English Monthly from Hyderabad, India

Aqua International

Estd. 1993

Health • Nutrition • Technology • Management

June 2025

Annual Subscription: ₹800 Foreign USD 100

Inside ...

Aqua International

English Monthly Magazine
(Established in May 1993)

Volume 33 Number 2 June 2025

Editor & Publisher
M. A. Nazeer

Editorial & Business Office:
AQUA INTERNATIONAL
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Website: www.aquainternational.com

Annual Subscription
India : Rs. 800
Foreign Countries : US $ 100
or its equivalent.

Aqua International will be sent to the subscribers in India by Book Post and to the foreign subscribers by AirMail.

Edited, printed, published and owned by M. A. Nazeer and published from BG-4, Venkataramana Apts., 11-4-634, A.C.Guards, Hyderabad - 500 004, India. Printed at Srinivasa Lithographics.
Registered with Registrar of Newspapers for India with Regn. No. 52899/93. Postal Regn. No. L II/RNP/HD/1068/2021-2023.

NRS PUBLICATIONS
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Subscriptions for Aqua International, English monthly, should be sent to:
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Shrimp-a-thon 2025, a significant step to highlight Shrimp's role in Nutrition and to Promote domestic Shrimp consumption

Indian fisheries sector represents an economically important and fast-growing production sector and contributing significantly to the national economy in terms of food, nutrition, socio-economic development and providing livelihood to a large section of the society.

Shrimp hatcheries are advancing towards precision nutrition by replacing outdated "cocktail" feeding methods with single formula diets enriched with functional ingredients. These components ranging from immune boosters to digestive aids improve larval survival, growth and environmental sustainability while reducing dependence on antibiotics and marine resources.

Dear Readers,

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

A wonderful initiative was taken to display the value of Proteinous food like Shrimp, and to promote domestic consumption of shrimp in India through **Shrimp-a-thon** 2025 held on May 4, 2025 at the heart of India's aquaculture hub at Bhimavaram, Andhra Pradesh by Skretting India. The event was useful to mark a significant step in promoting domestic shrimp consumption and to highlight shrimp's role in nutrition. The event brought together a diverse group of participants including farmers, dealers, fisheries students, health professionals, chefs, opinion makers and educators showcased the importance of supporting local shrimp consumption and embracing a healthier lifestyle through Shrimp for health campaign. The morning kicked off with energizing 3km and 5km runs, which saw strong participation and high spirits. The run symbolized a collective stride towards nutritional awareness, sustainable food choices, and a stronger domestic aquaculture ecosystem. Event concluded with delicious shrimp dishes sponsored by farmers-turning the experience into a celebration of both health and locally produced super food. A few companies joined Skretting with their sponsorship for the event.

Artificial reefs launched to boost fish stocks off Vizag coast: In a step towards the marine ecosystem restoration, Minister of Fisheries, Animal Husbandry and Dairy Development, Government of Andhra Pradesh Mr Kinjarapu Atchannaidu launched artificial reefs off the Jalari Yendada coast in Visakhapatnam district recently. These man-made structures aim to restore marine biodiversity and support the livelihoods of fishing communities. As part of the first phase, 22 artificial reef units are being installed in the marine waters of North Andhra. Similar installations are planned in other coastal districts of the state. The project is being implemented under the Pradhan Mantri Matsya Sampada Yojana (PMMSY), with 60% of the funding from the Union government and the remaining 40% from the State. Designed in shapes such as triangles, flowers and large pipes, the concrete reef structures aim to mimic natural habitats by providing shelter and breeding grounds for marine life.

The Mariculture Division of CMFRI is at the forefront of research and innovation aimed at propelling sustainable mariculture practices for livelihood enhancement and growth of the nation's blue economy. Focusing on cutting-edge technologies for broodstock development, seed production and farming of economically important finfish, shellfish, other invertebrates, and seaweed species, the Division endeavours to broaden the scope of production systems. Mariculture research

Contd on next page

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Our Mission

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

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

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

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

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

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spans biology, nutrition, bio-security, health, genetics and habitat enhancement, complemented by the development of spatial planning, techno-economic models, decision support systems, automation and digital technologies tailored for mariculture applications.

ZXBVSU Underwater Fishing Camera: Professional Underwater Fishing Camera consists of two parts, an underwater camera and a high-definition LCD monitor, which helps you to monitor the fish, observe the underwater terrain and clearly see if the fish bites the hook. Portable fishing camera can help you target the position where the fish is hooked. It is a good partner for people who like sea fishing or ice fishing. Underwater Fishing Camera 6000 mAh Lithium Battery. The working life of their ice fishing underwater camera is about 8 hours. You can use the USB charging port to connect a power bank or adapter to charge the monitor, which ensures the stable operation of the camera, allowing you to explore the underwater world without worries.

Microbiota and Quality in Live Shrimp: Keys to the Supply Chain - Maintaining the quality of live shrimp throughout the supply chain, from farm to consumer, is a crucial challenge for the aquaculture sector. Various stages such as harvesting, transportation, resting and marketing can cause stress in the animals affecting their survival, muscle quality, and gut microbiota. A recent scientific study published by researchers from Ningbo University, has thoroughly investigated these factors, providing valuable information for optimizing practices in the supply chain. This feature breaks down the key findings of this research, focusing exclusively on the information contained in the study.

Indian fisheries sector represents an economically important and fast-growing production sector and contributing significantly to the national economy in terms of food, nutrition, socio-economic development and providing livelihood to a large section of the society. Besides meeting the domestic demand, the sector has been substantially contributing to the foreign exchange earnings through export. The sector also generates business avenues and opportunities for number of subsidiary industries. Different resource specific Fisheries Research Institutes of Indian Council of Agricultural Research have been instrumental for glorious history of the fisheries sector in the country. The Fisheries Science Division under the Indian Council of Agricultural Research (ICAR) coordinates and monitor the research and academic programmes in fisheries and aquaculture of five resource specific fisheries research institutes viz., ICAR-Central Marine Fisheries Research Institute (CMFRI); ICAR-Central Inland Fisheries Research Institute (CIFRI); ICAR-Central Institute of Fisheries Technology (CIFT); ICAR-Central Institute of Freshwater Aquaculture (CIFA); ICAR-Central Institute of Brackishwater Aquaculture (CIBA), a Deemed University; ICAR-Central Institute of Fisheries Education (CIFE), a bureau; ICAR-National Bureau of Fish Genetic Resources (NBFGR) and a directorate, ICAR-Directorate of Coldwater Fisheries Research (DCFR) which are also supported by a wide network of their Regional / Research / Field centres.

Dr P.V. Krishna Rao, Managing Director, Peevee Pharma & Feeds Ltd says that farmers should judge the health and nutrition products quality and should encourage cash purchases, rather than credit purchases, only then we can expect good results. In order to have early harvest of shrimps, it needs quality nutritional products in aquaculture. Instead of doing more aquaculture, farmers should think of quality management of the ponds.

In the Articles section, article titled **"Functional Nutrition in Shrimp Hatcheries: Bridging Science, Performance and Sustainability"**, authored by *Dr Lumpan Poolsawat* and *Dr Natthinee Munkongwongsiri*, shrimp hatcheries are advancing towards precision nutrition by replacing outdated "cocktail" feeding methods with single formula diets enriched with functional ingredients. These components ranging from immune boosters to digestive aids improve larval survival, growth and environmental sustainability while reducing dependence on antibiotics and marine resources. SyAqua's science driven approach to feed formulation integrates genetics, nutrigenomics and rigorous quality control to deliver nutritionally complete, biosecure and environmentally responsible hatchery feeds. This strategic shift positions functional nutrition as a core driver of consistent performance and long term profitability in modern aquaculture.

Another article titled, **"Advancement of Sustainable Aquaculture through Biofloc Technology"**, authored by Chonyo Shinglai, it is mainly stressing the ever growing urgency for sustainable aquaculture with a huge population explosion and greater demand for food. It brings forth a few environmental and social economic issues of intensive aquaculture particularly those on the coastline. More emphasis is laid on environment management through Biofloc Technology (BFT) by keeping the hazards to the minimum and maximizing production through sustainable methodologies. BFT is thereby advocated as the sensible trade off concerning the reduction of water and land use for biological and economic sustainability. The message being cast through is that of striking a balance in pursuit of ecofriendly, economically feasible and socially agreeable ways of doing aquaculture, so that the industry does prosper in the longer run.

Another article titled, **India and the Blue Economy towards Sustainable Maritime Leadership**, authored by Tenji Pem Bhutia, Ravi Shankar Kumar and Saba N. Reshi, discussed that India is harnessing its coastline and marine wealth for a sustainable, inclusive blue economy. The SAGARMALA programme drives coastal infrastructure with over USD 120 billion investment. India fosters global ties in marine science, fisheries and maritime security. Challenges include technological gaps, skill shortages and underdeveloped sectors like cruise tourism and blue carbon.

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
Editor & Publisher
Aqua International

Uni-President

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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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Artificial reefs launched to boost fish stocks off Vizag coast

Fisheries, Animal Husbandry and Dairy Development Minister Kinjarapu Atchannaidu launched the 'Seaweed Harvest' programme and artificial reefs.

Visakhapatnam: In a step towards the marine ecosystem restoration, Minister for Agriculture, Cooperation, Marketing, Animal Husbandry and Fisheries, Kinjarapu Atchannaidu launched artificial reefs off the Jalari Yendada coast in Visakhapatnam district on Monday. These man-made structures aim to restore marine biodiversity and support the livelihoods of fishing communities.

As part of the first phase, 22 artificial reef units are being installed in the marine waters of North Andhra. Similar installations are planned in other coastal districts of the state. The project is being implemented under the Pradhan Mantri Matsya Sampada Yojana (PMMSY), with 60% of the funding from the Union government and the remaining 40% from the State. Designed in shapes such as triangles, flowers, and large pipes, the concrete reef structures aim to mimic natural habitats by providing shelter and breeding grounds for marine life.

Fish species including king fish, tuna, red snapper, prawns, crabs, squids, and octopuses are expected to thrive near these reefs, located within 2.5 km from the shore. This proximity is expected to help fisher men reduce fuel and operation-al costs by up to 80%. CMFRI Principal Scientist Dr Joe Kizhakudan is heading the project.

Speaking at the event, Minister Atchannaidu said the initiative is a response to the declining fish stocks caused by pollution and oil-related activity along the coast, which has severely impacted traditional fishing livelihoods. He also highlighted other support measures under PMMSY.

"A total of 634 transponders have been distributed free of cost to mechanised boats operating from the Visakhapatnam Fishing Harbour. These devices help track boats and are particularly useful during adverse weather events. Additional plans include subsidised distribution of GPS units, echo sounders, fishing boats, engines, nets, and ropes," he noted.

He added that efforts are underway to clear pending diesel subsidy and ex gratia payments. "Discussions will be held with the Port Chairman for the installation of cranes and cradles at the Visakhapatnam Fishing Harbour," Atchannaidu assured. He also inspected the cage culture and seaweed farming units off RK Beach, also implemented under PMMSY. He directed officials to expand these initiatives to generate employment for youth and women in fishing communities.

Special Chief Secretary B Rajasekhar, Fisheries Commissioner Ramashankar Naik, and a large number of fishermen were present at the event.

An update from CMFRI's Mariculture Division

The Mariculture Division is at the forefront of research and innovation, aimed at propelling sustainable mariculture practices for livelihood enhancement and growth of the nation's blue economy. Focusing on cutting-edge technologies for broodstock development, seed production, and farming of economically important finfish, shellfish, other invertebrates, and seaweed species, the Division endeavours to broaden the scope of production systems. Mariculture research spans biology, nutrition, bio-security, health, genetics, and habitat enhancement, complemented by the development of spatial planning, techno-economic models, decision support systems, automation, and digital technologies tailored for mariculture applications. Our notable achievements include pioneering technologies for captive breeding, seed production and farming >30 species, alongside the establishment of standardized culture systems encompassing Coastal ponds, Tanks, Cages, Pens, Rafts, RAS, and Integrated Multi Trophic Aquaculture (IMTA). The Division has made significant advancements in refining larval-rearing protocols, nursery systems, and mass culture techniques for diverse algal species and invertebrates as live feed for various stages of finfishes and shellfishes. Through extensive demonstrations, training, skilling initiatives as well as knowledge dissemination programs, the division has empowered countless individuals within the mariculture sector, thereby fostering livelihoods and blue economic goals. The Division remains steadfast in its commitment to driving forward the frontiers of mariculture research and facilitating a brighter, sustainable future for our oceans and communities.

ZXBVSU Underwater Fishing Camera, Fishing Camera with Infrared Night Vision Light, Portable Fish Finder with 100ft Cable, 5 Inch LCD and Upgraded HD Lens for Ice Lake Boat Kayak Fishing

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Instructions to use

or adapter to charge the monitor, which ensures the stable operation of the camera, allowing you to explore the underwater world without worries.

| Advanced Waterproof Camera: This fishing camera with monitor has a brightness of 2000cd, equipped with 6-12 infrared glare-free night vision lights and a 220° wide angle. The wide field of view can capture real and delicate underwater scenes. It can stay clear even in dark environments. | Excellent Design and Durability: The fish camera underwater for fishing is rugged and durable, equipped with a 30m/100ft cable, which is anti-corrosion, waterproof, cold-resistant, pressure-resistant, and can withstand a maximum load of 100kg. Please rest assured to use our ice fishing camera underwater. | Easy to Use, 1 s Plug and Use: Just plug in the power supply to use the underwater camera for fishing. Portable set box, you can take it with you, very suitable for sea fishing, ice fishing, lake fishing, boat fishing and other underwater adventures, suitable for lake fishing / ice fishing enthusiasts.

Microbiota and quality in live shrimp: Keys to the supply chain

Maintaining the quality of live shrimp throughout the supply chain, from farm to consumer, is a crucial challenge for the aquaculture sector. Various stages such as harvesting, transportation, resting, and marketing can cause stress in the animals, affecting their survival, muscle quality, and gut microbiota.

A recent scientific study, published by researchers from Ningbo University, has thoroughly investigated these factors, providing valuable information for optimizing practices in the supply chain. This article breaks down the key findings of this research, focusing exclusively on the information contained in the study.

The shrimp's journey: an analysis of the live supply chain

To understand how the supply chain affects Penaeus vannamei, researchers evaluated several critical phases: the post-harvest state (directly from the pond), post-transport (after a 30-minute transfer), post-rest (after a 3-hour recovery period), and a simulated sales phase of up to 48 hours under two temperature conditions: ambient temperature (AT, 29°C±0.3°C) and low temperature (LT, 23°C±0.3°C). This simulation allowed for the observation of changes in muscle quality and gut microbiota of the shrimp under controlled conditions.

How were the quality and microbiota of the shrimp evaluated?

The research employed a comprehensive approach to measure the impact of the supply chain. Scientists analyzed the cumulative survival rate of the shrimp at each stage.

To determine muscle quality, they measured key physicochemical parameters such as:

- **Color and transparency:** Using a colorimeter to record luminosity (L*) values, color coordinates a* (red-green) and b* (yellow-blue), and the total color difference (ΔE*).
- **Texture:** Texture profile analysis (TPA) was performed to measure the hardness, gumminess, chewiness, and springiness of the muscle.
- **pH and lactate content:** Indicators of metabolic stress and post-mortem degradation.

- **Thiobarbituric acid reactive substances (TBARS):** An indicator of lipid oxidation and flavor deterioration. In parallel, the researchers conducted a detailed analysis of the gut microbiota by sequencing 16S ribosomal RNA to identify the composition and diversity of bacterial communities and predict their metabolic functions in the different stages and conditions.

Impact of transport and rest: critical moments for the shrimp

The stress of the journey

The study, published in the journal MDPI, revealed that the transport stage is particularly stressful for shrimp. They observed the highest mortality (12%) after transport, which underscores the severe impact of this phase. The muscle pH significantly decreased from 7.19±0.02 (post-harvest) to 6.67±0.02 (post-transport), while lactate content soared from 8.41±1.25µmol/g to 31.48±1.02µmol/g.

See also The 2030 Agenda and the Sustainable Development Goals: The challenge for aquaculture development and management

The changes reported in the study are indicative of accentuated anaerobic metabolism due to stress. The gut microbiota also underwent alterations, with an increase in the relative abundance of Proteobacteria (from 21.63% to 32.53%) and Actinobacteria (from 18.81% to 33.44%), and a decrease in Firmicutes (from 28.90% to 7.43%) and Bacteroidetes (from 4.08% to 0.41%).

The importance of a rest

After transport, a 3-hour rest period proved beneficial. Although the survival rate continued to decline slightly to 82.48%±0.33%, signs of recovery were observed. Muscle pH increased to 6.92±0.02 and lactate content decreased drastically.

The gut microbiota also showed changes: the abundance of Firmicutes increased considerably (to 52.61%), while Proteobacteria and Actinobacteria decreased. These findings suggest that a rest period can help mitigate transport stress and promote physiological and microbiological rebalancing in shrimp.

Water temperature during sale: a key factor

During the simulated sales phase, the holding temperature was a determining factor for the survival and quality of the shrimp.

Benefits of cold

The group kept at low temperature (LT, 23°C) consistently showed better results compared to the group at ambient temperature (AT, 29°C).

Higher survival: At the end of the 48-hour simulation, the LT group had an 8% higher survival rate than the AT group (75.43% vs 67.81%).

Better muscle quality:

Texture: Muscle hardness in the LT group was significantly higher (34.9% more at the end of 48h) compared to the AT group, where hardness, gumminess, and chewiness tended to decrease.

Color: The LT group generally exhibited higher luminosity (L*) and b* values, and a lower total color difference (ΔE*), indicating better color stability and greater muscle transparency, especially at 24 and 48 hours.

pH: The pH in the LT group tended to be more stable and even increased slightly at the end of the period, while in the AT group it showed a slight decrease.

More stable gut microbiota:

The LT group showed an increase in the relative abundance of Bacteroidetes (from 3.63% to 7.39% between 0 and 48h), a bacterial phylum often associated with a healthy intestinal environment. In contrast, in the AT group, Bacteroidetes decreased.

The Firmicutes: Bacteroidetes (F:B) ratio in the LT group decreased from 13.29 to 7.28, while in the AT group it increased drastically from 30.44 to 115.22. A lower F:B ratio has been associated in some contexts with healthier states. These results highlight the effectiveness of keeping shrimp at a lower temperature during the sales phase to preserve their quality and extend their shelf life.

See also Low tropic aquaculture value chain report

Gut microbiota: a reflection of shrimp quality

The study delved into how the gut microbiota of Penaeus vannamei changes throughout the supply chain and correlates with muscle quality.

Scientists reported significant changes in microbiota composition at different stages. For example, transport induced an increase in diversity that later decreased after rest. During the simulated sale, diversity tended to increase in both temperature groups, being significantly higher in the LT group at 48 hours.

Of particular interest was the identification of two bacterial orders, Xanthomonadales (from the Proteobacteria phylum) and Oscillospirales (from the Firmicutes phylum), as potential biomarkers of good shrimp quality. In the LT group, the abundance of these bacteria correlated positively with higher survival rates, better muscle texture (hardness), and greater brightness (L*). These findings suggest that these bacteria could play a role in maintaining shrimp quality under cold stress conditions or that their presence is indicative of better adaptation and physiological state.

The gut microbiota influences host health through various pathways, including nutrient metabolism, immune system modulation, and protection against pathogens. Although this study did not explore direct mechanisms, the observed changes in microbiota and their predicted functions (through PICRUSt2 analysis) suggest a dynamic connection between the gut and muscle quality. For example, transport altered metabolic pathways related to energy, amino acid synthesis, and antioxidant stress. Rest, on the other

hand, seemed to activate pathways that could mitigate transport-induced damage.

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Critical control points and optimization strategies based on the observed changes in survival and quality parameters, the study identified three potential critical control points (CCPs) in the live shrimp supply chain:

- The transport stage.
- The 24 hours of the sales phase.
- The 40 hours of the sales phase (from which point some color parameters began to deteriorate more noticeably). These CCPs are moments where interventions could have the greatest impact on the final product quality. The main recommendations derived from this study to optimize the supply chain are:
- Standardize a post-transport rest procedure: This can alleviate stress and improve shrimp recovery, especially in longer transports.
- Maintain low temperatures (approximately 23°C) during the sales phase: This practice was shown to significantly improve survival and muscle quality parameters, in addition to stabilizing the gut microbiota.

See also Aquaculture's role in nutrition in the COVID-19 era.

Conclusion

This study underscores that the live shrimp Penaeus vannamei supply chain presents significant challenges, with transport being the most critical stage in terms of initial mortality. However, strategies such as an adequate rest period and, crucially, temperature control during marketing (maintaining around 23°C), can drastically improve survival and preserve muscle quality.

Furthermore, the research highlights the crucial role of the gut microbiota as a sensitive indicator of shrimp condition and a possible modulating factor of its quality. The identification of Xanthomonadales and Oscillospirales as potential biomarkers opens new avenues for monitoring and improving management strategies in aquaculture and in the post-harvest supply chain.

For shrimp producers and distributors, these findings offer a scientific basis for implementing practices that not only reduce losses but also ensure the delivery of a higher quality product to the end consumer, thereby strengthening the sector's competitiveness. Future research could focus on validating these results in longer-distance transports and further exploring host-microbiota interactions to develop even more refined quality control strategies.

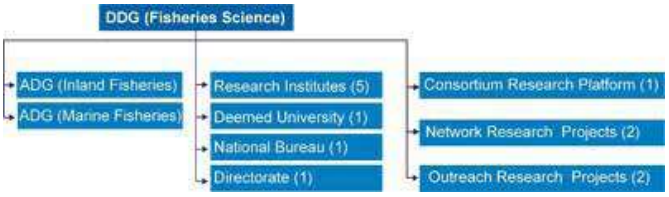
The study was funded by the National Key Research and Development Programs of China, the National Natural Science Foundation of China, the Natural Science Foundation of Zhejiang Province for Distinguished Young Scholars, and the Projects of the Bureau of Science and Technology of Ningbo City.

Efforts of ICAR's Fisheries Science Division

Indian fisheries sector represents an economically important and fast-growing production sector and contributing significantly to the national economy in terms of food, nutrition, socio-economic development and providing livelihood to a large section of the society. Besides, meeting the domestic demand the sector has been substantially contributing to the foreign exchange earnings through export. The sector also generates business avenues and opportunities for number of subsidiary industries. Different resource specific Fisheries Research Institutes of Indian Council of Agricultural Research (ICAR) have been instrumental for glorious history of the fisheries sector in the country.

The Fisheries Science Division under the Indian Council of Agricultural Research (ICAR) coordinates and monitor the research and academic programmes in fisheries and aquaculture of five resource specific fisheries research institutes viz., ICAR-Central Marine Fisheries Research Institute (CMFRI), ICAR-Central Inland Fisheries Research Institute (CIFRI), ICAR-Central Institute of Fisheries Technology (CIFT), ICAR-Central Institute of Freshwater Aquaculture (CIFA), ICAR-Central Institute of Brackish water Aquaculture (CIBA); a Deemed University, ICAR-Central Institute of Fisheries Education (CIFE); a bureau, ICAR-National Bureau of Fish Genetic Resources (NBFGR) and a directorate, ICAR-Directorate of Coldwater Fisheries Research (DCFR) which are also supported by a wide network of their Regional/Research/ Field centres. The Fisheries Science Division has also initiated Network Projects on Mari culture, Fish Health Management, Breeding & Culture of Ornamental Fishes and Antimicrobial Resistance and is also coordinating a Consortium Research Platform (CRP) project on 'Genomics'.

The research programmes of the fisheries research institutes have been strengthened, re-structured, re-oriented and prioritized with thrust on enhancing fish production and productivity through optimum and sustainable utilization of resources with due emphasis on conservation of fish resources to realize the full production potential from the fisheries and aquaculture sectors and to address the critical research gaps. The research implementation, monitoring & evaluation mechanism has also been strengthened for bringing more accountability and transparency in the research programmes.



Glimpses of Shrimp Improvement Systems Conference held at Kakinada

***Nanang Hindarto**, Technical Head, Shrimp Improvement Systems*

***Siva Prasad**, Sales Manager, Shrimp Improvement Systems*

***Nanang Hindarto** presenting a momento to a customer. Tikku, Shiva Prasad and **Dr Rushi R.K,** Technical Manager, Shrimp Improvement Systems are also in the picture*

Shrimp Improvement Systems team during the conference

SIS and participants during the conference

A view of participants in the conference

Note: An interview with Shrimp Improvement systems may be seen in July 2025 issue

READY STOCK AVAILABILITY

DISINFECTANTS & SANITIZERS

2-4-Dichloro-3,5-Dimethylphenol (DCMX), 4-Chloro-3,5-Dimethylphenol (PCMX), Benzalkonium chloride (BKC), and Glutaraldehyde, which help in maintaining hygiene and preventing microbial contamination.

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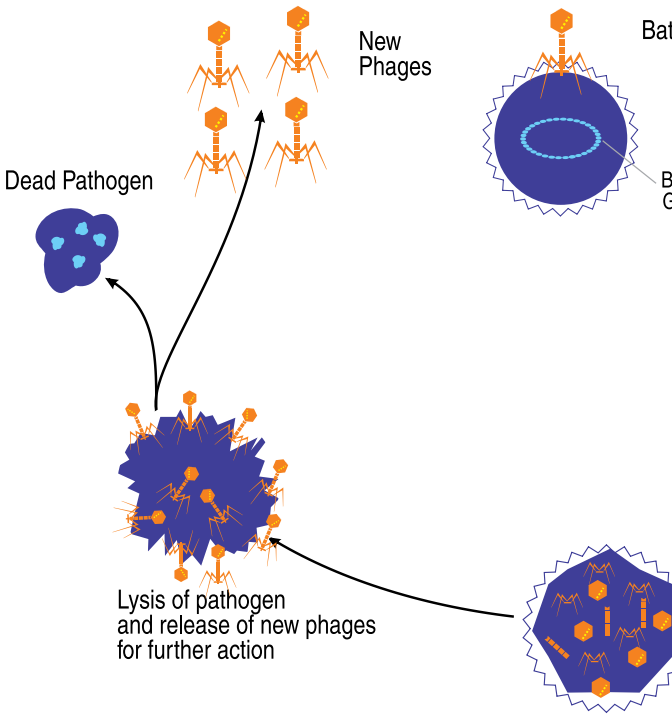

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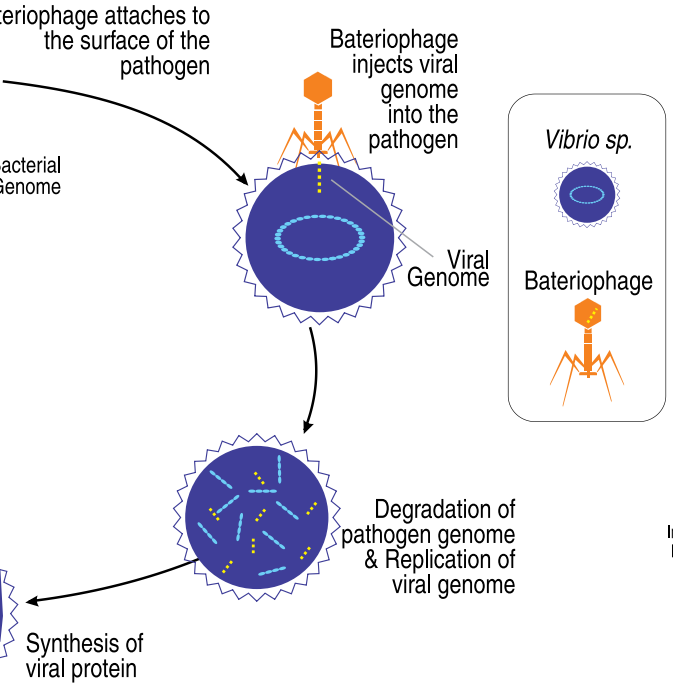

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- Prevents sudden crop loss and extends Life of Pond during critical profit-making period.
- Enhances Probiotic performance.

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

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

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

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

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

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Shrimp-a-thon 2025:
An initiative to raise domestic shrimp consumption in India

Joyful Event: *Dr Saurabh Shekhar taking selfie with participants in Shrrimp-a-thon 2025 held at Bhimavaram on 4th May 2025*

Shrimp-a-thon 2025 concluded successfully — marking a significant step in promoting domestic shrimp consumption and to highlight shrimp's role in nutrition and India's aquaculture sector. Held in the heart of India's aquaculture belt— Bhimavaram, Andhra Pradesh held on May 4, 2025 —the event brought together a diverse group of over 500 participants, including farmers, dealers, fisheries students, health professionals, chefs, opinion makers and educators showcased the importance of supporting local shrimp consumption and embracing a healthier lifestyle through Shrimp **For Health** campaign.

The morning kicked off with energizing 3km and 5km runs, which saw strong participation and high spirits. The run symbolized a collective stride toward nutritional awareness, sustainable food choices, and a stronger domestic aquaculture ecosystem. Event concluded with delicious shrimp dishes sponsored by farmers-turning the experience into a celebration of both health and locally produced super food.

Fisheries students during Shrimp-a-thon 2025

The event highlighted a critical paradox: while India is one of the world's leading shrimp producers, more than 90% of its shrimp is exported, even as protein deficiency continues to affect a large portion of the population. This became the central theme of the event— emphasizing the urgent need to bridge the gap between production and consumption locally

Dr Saurabh Shekhar, General Manager, Nutreco South Asia, addressed the audience and debunked common myths surrounding shrimp consumption. He emphasized shrimp's nutritional profile—high-

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Skretting felicitated participants and supporters in Shrimp-a-thon 2025 at Bhimavaram

quality protein, low fat, and essential micronutrients—and stressed its potential to become a mainstream protein source for Indian households.

Initiatives like this acts as a trigger for a sustained, concentrated effort to build long-term awareness and boost domestic consumption.
Mr Ravi Kumar Yellanki, President of the All India Shrimp Hatcheries Association, cited the opportunity to grow local consumption, comparing India's potential to China's 25-fold growth in 15 years. **Dr Manoj Sharma** of Zhingalala emphasized shrimp's nutritional value and supported efforts to promote locally produced protein. **Mr Chandrasekar S of USSEC and Right to Protein** aid shrimp is

important to India's economy and protein goals.

Beyond the run, the event featured interactive stalls such as the Protein-o-Meter and Live Shrimp Counter, enriching the experience. It not only positioned shrimp as a powerful super food but also showcased the strength of collaboration within the aquaculture industry.

A collective effort: Thanks to our valued co-sponsors

The success of Shrimp-A-Thon 2025 was made possible by the strong support of more than 17 co-sponsors and partners, all integral to the aquaculture value chain. United by a common goal, we worked together to promote a healthier, protein-rich India and a more sustainable aquaculture industry. Their commitment to the cause played a vital role in making the event a remarkable success.

A strong foundation for the future

Shrimp-A-Thon 2025 was more than just a run it was a powerful initiative to change perceptions, encourage local shrimp consumption, and create a lasting impact. With exceptional participation and collective support, this initiative has set a strong foundation for future campaigns focused on raising awareness about domestic shrimp, enhancing food security for sustainably **feeding the future.**

Participants in 3 km and 5 km run during Shrimp-a-thon 2025

As we move forward, the momentum created here will continue to build bridges

between **producers and consumers**, inspire more informed dietary choices, and strengthen India's position as not just a leading shrimp exporter—but also a nation that values and consumes what it grows.

*By **Ms Bhavana Reddy**, Strategic Marketing Lead, Skretting India*

Gassen Plus

Bon Ammonia and obnoxious Gasses

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

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

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

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

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

PRESENTATION: 500 gms &1 kg

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Farmers should judge the health and nutrition products' quality and should encourage cash purchases, only then we can expect good results

Dr P.V. Krishna Rao lost his mobility because of his spinal cord surgery in 1997. Since then his life partner Mrs Vidyullata is giving support in production side as well personal life without losing willpower. For the past 28 years he is working from his bed only because of his positive attitude and unconditional support given by his customers.

Vijayawada: Dr P.V. Krishna Rao attributed scrupulous quality and economic prices of the products for the success and growth of his company Peevee Pharma & Feeds Ltd. In order to have early harvest of shrimps, it needs quality nutritional products in aquaculture, he stated.

Answering to a question on what is needed to maintain the best quality of products to ensure optimum results with the customers, Dr P.V. Krishna Rao said, farmers should judge the health and nutrition products' quality before prices and should encourage cash purchases rather than credit purchases, then only we can expect good results. Instead of doing more aquaculture, farmers should think of quality management of the ponds, he stated.

Turning point in his career & life

I lost my mobility because of spinal cord surgery in 1997. Since then, my life partner Mrs Vidyullata is giving me support in production side as well personal life without losing willpower. For the past 28 years, I am working from my bed only because of my positive attitude and unconditional support given by our customers.

Dr P.V. Krishna Rao & his wife Mrs Vidyullata, Director - Production

***Dr P.V. Krishna Rao,** Managing Director, Peevee Pharma & Feeds Ltd*

Commenting on the present issues, trends and for sustainable growth in aquaculture sector, Dr Krishna Rao said, the lease rates should come down and the customer either farmers or traders should not depend only in credit facilities. They should reduce the extent of culture area and should concentrate on better management. Culture should be carried on with technical support mainly.

Dr P.V. Krishna Rao, was born in 1951 at Koduru of Krishna District, and was brought up at Vinukonda, Guntur District, Andhra Pradesh. He did his B.V.Sc in 1972 at College of Veterinary Science, Tirupati.

About the Company and its promoters

Dr P.V. Krishna Rao and his wife Ms Vidyullata are the promoters of Peevee Pharma & Feeds and the company was promoted in 1995. The company's registered office is situated in Vijayawada and the factory is located in Pedaoutapalli near Gannavaram. The Company is supplying products pertaining to Fish and Prawn culture sector.

The manufacturing activity was started in 1988 with products in poultry industry, during 1992 we brought products for aquaculture industry. In 1993 we started producing Shrimp feed, but it was closed in 2008. At present we are producing health and nutritional products for fish and prawn culture only, said Dr Krishna Rao.

In fish culture our products like Alcidal, Protox, G Pro, Vetcophor, Protector pls, etc are popular. In Prawn culture DNF Gel, Qualimin, Aquazyl, Ayush SP, Ayush WP, Instant O2, Hydrotreat, Feed Gel, Vetcoplex etc are our esteemed products, he stated.

At present the company is marketing its products in Andhra Pradesh, Odisha and West Bengal states.

We market our products directly in Andhra Pradesh, and through propaganda cum distribution in West Bengal and Odisha states. We give financial support through qualified field staff working in different places and respective dealers, he stated replying to a question about his sales and service network.

Mr G. Ramakrishna is the sales coordinator of the company.

Dr Krishna Rao said, we have 100% satisfied customers because of our quality and economic prices. I can confidently say one thing that though the turnover is less, we market our products with atmost satisfaction, he told. We have a very respectable position in the market, he added.

Peevee Pharma has a business turnover of Rs. 20 crores per annum in India.

Mrs Vidyullata is the production director looking after production and quality control of the products, he informed. Instead of doing more aquaculture, farmers should think of quality management of the ponds.

Talking about his future plans and targets, Dr Krishna Rao told, we have to increase our market share in India and also has plans to export products to other countries.

Giving a message to the farmers and other stakeholders of the industry, Dr Krishna Rao said that the price structure starting from seed, feed and medicines should be seriously taken for the survival of the industry because the basic customer, the farmer, should be safe and more and more people should come into the culture.

Falcon Feeds opens regional office at Vijayawada

G. S. Rath,
Sr General Manager, Feeds Division, Falcon Group

Vijayawada: Falcon Group opened its Regional Office at Vijayawada on 20 March 2024 for marketing of its shrimp feed. Mr G. S. Rath, Senior General Manager, Feeds Division, is heading the regional office.

The Sales and Technical team of Falcon Feeds is located at Vijayawada. The company has 40 sales personnel in Andhra Pradesh and four technical professionals Pan India. It has 70 sales personnel in India. Mr Deepak Joshi is the Technical Head of the Feeds Division of Falcon Group.

Falcon Group has its Head Quarters in Bhubaneswar, Odisha. Falcon Group's Falcon Marine Exports Ltd is a leading sh rimp processor-cum-exporter in India.

To focus more on customer relation and better services to the farming community, the company is expanding its sales and technical team with regional office in Vijayawada, informed Mr G.S. Rath.

Functional Nutrition in Shrimp Hatcheries:

Bridging Science, Performance, and Sustainability

By Dr Lumpan Poolsawat and Dr Natthinee Munkongwongsiri, SyAqua

Dr Natthinee Munkongwongsiri

Shrimp hatcheries are advancing toward precision nutrition by replacing outdated "cocktail" feeding methods with single-formula diets enriched with functional ingredients. These components—ranging from immune boosters to digestive aids—improve larval survival, growth, and environmental sustainability, while reducing dependence on antibiotics and marine resources. SyAqua's science-driven approach to feed formulation integrates genetics, nutrigenomics, and rigorous quality control to deliver nutritionally complete, biosecure, and environmentally responsible hatchery feeds. This strategic shift positions functional nutrition as a core driver of consistent performance and long-term profitability in modern aquaculture.

Precision Nutrition for Modern Hatcheries

Shrimp hatcheries are entering a new era of innovation, driven by the need for greater consistency, sustainability, and disease resilience. The traditional cocktail feeding approach—mixing multiple dry feeds and additives—has long served as a practical but imperfect solution to meet larval nutritional demands (*Cui et al., 2020*). However, this method often suffers from inconsistency in feed quality, over- or underfeeding, nutrient imbalances, variable water quality outcomes, and inefficiencies in labor and cost (*Skretting, 2023; Saengpeng et al., 2024*).

In response, the industry is shifting toward single-formula diets scientifically formulated to meet specific larval stage requirements. Central to this evolution is the integration of functional feed ingredients—a category of innovative compounds that optimize nutrition while supporting animal health, feed conversion, and environmental sustainability.

The traditional cocktail feeding approach, however, relies on mixing feeds of varying quality, often leading to nutrient imbalances and inefficiencies. While some hatcheries attempt to compensate for these imbalances by adding vitamins and minerals, this can disrupt the precise nutrient balance required for optimal performance. Instead of using low-quality feeds to cut costs, hatchery managers should prioritize digestibility and efficiency, which leads to better water quality, improved survival rates, and increased profitability.

The Science Behind Functional Ingredients: More Than Just Nutrition

Functional feed ingredients are not mere fillers or nutrient sources; they serve as biochemical tools to optimize growth, survivability, immunity, and environmental outcomes. These ingredients are carefully selected based on their ability to complement or enhance traditional protein sources, improve digestibility, and address nutrient gaps that often arise from reducing dependence on fishmeal or other marine resources (*Boyd et al., 2020*; *Serra et al., 2024*).

Dr Lumpan Poolsawat

Key categories of functional feed ingredients include:

- **Nutrient Enhancers:** Bioavailable amino acids, phospholipids, fatty acids, and vitamins that fulfill larval nutritional requirements in early life stages (*Onomu & Okuthe, 2024*).
- **Digestive Aids:** Enzymes, bioactive peptides, and yeast-derived nucleotides that enhance nutrient absorption and feed conversion efficiency (*Naiel et al., 2020; Zuberi et al.,2024*).
- **Immune Modulators:** Probiotics, prebiotics, organic acids, and phytogenic compounds that support gut microbiota, strengthen immunity, and improve resilience to pathogens (*Van Doan et al., 2020; Poolsawat et al., 2020*).

Environmental Optimizers: Additives

that help maintain water quality by mitigating nitrogenous waste and promoting beneficial microbial populations (*Hlordzi et al., 2020, Li et al., 2022*).

The synergy of these components enables hatcheries to reduce the reliance on antibiotics, stabilize larval performance, and enhance the cost-effectiveness of post-larval production.

Functional Ingredients: Strengthening the Foundation of gut health

Modern high-throughput hatchery operations require high levels of operational efficiencies from broodstock to water systems and this rigor must extend to the feeds provided. While nutritionally complete aquafeed aims to maximize growth by meeting nutritional requirements, its role must evolve to also enhance shrimp robustness and resilience. This is where functional feed ingredients play a critical role.

Functional ingredients offer two key benefits to efficient feed systems:

- **Functional Performance:** Functional ingredients such as yeast-derived nucleotides, marine hydrolysates, algae extracts, and immunostimulants are sourced and processed to maintain functionality. These ingredients are screened and handled under strict quality protocols to prevent contamination while contributing essential nutrients and gut health enhancers that improve performance might be missing from reduced fishmeal diets.
- **Support for Early Immunity and Survival:** The inclusion of targeted probiotics, bioactive peptides, and organic acids in SPF feeds helps improve gut integrity, immune function, and pathogen tolerance during the early and highly sensitive larval stages. For example, beta-glucans and nucleotides support innate immune response, while algae-derived compounds can enhance antioxidative capacity under hatchery stressors (*Raman, 2017; Van Doan et al., 2020*).

By combining well formulated digestible ingredients with the physiological benefits of functional nutrition, modern hatchery feeds can now efficiently stimulate early development while minimizing ammonia buildup and water quality degradation, giving hatcheries a measurable performance edge.

From Ingredient to Outcome: Science-Driven Feed Formulation

At SyAqua, the development of hatchery feed is grounded in integrated research across genetics, nutrigenomics, and functional ingredient evaluation. The company's feed mill operates under stringent quality control (QC) protocols. All raw materials—whether marine-derived, plant-based, or functional additives—are vetted for nutritional, microbiological, and traceability standards. This ensures that the final feed product not only meets nutritional requirements but also aligns with SPF standards and sustainability objectives.

The feed formulation process is informed by both laboratory data and field performance trials. Each finished feed product is optimized to deliver:

- **Nutritional Completeness:** Meeting essential amino acid profiles and micronutrient levels for early-stage shrimp.
- **Health Support:** Boosting early immune development through specific functional additives.
- **Environmental Performance:** Reducing nutrient leaching and reliance on antibiotics, and improving feed conversion ratios (FCR), contributing to eco-friendly operations.

This holistic approach turns finished feed into a precision tool for hatchery success—connecting the dots between ingredient selection, larval health, environmental sustainability, and long-term profitability.

SyAqua's Vision: Pioneering Sustainable Hatchery Nutrition

SyAqua's commitment to sustainable aquaculture extends beyond genetics and broodstock development. SyAqua is actively developing SPF hatchery feeds that incorporate functional ingredient research to support the full expression of genetic potential, ensuring robust larval performance even under challenging rearing conditions.

Through collaborations with research institutions and hatchery partners, SyAqua has adopted a systems-thinking approach. This includes:

- **Use of alternative proteins** that reduce pressure on marine resources.
- **Adoption of biosecurity protocols** to ensure SPF integrity throughout the production chain.
- **Continuous innovation in feed additives** that promote larval health and improve ROI for farmers.

Looking Ahead: Functional Nutrition as a Strategic Imperative

The convergence of disease pressure, climate variability, and resource constraints demands a new generation of hatchery solutions. Functional nutrition — especially when paired with SPF biosecurity protocols — offers a way forward that is both sustainable and profitable.

At SyAqua, we view functional ingredients not as add-ons, but as foundational elements in the future of high-performance, SPF-certified feeds. Our ongoing R&D aims to integrate these components thoughtfully and effectively. Our mission is to help hatchery operators unlock the full potential of their genetics and systems through precision nutrition that is safe, consistent, and future-ready.

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More references can be given on request*

Advancement of Sustainable Aquaculture through Biofloc Technology

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1. INTRODUCTION

The high growth rates at which the population grows on earth have made food production including aquaculture, a vital industry that needs to be developed. Development in the aquaculture industry must consider the environment, socio-economic and include certain factors of sustainable development in making expansion in this industry. Intensified activity in aquaculture particularly in coastal regions increased the organic matter load introduced into water and this creates long-term environmental risks (Sharifinia *et al*, 2019). As the outlook for land and water resources becomes limited, the sustainability of aquaculture will most probably hinge on improvement of the environment, productivity enhancement, application of aquaculture technology and reduction in the cost of production. Biofloc technology (BFT), which is the proposed sustainable aquaculture system is very well known since the early 1970s. However, large-scale research on the development and application of BFT has been done chiefly since the early 1990s and promising results have been reported (Avnimelech, 2015). The main objective of such an expansion would be to produce aquaculture products more intensively but without much additional use of the natural water and land resources involved (Avnimelech, 2009). The second goal is furthering sustainable aquaculture systems that do not have adverse environmental side effects (Naylor *et al*., 2000). The third goal describes establishing systems that provide a fair cost/benefit equilibrium for facilitating economic and social products.

- **It is mainly stressing the ever-growing urgency for sustainable aquaculture with a huge population explosion and greater demand for food.**
- **It brings forth a few environmental and social-economic issues of intensive aquaculture, particularly those on the coastline.**
- **More emphasis is laid on environment management through Biofloc Technology (BFT) by keeping the hazards to the minimum and maximizing production through sustainable methodologies.**
- **BFT is thereby advocated as the sensible trade-off concerning the reduction of water and land use for biological and economic sustainability.**
- **The message being cast through is that of striking a balance in pursuit of eco-friendly, economically feasible, and socially agreeable ways of doing aquaculture so that the industry does prosper in the longer run.**

2. Biofloc technology

Biofloc system, popularly known as biofloc technology (BFT) has today raised enormous interest as a cost-effective, sustainable and environmentally friendly method of improving water quality while producing microbial protein for aquatic species (Avnimelech & Kochba 2009). According to National Agricultural Library Glossary (United States Department of Agriculture), biofloc technology refers to 'the aggregates of bacteria, algae or protozoa aggregated within the matrix of particulate organic matter to improve water quality, waste management and disease prevention in intensive aquaculture systems. It improves water quality, feed conversion efficiency, lowers protein diet ratios, reduces production expenses and substitutes expensive conventional feeds with alternative protein sources (Wasielesky *et al*., 2006). The basis of this technology is flocculation or co-cultural heterotrophic bacteria-algae in the system (Avnimelech 2006). A well-balanced composition of carbon and nitrogen in the solution would convert ammonium with organic nitrogenous waste into bacterial biomass (Schneider *et al*., 2005). This renders ammonia removal from the culture systems and turns waste materials into possible supplemental food sources for farmed aquatic species (Browdy *et al*. 2012).

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3. Biofloc formation and mechanism of microbial cell bonding

To convert into biofloc, firstly fill the tanks with water and subsequently add appropriate amounts of nitrogenous materials (aquatic feeds and urea fertilizer) to provide nitrogen. Carbonaceous organic materials (including molasses, wheat flour and starch) are dispersed on the water surface of the tanks to provide a source of carbon. The clay is also added to the microbial reservoir for enhancing the formation of the microbial mass post softening and sieving through a mesh with 53 µm sized openings. The addition of clay at the initiation as well as during biofloc formation is beneficial in order to enhance the further mass continuity. Further, the application of farm wastewater with nitrogenous wastes provides inoculum assistance. The 20g of clay, 10 mg of ammonium sulfate and 200 mg of carbonaceous organic matter like molasses induce biofloc in a litre of water. Various studies propose that inoculating primal clay and biofloc-rich water into the production cycle enhances microbial mass generation into the emerging culture system (Gaona *et al*., 2011; Zemor *et al*., 2019). While organic nitrogenous wastes will be turned to bacterial biomass, ammonium will mostly follow suit if the carbon and nitrogen balance of the solution outweighs the wastes (Schneider *et al*. 2005).

There are many processes responsible for the formation, appearance and stability of the microbial mass. Numerous organisms repel polymeric substances of humic, proteinaceous and polysaccharidic nature that coat their outer surface; these slimy polymers act as adhesives, bringing together other cells and particles to form a biofloc. Another mechanism is an equilibrium between gravity forces (be it molecular, dipole, or hydrogen bond) and electrostatic repulsion forces. Most organisms have a negative charge and repel one another electrostatically. Should this repulsion be reduced, strong gravity forces would come into play; this situation occurs at high salt concentration with the presence of multivalent ions in the environment (Avnimelech, 2009).

4. Essential water quality parameters monitored in BFT systems and their recommended ranges (Emerenciano *et al*., 2017).

Factors	Normal and/or Ideal Detected Ranges	Remarks
Temperature	28–30°C (ideal for tropical species)	Low temperatures (~20°C) may impact microbial activity in addition to fish and shrimp.
pH	6.8 to 8.0	pH levels below 7.0 are common in BFT but may interfere with the nitrification process.
Dissolved Oxygen (DO)	Above 4.0 mg/l and at least 60% saturation	Crucial for respiration and growth of fish, shrimp and beneficial microbes.
Total Ammonia Nitrogen (TAN)	Less than 1 mg/l when pH ≤ 7.0	pH significantly affects the toxicity of TAN.
Salinity	Depends on the species being cultured.	BFT can be used across a wide salinity range from 0 to 50 ppt.
Alkalinity	Greater than 100 mg/l	High alkalinity supports nitrogen assimilation and aids nitrification by microbes.
Nitrite	Less than 1 mg/l	A challenging but essential factor that requires careful monitoring.
Orthophosphate	0.5 mg/l to 20 mg/l	Generally safe for fish and shrimp within this range.
Nitrate	0.5 mg/l to 20 mg/l	Similar considerations as for orthophosphate.
Total Suspended Solids (TSS)	Less than 500 mg/l	Excess TSS reduces oxygen availability due to gill blockage and microbial competition.
Settling Solids (SS)	Varies with species: 5–20 ml/l for fingerlings, 5–15 ml/l for shrimp, 20–50 ml/l for adults	Functions similarly to TSS in its effects on water quality.

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5. Importance of aeration in BFT

Ammonia was oxidized into nitrites and then to nitrates by ammonia-oxidizing bacteria (AOB) and nitrite-oxidizing bacteria (NOB) in the nitrification process (Ebeling et al. 2006). This process requires sufficient and continuous oxygen supply; otherwise, it shall be suppressed (Avnimelech, 2015). On the other hand, over-aeration would reduce flocs aggregation and cause their breakage. It implies that the aeration intensity should be kept at an appropriate rate to keep flocs suspended without breaking them and facilitate nitrification. BFT aeration intensity also affects performance, water quality and biofloc composition. A number of studies considered the effect of aeration systems and their intensities on shrimp culture in BFT systems. For example, diffused air system (air blowers) was found to establish a better bioflocs formation and improvements of the performance of white leg shrimps (L. vannamei) compared to propellers and vertical pumps (Lara et al. 2017a). Diffused air caused even greater biofloc aggregation while the use of vertical pumps and propellers ruptured or broke apart these bioflocs. Aerotubes are also better than air stones in water movement and circulation for biofloc formation in BFT based white leg shrimp culture (Harun et al. 2019). In the meantime, the nitrification activity is more efficient when undergoing higher airflow rates with biofloc than at lower rates (de Morais et al., 2020).

6. Nutritional value of biofloc

In this particular scenario, nutritional value relies on the following variables: particle size, digestibility and biochemical compounds. Ekasari et al. (2014) reported that the floc particle sizes > 100 and < 48 µm due to more favourable nutritional value and N recovery are better for the shrimps (L. vannamei), red tilapia (Oreochromis niloticus) and the mussel (Perna viridis). They further reported the following: flocs > 100 µm contained the highest levels of protein and lipid, while flocs < 48 µm were rich in essential amino acids. As a matter of quality, when expressed as dry matter, biofloc are 38% protein, 3% lipid, 6% fiber, 12% ash, and 19 kJ/g energy (Azim and Little, 2008). According to Khanjani (2015), the biofloc presence led to a decrease in the FCR from 1.20 to 1.29 and an increase in feed efficiency from 78.61 to 84.26% when compared to the clear water treatment which had an FCR of 1.52 and feed efficiency of 66.81%.

7. Balancing carbon and nitrogen

The carbon sources may be utilized or, preferably, the protein content in the feeds should be decreased. Cost-efficacy and efficiency of carbon sources for BFT units should be carefully studied. The key to controlling nitrogen toxicity in BFT is the maintenance of the C/N ratio. However, control of the C/N ratio is typically a very big challenge toward the successful operation of BFT. The plentiful supply of carbon at the initial stage of the farming cycle guarantees ammonia spikes are avoided. The carbon is really allowing heterotrophic bacteria to flourish and uptake the ammonia in the water, keeping the ammonia concentration low. It is best to use carbon sources and feed mixtures with a C/N ratio over 10 (Avnimelech 2019).

8. Studies on species and carbon sources in biofloc production systems

In BFT systems, the most commonly cultured species are tilapia and shrimp and tilapia is said to be doing particularly well because of its adaptability and ability to utilize biofloc particles (Sharma et al., 2023). Factors in BFT performance include the cultivation period, stocking density, carbon-to-nitrogen ratio and type of carbon source used (Khanjani et al., 2022). The C/N ratio of the aquaculture system can be increased by the addition of different locally available low-cost carbon inputs (agricultural wastes) and also by reducing the protein content of the feeds. Different organic carbon sources (glucose, cassava, molasses, wheat, corn, sugarcane bagasse, sorghum meal, etc.) are utilized to enhance production and improve nutrient dynamics by varied C/N ratios in shrimp culture (Avnimelech, 1999).

Schematic calculation of the daily amount of carbon needed to remove the nitrogen wasted from uneaten feed and excretion from the animals by bioflocs (Piedrahita, 2003).

Daily feeding of 2% of fish weight (Craig and Helfrich, 2002)

↓

20 g feed added per kg fish per day.

↓ *Take a feed with 25% protein*

5 g protein added per kg fish per day

↓ *16% of protein is N (Craig and Helfrich, 2002)*

0.8 g N added per kg fish per day

↓ *On average 75% of the feed-N ends up in the water (ammonification of uneaten feed + excretion) (Piedrahita, 2003)*

0.6 g N per kg fish per day ends up in water

↓ *Micro-organisms need a C/N ratio of 10 (Avnimelech, 1999)*

6 g C per kg fish per day needed for biofloc production

Species	Carbon Sources	Reference
Macrobrachium rosenbergii	Acetate	Crab *et al.* (2010)
Litopenaeus vannamei	Dextrose	Suita (2009)
M. rosenbergii	Glucose	Crab *et al.* (2010)
L. vannamei and *Penaeus monodon*	Molasses	Burford *et al.* (2004)
L. vannamei and *M. rosenbergii*	Starch	Asaduzzaman *et al.* (2008)
Farfantepenaeus brasiliensis, *F. duorarum*	Wheat flour + Molasses	Emerenciano *et al.* (2012a,b)
Tilapia	Cellulose	Avnimelech (2009)
Tilapia (*O. niloticus*)	Wheat flour	Azim and Little (2008)
F. paulensis	Wheat bran + Molasses	Emerenciano *et al.* (2011)
L. vannamei	Wheat bran	Wang *et al.* (2016)
L. vannamei	Molasses + Dextrose + Rice flour	Serra *et al.* (2015)
L. vannamei	Molasses + Wheat flour + Starch	Khanjani *et al.* (2017)

9. Implementation of biofloc technology in aquaculture

Monitoring the ponds is a very important aspect in the implementation of biofloc technology in aquaculture. Biofloc technology is not yet so well predictable, making it risky to implement on the farm level. Possible monitoring tools are the concentration of total suspended solids or bioflocs and the settleability of the biofloc, both of which can be easily and quickly determined using simple experiments (De Schryver *et al.*, 2008). It is also possible to use molecular monitoring to find out about the conditions of the bioflocs, but limitation of time and cost might affect further application of this method in real biofloc systems.

10. Use of bioflocs as supplemental feed for farmed shrimps

Abbreviations: BFM = Biofloc meal, FM = Fish meal, SBM = Soybean meal, DE = Digestible Energy

11. Management aspects

Water quality parameters have to be monitored in BFT (Avnimelech, 2009):

Species (Size/ Stage)	Levels Tested / Replaced	Recommended Level (%)	Remarks	References
L. vannamei (1.48 g)	25, 30, 35, 40 & 45% crude protein	35	Shrimp performed better at protein levels of 35% and above.	Panigrahi *et al.* (2019d)
L. vannamei (PL10)	24, 32 or 40% crude protein	32	Shrimp in BFT systems showed better growth and health than those in standard conditions.	Correia *et al.* (2014)
L. vannamei (PL13)	BFM: 10–30% of FM and SBM	30	Flocs created using sucrose showed better shrimp growth compared to the control group.	Kuhn *et al.* (2010)
L. vannamei (6.5 g)	BFM: 7.5, 15 & 30% of FM	30	A 30% inclusion of biofloc yielded the highest growth and feed efficiency.	Xu and Pan (2014b)
F. paulensis (72 mg)	20, 25, 30 & 35% crude protein	25	Protein levels can be reduced from 35% to 25% without compromising shrimp growth or health.	Ballester *et al.* (2010)
L. vannamei (23 mg)	BFM: 10–21% of FM and SBM	21	Flocs produced without added carbon source improved shrimp growth over the control.	Dantas *et al.* (2016)

Units of BFT

- Oxygen- Reduce the number of aerators if the level of dissolved oxygen is high. However, if the level of dissolved oxygen is less than 4 mg/ L, some aerators should be added.
- TAN- Low level of TAN (<0.5 mg L^{-1}) means system is working well; if TAN is found to be higher than that, carbon should be added.
- NO_2 -The presence of nitrite is detrimental to tilapia. Increase in nitrite could be an indicator of the existence of anaerobic zones. Change in aerator position may be warranted if nitrite levels are elevated due to the possible accumulation of sludge in the pond.
- Determining floc volume (FV) with Imhoff cones is simple and inexpensive. FV levels should range between 550 ml/ L. If FV is low, add carbohydrates, and if FV is high (>50), remove the sludge.
- Low level of TAN is <0.5 mg/L means that the system is working well. If TAN is found to be higher than that, thereby add-on carbon.

12. Conclusion

- Biofloc technology is the latest innovation in aquaculture that can be beneficial for so many things such as diminishing water pollution through a zero-water discharge system, eliminating the cost incurred for water treatments as well as promoting better growth in cultured organisms Quality of water under biofloc technology helps to prevent the disease spread and limits water exchange. In BFT, waste is converted into biofloc. Biofloc is the natural food resource for fishes and shrimps reducing the external nutrients input. Another disadvantage of the aeration system in biofloc technology is the need for high energy in operating it and high-cost aeration facilities. This also is resulted from rapid alteration in the quality of water from nutrients accumulation. High water temperatures are needed for the implementation of this system. Despite these disadvantages, BFT has great potential for sustainable aquaculture development, especially when coupled with other technologies such as aquaponics and vertical farming.

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*More references can be given on request**

India and the Blue Economy Towards Sustainable Maritime Leadership

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Highlights

- **India is harnessing its coastline and marine wealth for a sustainable, inclusive blue economy.**
- **The SAGARMALA programme drives coastal infrastructure with over USD 120 billion investment.**
- **India fosters global ties in marine science, fisheries, and maritime security.**
- **Challenges include technological gaps, skill shortages, and underdeveloped sectors like cruise tourism and blue carbon.**

Introduction

The blue economy represents a forward-looking vision for harnessing ocean and coastal resources in a way that balances economic growth, environmental sustainability, and social well-being. Unlike traditional exploitative models, it promotes an integrated, ecosystem-based approach that safeguards marine environments while driving inclusive development. Key sectors within this framework include marine fisheries, aquaculture, coastal tourism, marine biotechnology, maritime transport, and offshore renewable energy—all managed with a focus on sustainability and equitable benefits (Patil et al., 2016).

Despite the vast potential of the world's oceans, much of the deep-sea and marine wealth remains unexplored. These largely untapped resources could become a foundation for future green economic growth, especially for coastal nations. For India, which enjoys a strategic position along the Indian Ocean, the blue economy offers a promising pathway. With ongoing efforts to expand infrastructure and regional connectivity, India is actively exploring the opportunities that lie beneath its waters. The aim is not just economic acceleration, but also crafting policies that support long-term ecological balance and inclusive progress. Harnessing marine resources wisely can transform them into valuable natural capital—fuelling diverse industries and opening up livelihood opportunities for coastal communities, all while preserving the delicate ocean ecosystems for future generations.

Blue economy in India

India's vast coastline, rich marine biodiversity, and strategic location along the Indian Ocean offer immense potential for building a strong and diversified blue economy. Traditionally, coastal communities have engaged in fishing, aquaculture, and maritime trade—activities that are deeply embedded in India's socio-economic and cultural fabric. Now, as the global focus shifts toward sustainable ocean-based development, India is beginning to leverage these long-standing practices with modern infrastructure and policy frameworks.

In recent years, India has taken significant strides to tap into the opportunities offered by the blue economy. Initiatives such as the SAGARMALA Programme, which envisions over 600 projects with an investment of over USD 120 billion, aim to enhance port infrastructure, promote coastal economic zones, and foster industrial development along the coastline. Prime Minister Narendra Modi has emphasized that the blue economy must act as a "catalyst in improving India's progress," signalling its importance in national development planning.

Beyond traditional sectors like fisheries and tourism, India is also exploring emerging domains such as offshore renewable energy in states like Gujarat and Tamil Nadu (Joshi, 2020). These projects hold the potential to contribute to climate goals and the UN Sustainable Development Goals (SDGs), particularly in clean energy and sustainable livelihoods. However, many of these ventures remain in early stages, and their long-term impact is yet to be fully realized.

India's Blue Economy and Multilateral Engagement

India has increasingly prioritized economic goals in its foreign policy, positioning itself as an attractive investment destination through its strengths in democracy, demography, demand, and decisiveness. Prime Minister Modi has highlighted these factors as key to India's global economic engagement. A growing emphasis is also placed on inclusive and sustainable development, with the blue economy emerging as a strategic focus. Ensuring maritime security, freedom of navigation, and sustainable marine resource management is seen as vital to regional cooperation and economic growth. India actively supports multilateral collaboration in marine science, technology transfer, sustainable fisheries, and environmental protection, engaging with partners across South Asia, Africa, Pacific Island nations, and Europe to advance blue economy strategies and regional development.

Challenges

Despite its potential, India faces critical challenges that may hinder its leadership in the global blue economy. Key among them is the lack of advanced marine technology

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and a skilled workforce in ocean-related disciplines (Banchariya, 2018). While institutions for oceanographic research exist, the academic ecosystem still lacks dedicated programs in marine economics and blue economy studies. Experts argue that without targeted education, research funding, and capacity-building initiatives, India may struggle to scale innovation in marine sectors.

Moreover, sectors like cruise tourism, marine biotechnology, and ocean-based renewable energy remain underdeveloped, despite growing global demand. For instance, while coastal destinations like Goa and Kerala attract tourists, India has yet to establish itself as a major cruise tourism hub. Similarly, potential blue carbon markets—linked to ecosystems like mangroves and seagrass—remain untapped opportunities for climate finance.

The FICCI Task Force on Blue Economy has highlighted the urgency for timely preparedness from both government and industry. A lack of readiness, they warn, could result in missed business opportunities and increased dependence on foreign technologies (FICCI Task Force, 2017.

Recommendations

To emerge as a global leader in the blue economy, India must go beyond infrastructure development and adopt an integrated, ecosystem-based approach. This means investing in research and education, fostering public-private partnerships, and ensuring sustainable use of marine resources that benefit both the environment and local communities. With its unique geographic advantages, youthful population, and policy momentum, India is well-positioned to lead. But achieving leadership in the global blue economy will require visionary planning, bold reforms, and above all, a commitment to sustainability.

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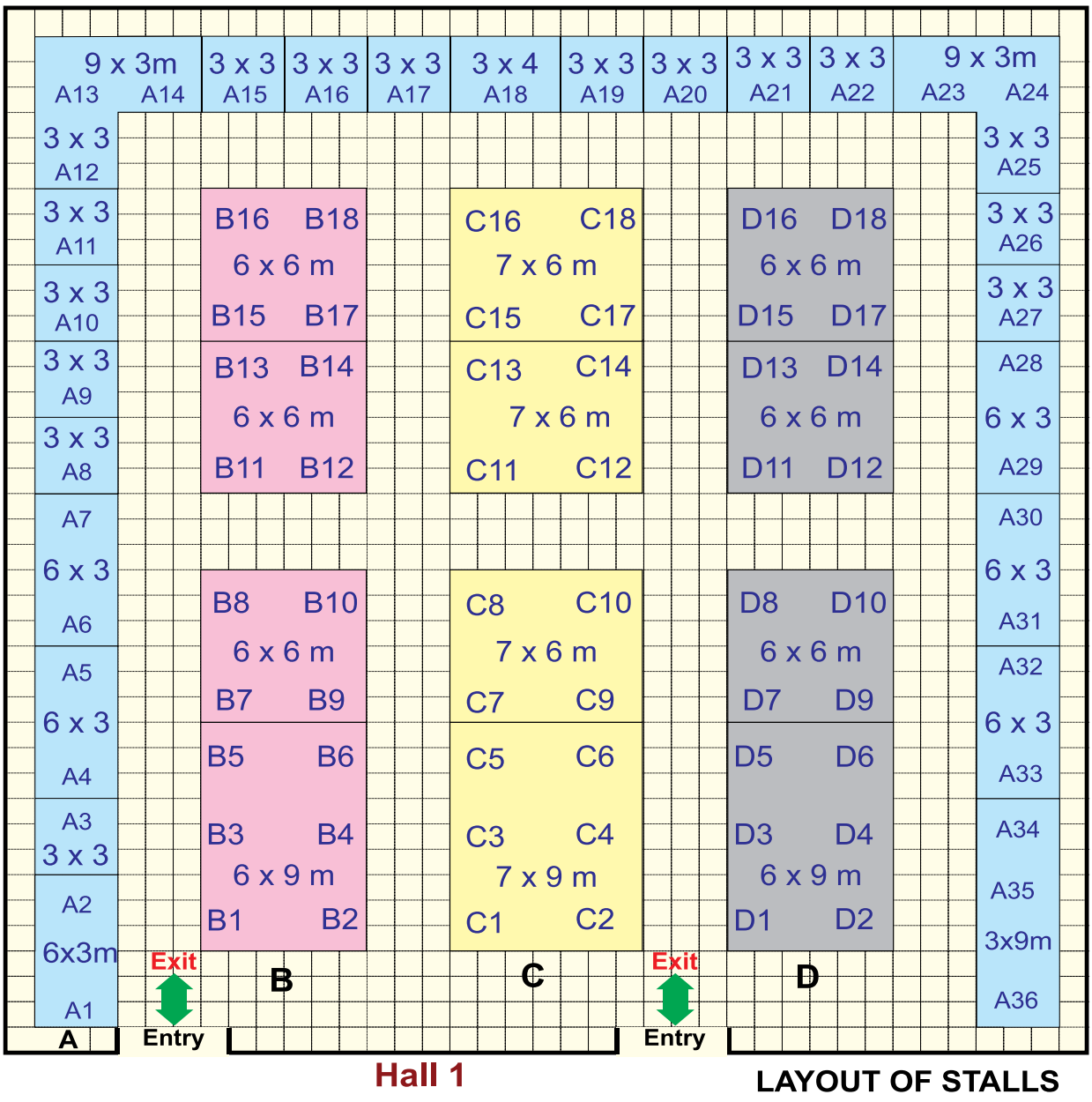

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Date of Publishing:
7 June 2025

RNI Regn. No.: 52899/93
Postal Regn. No.: HCD/1068/2024-2026

Date of Posting:
8th, 9th June 2025

Posting at BPC-IV, Patrika Channel, Nampally, Hyderabad - 500 001