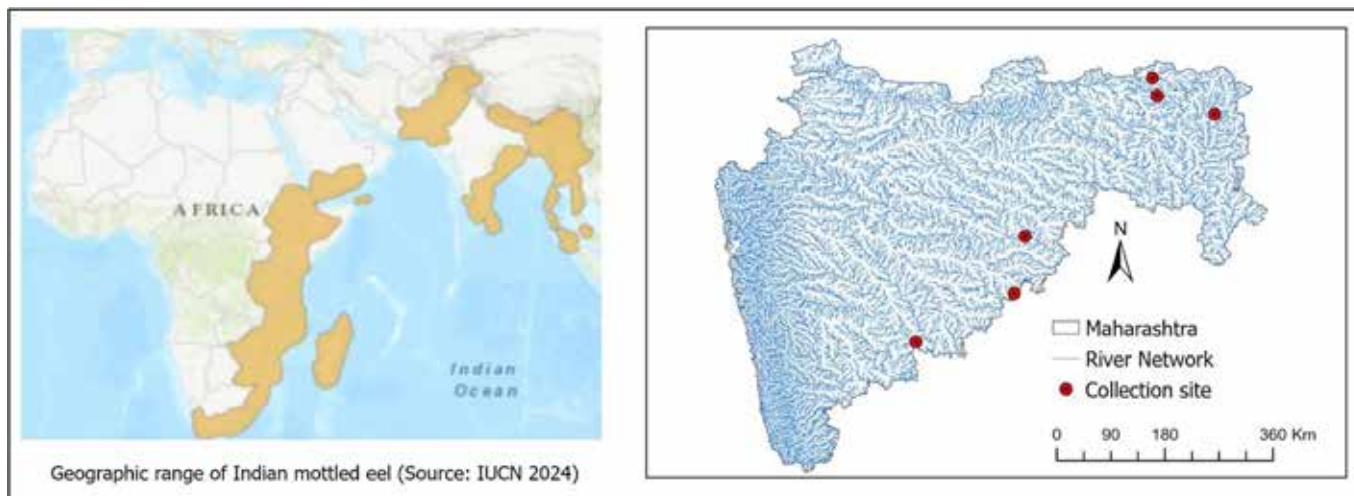


Fig. 1 Global distribution and sample collection location in Maharashtra of Indian mottled eel



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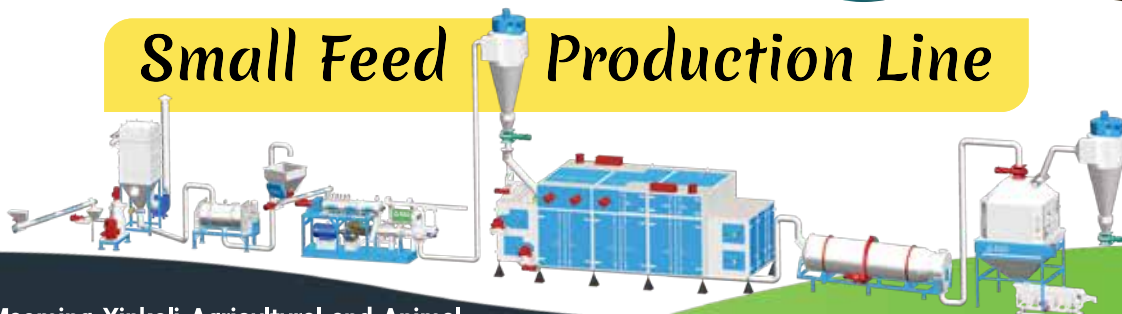
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Fig. 2 *Anguilla bengalensis* (Gray, 1831)

longevity, living for over 14 years, with the majority of their lifespan spent in freshwater habitats. During the freshwater growth phase, known as the yellow eel stage, these eels are primarily sedentary, residing in freshwater streams, pools, reservoirs, and particularly in muddy substrates of tanks or deep rock pools in rivers. As omnivores, yellow eels feed on a varied diet that includes fish, crabs, aquatic vegetation, and insects. They are also known for their cannibalistic behaviour, adding a unique dimension to their ecological interactions.

The Incredible Life Cycle and Migration of Freshwater Eels:

Freshwater eels (*Anguilla bengalensis*) are remarkable for their growth and migration. These eels can grow to over 6 kg in weight and reach lengths of up to 3 feet. However, they cannot attain sexual maturity or reproduce in freshwater. After spending approximately 14 years in lakes and rivers during their sedentary **yellow**

eel stage, they begin an extraordinary downstream migration toward the sea.

The journey spans more than 1,000 km, culminating in estuaries, where the river meets the sea. Here, the eels undergo a transformative process called **silvering**, during which their yellow coloration changes to a silver hue. This silver coloration offers countershading, protecting the eels from predators as they navigate oceanic waters. The eels also stop feeding and develop physiological adaptations for their deep-sea migration.

Once in the sea, the **silver eels** begin sexual maturation, which is completed upon reaching their spawning grounds. During this journey, they undergo further changes, including modifications to their swim bladder and eyes, enabling them to withstand the high pressure of ocean depths, achieve buoyancy, and see in dim light. Their body coloration also changes further.

After traveling thousands of kilometres in ocean currents, Indian freshwater eels reach their spawning grounds, likely near the Mantewi Deep, west of Sumatra in the Bay of Bengal. This is where their epic migration ends, and the males and females spawn by releasing gametes. Following reproduction, both sexes die, making the eels **semelparous species**, as they reproduce only once in their lifetime.

The eggs hatch into transparent, leaf-like larvae called **leptocephalus**,

which drift with ocean currents back toward the land. This return migration can take several months. Upon reaching coastal waters, the leptocephalus undergo metamorphosis into **glass eels**, small, transparent juveniles measuring about 4-5 inches in length. Glass eels typically arrive along the East Coast of India between October and February.

As they enter estuaries and rivers, the glass eels develop pigmentation, becoming **elvers**, juvenile eels approximately one and a half years old. During this stage, scales form on their bodies. The elvers begin migrating upstream, overcoming numerous obstacles, including barriers, low waterfalls, and even dam walls. They can leave the water temporarily, crawling overland to continue their journey.

Upon reaching freshwater lakes and rivers deep inland, the elvers transition into the **yellow eel** stage, completing the cycle of life. They spend their lives growing in these freshwater habitats, just as their parents did, before embarking on their own incredible migration to the sea.

Conservation Concerns:

Freshwater eels are long-lived species with a unique life cycle that requires freshwater habitats for growth and the sea for reproduction. However, this remarkable species has been classified as '**Near Threatened**' in India, primarily due to a significant decline in their population. These assessments are primarily based

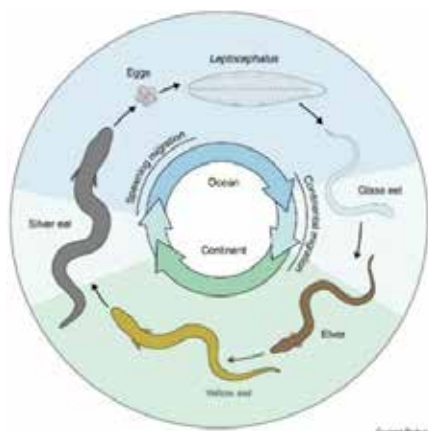


Fig. 3 Life cycle of eel
(Source: Williamson et al. 2023)

on anecdotal information and local knowledge of population declines, highlighting the need for more systematic and scientific data collection to fully understand the extent of the issue.

The reduction in eel numbers is closely linked to various anthropogenic activities, including pollution from industrial and municipal waste, construction of dams and weirs across rivers, and unsustainable juvenile fishing practices. In particular, the construction of dams and weirs has severely disrupted the natural migratory routes of these eels. Without access to their freshwater habitats or the ability to return to the sea, eels are increasingly restricted to limited areas, many of which they no longer inhabit compared to a few decades ago.

Exploitation of the species across their range appears to be increasing significantly, with current fishing rates deemed unsustainable. The harvesting of eels at all life stages—from yellow eels to mature adults—poses a high risk of recruitment failure and significant mortality among spawning individuals. Such exploitation threatens the long-term viability of populations, as it impacts both reproduction and population replenishment.

Furthermore, climate change is believed to influence the abundance of anguillid species, particularly affecting larval transport and the recruitment of glass eels. Shifts in ocean currents, temperature, and other climatic factors may disrupt the delicate migration and developmental processes of these eels. However, there remain significant knowledge gaps regarding eel migration routes, making it difficult to assess the full impact of environmental and anthropogenic changes.

Adding to these concerns, the life history of freshwater eels varies significantly across geographic regions, yet data on many populations are scarce. This lack of knowledge risks miscalculating

the mean generation times for the species, leading to ineffective conservation measures.

To address these challenges, increased monitoring and research are urgently needed to better understand population dynamics, migration routes, and the potential impacts of shifting fisheries trends. Conservation efforts must focus on habitat connectivity, sustainable exploitation practices, and filling critical knowledge gaps to ensure the survival of this ecologically and culturally significant species.

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Management practices in *Litopenaeus vannamei* farming in simplified form

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Highlight points

In last one decade, increased numbers of fish farmers in three coastal districts of West Bengal (WB) have adopted *Litopenaeus vannamei* farming in brackishwater ponds on a commercial scale as means of self-employment and income generation. Since 2017, the first author, aged 52 years, has visited 90-100 nos of *L. vannamei* farms in private sector in these districts on requests to give necessary advice for protecting the growing *L. vannamei* from diseases and keep pond and water conditions healthy all throughout culture period. This write-up is a genuine translation of a one-page leaflet already prepared on the basis of ideas and practical experience gained by him, aiming for successful and sustainable *L. vannamei* farming and good (expected) production. The useful leaflet prepared in Bengali



Mr Jana examining condition of L. vannamei

language was distributed to many *L. vannamei* farmers in coastal CD Blocks of WB, who have obtained adequate information and guidance, and have been benefitted.

Introduction

In 2020-2021, the total aquaculture production of brackishwater shrimp in India was 8.52 lakh tonnes, of which contribution of *Litopenaeus vannamei* was 8.16 lakh tonnes. It is the major commodity of brackishwater aquaculture in our country. In 2024, total shrimp production in WB was 703661 tonnes. Scientific *L. vannamei* farming is presently practiced in 4500ha of ponds in Purba Medinipur, 770ha in South 24 Parganas, 800ha in North 24 Parganas districts. A simplified form of the management practices in general of *L. vannamei* farming is presented below. With innovative approaches and efforts on-field, first author advocates less use of commercially-available medicines, seeks to demonstrate practices so that cost of production can be lowered and emphasizes on proper

pond preparation methods (pre-stocking phase) to avoid incidences of infection in growing *L. vannamei* in culture ponds by pathogens and parasites. It will help in causing increase in *L. vannamei* body weight @ 3-4gm per week from 30th day of



A haul of healthy disease-free L. vannamei



Mr Jana examining health condition of growing L. vannamei



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Mr. Jana in a classroom session

culture. Application of all necessary inputs, as mentioned below step-wise, should be done and meant for every 1000sq.mt of pond (effective water area, i.e., 25 decimal), depth 1.2-1.5mt.

Step-wise activities

- **Step-1:** The upper thick layer of soil is ploughed manually and entirely in dewatered pond. At 2-3 inch water depth, 70kg bleaching powder is applied and pond allowed to dry. This is particularly applicable in areas where incidences (outbreaks) of viral diseases in *L. vannamei* have appeared previously.
- **Step-2:** After 1 day of Step-1, water is filled in at 4-5 feet depth. Now 50-70kg bleaching powder is applied and thereafter 5kg urea within next 2 hours.



*A dewatered *L. vannamei* pond*

- **Step-3:** After 4 days of Step-2, 70-100kg agricultural lime CaCO_3 is applied. From next day onwards and till 5th day, raking (with iron hooks and chain) of pond bottom is done everyday.
- **Step-4:** After 9 days of Step-3, a mixture comprising 50-70kg 100% natural organic manure (preferably vermicompost), 300gm commercially-available probiotics,

1kg sugarcane or date palm molasses and 200gm bakery yeast is applied. It leads to sufficient production of planktonic food matter. *L. vannamei* seeds have to be stocked in between the next 3rd and 6th day. 2kg Minerals mix (commercially-available) is applied on the same night.

- **Step-5:** On next day of seed stocking, 5kg Minerals mix is



*Blackish GI tract of healthy *L. vannamei**

applied. Further, it is followed accordingly: 3kg after 5 days of stocking, 4kg after 12 days, 5kg after 20 days, 6kg after 30 days, 6kg after 37 days, 7kg after 45 days, 7kg after 52 days, 7kg after 60 days, 7kg after 68 days, 7kg after 75 days, 8kg after 84 days, 8kg after 92 days. CaCO_3 should be applied @ 6-7kg in every morning of all the specific days of Minerals mix application.

- **Step-6:** On the 15th day of Step-4, a mixture comprising 25kg 100% natural organic manure, 200gm probiotics, 1kg sugarcane or date palm molasses and 200gm bakery yeast is applied. The mixture is prepared in evening hours, soaked in water and applied (sprinkled on water surface entirely) on next day at 10am during paddle wheel aeration (pond oxygenation).

- **Step-7:** On the 15th day of Step-6, the same mixture (100% organic feed) is applied.
- **Step-8:** On the 5th day of Step-7, 2kg bleaching powder or commercially-available pond water sanitizer (disinfectant) is applied.
- **Step-9:** On the next day, 4kg TATA iodized salt is applied.
- **Step-10:** On the 3rd day of Step-8, a mixture comprising 5kg Zeolite (detoxifying agent), 5kg Single



Mr. Jana discussing with a shrimp farmer

super phosphate and 200gm medicine for toxic gas removal is applied.

- **Step-11:** On the 3rd day of Step-10, Step-6 is repeated.
- **Step-12:** On the 5th day of Step-11, 3kg bleaching powder or pond water sanitizer is applied.
- **Step-13:** On the next day, 5kg TATA iodized salt is applied. Non-refined sea salt/crystal salt, 10kg in amount mixed with water, may be applied before or after application of TATA salt.
- **Step-14:** On the 3rd day of Step-12, a mixture comprising 5kg Zeolite crystal, 6kg Single super phosphate (3kg powdered and 3kg crystal) and 200gm medicine for toxic gas removal is applied.
- **Step-15:** On the 3rd day of Step-14, Step-6 is repeated (application of the mixture).
- **Step-16:** On the 5th day of Step-15, 5kg bleaching powder or pond water sanitizer is applied.
- **Step-17:** On the next day, Step-13 is repeated, with 6kg TATA salt in place of 5kg.
- **Step-18:** On the 3rd day of Step-16,



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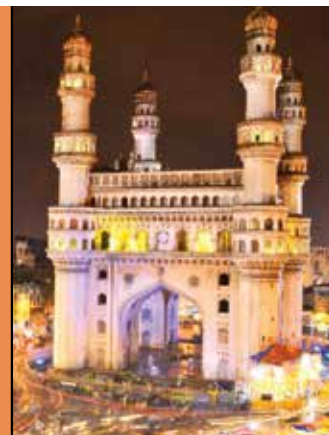


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Mr. Jana at a farm in Hasnabad

a mixture comprising 7kg Zeolite crystal, 8kg Single super phosphate (4kg powdered and 4kg crystal) and 200gm medicine for toxic gas removal is applied.

- **Step-19:** On the 3rd day of Step-18, Step-6 is repeated (application of the mixture) with amount of 100% organic manure increased to 50-60kg.
- **Step-20:** On the 5th day of Step-19, 5kg bleaching powder or pond water sanitizer is applied.
- **Step-21:** On the 6th day of Step-19, Step-13 is repeated with amount of TATA salt increased to 6kg.
- **Step-22:** On the 3rd day of Step-20, a mixture comprising 8kg Zeolite (4kg powdered and 4kg crystal), 8kg Single super phosphate (4kg powdered and 4kg crystal) and 200gm medicine for toxic gas removal is applied.
- **Step-23:** On the 3rd day of Step-22, a mixture comprising 25kg 100% natural organic manure, 300gm probiotics, 1kg sugarcane or date palm molasses and 200gm bakery yeast is applied.
- **Step-24:** On the 5th day of Step-23, Step-20 is repeated (5kg bleaching powder).
- **Step-25:** On the next day, Step-13 is repeated, with 7kg TATA salt.
- **Step-26:** On the 2nd day of Step-24, Step-22 is repeated with 8kg Zeolite crystal and rest same.
- **Step-27:** On the 3rd day of Step-26, a mixture comprising 25kg 100% natural organic manure, 400gm

probiotics, 1kg sugarcane or date palm molasses and 200gm bakery yeast is applied.

Important points

For any kind of technical assistance in *L. vannamei* farming, shrimp farmers and readers can contact first author on phone numbers 9333897511 and 9339156925. The Yard Manager (YM), Government Fish Technological Station, Junput introduced second author with the first author Mr. Jana on 27/08/2025 when Mr. Jana was invited as one of the Resource Persons in a 4-days' training programme for fish farmers here at GFTS. Second author is thankful to the YM.

L. vannamei seed stocking should be done @ 60000nos per 1000sq. mt pond, (6-9PL stage; 10-12mm) and harvest done on 90th-92nd day at 22-25gm size. The mixture comprising 100% organic manure, probiotics, molasses and yeast should be applied every time during paddle wheel aeration in between 10am and 12noon. Supplementary feed should not be given to *L. vannamei* in this period. In addition to that mentioned in Steps-1 to 27, scientifically formulated (pelleted) feed supplied by major companies should be given to growing *L. vannamei* routinely daily. In order to keep up normal and healthy gut conditions of *L. vannamei* and facilitate effective digestion, 10kg of 100% natural organic manure to be kept soaked in water; yeast, molasses, probiotics and pelleted feed are to be added to it and dried for 15mins in air. This preparation should be given in 2-3 installments daily out of the total schedule of

5-6 times feeding. Organic protein powder, prepared by first author, should be added to feed @ 10gm per kg and applied two times daily - commercially-available Vitamins need not be applied.

Medicine for toxic gas removal will not work in absence of Zeolite crystal and Single super phosphate. First author tests some new methods on field, like efficacy of adding lemon juice in feed in providing Vitamin-C and Calcium to growing shrimps and increasing appetite, and others. He has formulated a home-made medicine (preventive/prophylactic) for White Faeces Syndrome in farmed *L. vannamei*, which should be applied along with feed @ 10ml per 10kg feed on the 25th day, 45th day, 55th day and 70th day of seed stocking. The 100% natural organic manure is also prepared by him, which contains humic acid, *Bacillus* sp and other beneficial bacteria, essential micronutrients, phyto-hormones, etc. Water exchange in ponds should be done only after 40 days of seed stocking, once in every 15 days, that facilitates proper moulting. Dissolved oxygen content in pond must be sufficient. General features, concept and trend of *L. vannamei* farming in leading Purba Medinipur district was presented by second author in August 2025 issue of this magazine; the present piece of information co-authored is more enriching and concise. Authors believe that readers of this esteemed magazine and *L. vannamei* farmers will be benefitted after reading this write up.



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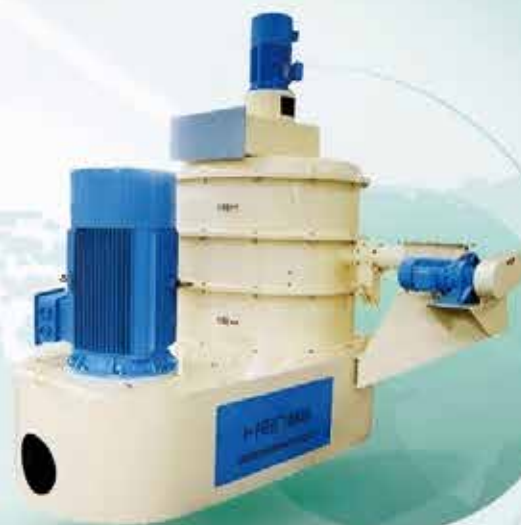
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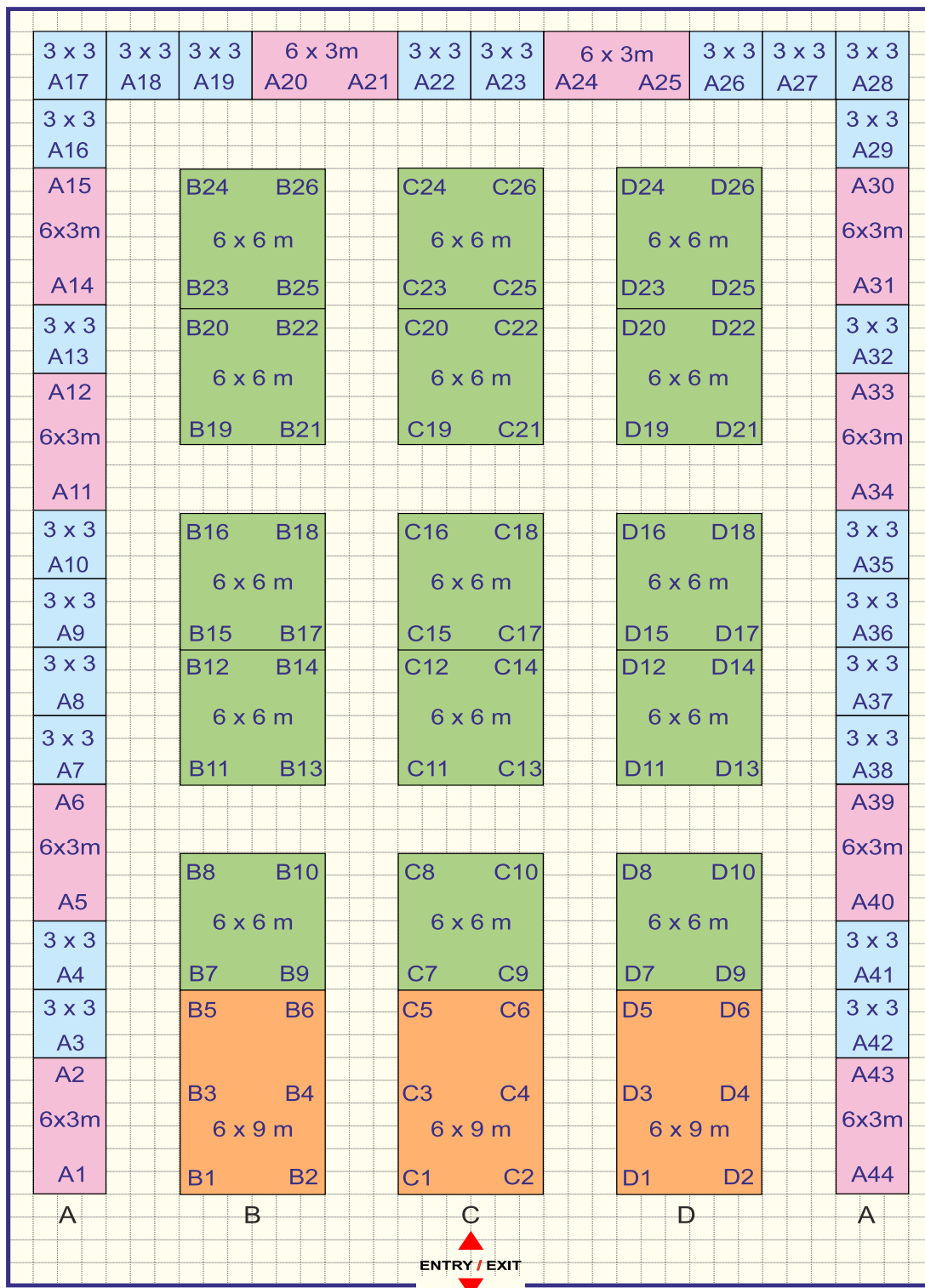
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