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Aqua International

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Inside ...

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Are we caring for the quality of baby shrimp?

Artificial intelligence (AI) and smart sensing technologies are rapidly transforming aquatic animal health management from reactive treatment to proactive, real-time disease prevention in commercial farms. Global experience shows that well-designed AI systems can achieve diagnostic accuracies above 90 percent, reduce disease-related economic losses by up to half, and improve feed and resource efficiency at scale.

Dear Readers,

The April 2026 issue of Aqua International is in your hands. In the news section, you may find news about....

The shrimp farming season has begun in the coastal areas of India. Farmers buy baby shrimp from hatcheries for about a rupee each, and farmers are complaining that the baby shrimp are dying within a few days of being put in the pond. Farmers who wait ambitiously for the new season in 2026 feel disappointed as their investment for seed is gone with the death of seed.

The farmers are suffering immense losses. The authorities who should be concerned about this are just waiting to see if they receive complaints. Vannamei (Litopenaeus Vannamei) and Tiger shrimp (Penaeus Monodon) are being cultivated in huge number in the country. Farmers are worried as the baby prawns brought from hatcheries are dying within 20 days of being placed in the pond. Hatcheries get their revenue with the sale of their shrimp seed. Farmers invest for preparing the pond, labour, transportation of the baby prawns, electricity, feed, healthcare, management etc. They say the hatchery managers do not care about the quality at all. While the farmers were thinking about whether to go for the crop or not due to the fear of ongoing war, the farmers are now complaining about how they will start cultivation with poor quality of shrimp fry.

It is necessary to honestly review accountability of the hatcheries and the farmers in producing quality shrimp and to take measures to prevent mortality of baby shrimps in the ponds. Farmers also should not compromise in pond preparation, soil and water treatment for the coming crop. We do not have proper verification, certification and process of confirming the truth about the quality of shrimp. Also the preparation of the ponds by the farmers to receive the shrimp seed. The government and its concerned department along with industry stakeholders should come out with a system where farmers and genuine hatcheries are satisfied, and the farming goes successfully in 2026.

Benefits of Nursing Shrimp – Over the past six years, nursery systems for shrimp seed have evolved rapidly in Latin America. Currently, the rearing time in nurseries is longer, the biomass is bigger, the transfer systems and water control systems (without water exchange) are all better. Feed and probiotics have also been improved. The goal is to produce Healthier Postlarvae / Shrimp that adapt to the pond environment. This approach leads to a better survival rate in the first days of culture and minimize exposure to the carriers. Since the EMS / AHPND pathogen is Vibrio, nursery systems allow farmers to focus on controlling Vibrio bacteria in a smaller area and hinder exposure to the pathogen. In Mexico and Asia, this is one of the strategies used to minimize premature mortality syndrome (EMS). The biggest cost in shrimp farming is during growth. Larger stocking / Postlarvae (PLS), namely PL 45, instead of PL 12, reduces the duration of the growout period by 20-30 days. A shorter crop means lower energy and feed costs. Feed Conversion Ratio (FCR) can be reduced by 10-30%. The evolution of a nursing system in Mexico White spot virus, coupled with restrictions due to local weather (Mexico) has severe weather conditions, hot summers and cold winters, have forced farmers to modify the nursery system. The 50 Ton round tanks in 2008, rose to 100 Ton raceway in 2009, and then 500 Ton in 2011. Currently, even larger rectangular tanks with a capacity of 800 up to 1,000 tons of closed greenhouse were used.

A Pond bottom-up approach – To improving shrimp welfare Sustainable Shrimp Farming in India

Contd on next page

NRS GROUP

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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is helping smallholders in Andhra Pradesh improve shrimp welfare and their own livelihoods through a variety of simple, yet effective, interventions. For thousands of India's smallholder shrimp farmers, the accumulation of sludge at the bottom of their ponds is gradually undermining animal welfare, water quality and financial stability. Left unmanaged, this mixture of shrimp faeces, shed shells, uneaten feed and dead shrimp produces toxic gases, disease outbreaks and mass mortalities that can push already vulnerable farmers to the brink. This is the problem that Sustainable Shrimp Farming in India has set out to address, armed with nothing more sophisticated than industrial pumps, excavators and the testaments of an ever growing number of farmers who have benefitted from the organisation's simple interventions. Formed as a key component of non-profit Shrimp Welfare Project (SWP), SSFI works directly with smallholders in the vicinity of Serepalem village to improve shrimp welfare while stabilising livelihoods. Its flagship initiative subsidised sludge removal is already delivering measurable improvements in pond conditions, shrimp survival and farmer confidence. "Our intervention is primarily focused on smallholder farmers," explains Srirang Kavali, SSFI's director of India operations. "When we say smallholders, we mean farmers with less than two hectares [five acres], and very often they don't even own the ponds they lease them."

The one day district level Bengal Fish Fest - 2026 programme was organized by Department of Fisheries, Aquaculture, Aquatic Resources and Fishing Harbours, Government of West Bengal on 27 and 28 February 2026 at different district headquarters. Also, various fish based value added edible products and valuable byproducts, local fishery products produced by skillful persons were showcased at the stalls. As an important part of the programmes, the topics and subject matter of technical-cum-awareness sessions included maintaining good management practices in aquaculture. It was a very good platform for learning on the part of participants, their motivation and sharing of knowledge on recently developed aquaculture practices.

Opinion of fishery experts and former CIFRI Directors on Ganga Innovation Meet – 2026, that the ICAR-Central Inland Fisheries Research Institute, Barrackpore organized the Ganga Innovation Meet - 2026 programme during 13 to 15 January 2026 at this premier fisheries research institute of the country under National Mission for Clean Ganga Project 'Namami Gange' focusing on conservation of fish diversity of the mighty river Ganga. The Meet was entirely a three day programme, devoted to special theme 'Biodiversity conservation, stock enhancement and small-scale fisheries in Ganga river basin'. The inaugural session of Ganga Innovation Meet was held on 13 January 2026.

In the Articles section, **AI Beneath the Surface: Industrial-Scale Smart Aquaculture for Disease-Free Production** authored by Madhan discussed that 90-99% AI diagnostic accuracy for shrimp, finfish, shellfish diseases. 30-50% reduction in disease losses + feed wastage. Asia / India case studies + ROI analysis for farm managers. IoT sensors, computer vision, edge AI trends. Artificial intelligence (AI) and smart sensing technologies are rapidly transforming aquatic animal health management from reactive treatment to proactive, real-time disease prevention in commercial farms. Global experience shows that well-designed AI systems can achieve diagnostic accuracies above 90 percent, reduce disease-related economic losses by up to half, and improve feed and resource efficiency at scale. For an industry-facing audience, the core message is clear: AI is no longer a laboratory concept but a practical productivity tool that can be deployed in shrimp ponds, fish cages, hatcheries, and recirculating aquaculture systems. This article reframes current scientific knowledge into an industrial perspective tailored for decision-makers, farm managers, technologists, and investors in aquaculture. It focuses on business value, operational workflows, and adoption strategies rather than algorithms alone, with case-led explanations from Asia and India where smart aquaculture is expanding fastest. Aquaculture's Disease Challenge: Why AI Matters Now ? Aquaculture already contributes more than half of global fish consumption and remains the fastest-growing food production sector, but disease continues to be the single largest constraint on profitability and sustainability. Annual global losses from aquatic animal diseases are estimated in the billions of dollars, driven by mortality, growth depression, rejected consignments, and emergency harvests. Traditional diagnostic workflows rely on farmer observation, sampling, microscopy, and laboratory tests such as PCR or histopathology. While robust, these steps are slow, expensive, and typically detect problems after an outbreak is underway, when treatment options are limited and trade damage is already occurring.

Another article titled, **Next-Generation Ornamental Fish Farming in India: From Backyard Units to High-Tech Production Systems (Aquatic Rainbow Technology Parks)** authored by S. Felix, Jenisha Mol JG and M. Thamizhanthi said that the future of ornamental aquaculture in India depends on its ability to transition from traditional, cottage based systems to organised, bio-secure, and technology-driven production models. The Aquatic Rainbow Technology Park and Mall represent a holistic approach integrating production, training, and marketing under one framework. Ornamental aquaculture in India has long been rooted in small-scale, backyard operations often referred to as cottage-level production systems. These decentralized units have played a crucial role in sustaining rural livelihoods and supporting local markets. However, with rapidly increasing domestic demand and the expanding global ornamental fish trade, the sector now stands at a critical transition point. To remain competitive and meet international standards, India must shift from fragmented, low-volume production to organized, bio-secure, and intensive aquaculture systems. To address these constraints, a paradigm shift toward technology-driven, bio-secure, and scalable production systems is essential. **The "Aquatic Rainbow Technology Park": A Model for the Future,** a promising solution lies in the development of integrated ornamental aquaculture hubs such as the **Aquatic Rainbow Technology Park.** Designed over a 5-acre area, this model facility integrates advanced aquaculture technologies with training, production, and market linkage 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
Editor & Publisher
Aqua International

The four Pillars of Indian Aquaculture industry; Farmer is a big scientist: V. Mohan Krishna

V. Mohan Krishna, GM, Devi Sea Foods Ltd

Peddapuram: With the success of Vannamei shrimp farming in India, the aquaculture sector has been growing well in the country. Farmers, Seed producers, Feed manufacturers and Exporters are the four pillars of aquaculture sector in India. These four segments should be healthy and should do well financially to safeguard the interest of Indian aquaculture sector, said a senior executive of the industry Mr V. Mohan Krishna, General Manager, Devi Sea Foods Ltd while talking to Aqua International Editor M.A. Nazeer here. Without these four segments together the industry cannot stay healthy, he added.

Shrimp Exporters from India are putting lot of efforts in modernising the Plants time to time with highest food safety standards and getting plants certified to meet norms of importing country which is helping a lot to the growth of Indian aquaculture, he stated.

Farmer is a big scientist:
I have been in aquaculture sector for over 30 years and I found Farmer is a big scientist and he is knowledgeable to take care of his farm and its wellbeing. The farmers are looking forward to have better shrimp culture and get better yield in the year 2026.

Who cares about the quality of baby shrimp?

Ongole, Andhra Pradesh: The shrimp farming season has begun in the coastal areas. If you buy a baby shrimp from a hatchery for a rupee each, they die within a few days of being put in the pond. The hatchery owners are making a fortune because there is no quality assurance. The farmers are suffering immense losses. The authorities who should be concerned about this are just waiting to see if they receive complaints.

The farmers here recently told the media that Tiger prawns are being cultivated in more than ten thousand acres in Ongole district. For the past one month, some farmers have started cultivating the crop in Kothapatnam, Tanguturu and Singarayakonda areas. Farmers are worried as brought from hatcheries are dying within 20 days of being placed in the pond. The cost of seed including transportation the baby prawns per acre is Rs 50,000; the cost of preparing the pond at Rs 25,000; for feed, electricity, labour etc, the farmer has to initially invest Rs 60,000 for the cultivation. Now, the shrimp fry are dying within a month due to poor quality, so the farmers are losing Rs. 1.5 lakh. The hatchery managers do not care about the quality at all. While they were thinking of whether to go for crop or not due to the fear of ongoing war, the farmers are now complaining about how they will start cultivation with poor quality shrimp fry. Farmers suffer losses as fish die in ponds within a few days

The then Collector intervenes

For the past two to three years, farmers have been worried about the poor quality of shrimp fry, so Mr Tamim Ansaria, who worked as the collector last year, held a meeting with the hatchery managers. He strictly warned that the quality should be verified responsibly and the goods should be handed over to the farmers, otherwise he would put them in the black list. Last year, the quality of shrimp fry was verified responsibly and good yields were obtained. This year, the farmers are expressing concern as the story of the year has come to the fore again. Mr Gopinath, President of the Ongole District Prawn Farmers Association, says that they are facing irreparable losses if quality is not verified. He informed that they will meet the district higher officials and explain them the problem in this regard.

Fisheries Dept. assures to take action

We have not received any requests from the representatives of the farmers' association. No complaints have been received. If anyone comes, we will definitely take action on seed quality assurance.
- Srinivasa Rao,
District Fisheries Officer.

Benefits of nursing shrimp

Over the past six years, nursery systems for shrimp seed have evolved rapidly in Latin America. Currently, the rearing time in nurseries is longer, the biomass is bigger, the transfer systems and water control systems (without water exchange) are all better. Feed and probiotics / probiotics have also been improved. The GOAL is to produce HEALTHIER POSTLARVAE / SHRIMP that adapt to the pond environment.

This approach leads to a BETTER SURVIVAL rate in the first days of culture and MINIMIZES EXPOSURE TO THE CARRIERS.

Since the EMS / AHPND pathogen is Vibrio, nursery systems allow farmers to focus on controlling Vibrio bacteria in a smaller area and hinder exposure to the pathogen.

In Mexico and Asia, this is one of the strategies used to minimize premature mortality syndrome (EMS).

The BIGGEST COST in shrimp farming is DURING GROWTH. Larger stocking / postlarvae (PLS), namely PL 45, instead of PL 12, reduces the duration of the growout period by 20-30 days.

A SHORTER CROP means lower energy and feed costs. Feed conversion ratio (FCR) can be reduced by 10-30%.

The evolution of a nursing system in Mexico White spot virus, coupled with restrictions due to local weather (MEXICO) has severe weather conditions, HOT SUMMERS and COLD WINTERS), have forced farmers to modify the nursery system.

The 50 TON round tanks in 2008, rose to 100 TONS raceway in 2009, and then 500 TONS in 2011.

Currently, even larger rectangular tanks with a capacity of 800 up to 1,000 tons of CLOSED GREENHOUSE were used.

PREBIOTICS / PROBIOTICS are used to control water quality. Different ways of using probiotics are adjusted depending on biomass conditions, water quality and animal health:

- For ORGANIC MATTER, 3 ppm every 72 hours
- For TOXINS, 2-5 ppm every 48 hours.
- For domestic pathogens, 2 ppm every 72 hours

High quality shrimp feed with LESS GRAIN is the most preferred feed.

NURSERY MANAGERS DO NOT FOLLOW A FIXED FEEDING TABLE.

Typically, they fed a HIGH-ENERGY DIET with at least 45% crude protein about 2 hours apart. The amount of food is adjusted depending on the sieve, water quality and growth of animals.

Since 2012, pumps have been used to transfer PL from nursery tanks to growout ponds, reducing mortality during shrimp transfer to only 3-5%.

The shrimp transfer process has been fine tuned so that animals don't get out of the water for more than 30-60 seconds.

In 2013, using a pump, the distance to transfer shrimp has increased to 3 km and the volume up to 15 kg of shrimp / minute. It is important to carry out shrimp transfer in the morning, late afternoon or at night. Should check the status of shrimp before each transfer.

A recent development is a reduction in stocking densities in raceway systems to achieve larger postlarvae and higher survival, achieving biomass of 6.9 kg / m 3 .

Experience of Asia on nursing camps In 2013-2014, nursery techniques applied in MEXICO were successfully transferred to a MALAYSIAN SHRIMP FARM. Post-larvae / juveniles are stocked in a raceway system for 25-30 days to produce 1-1.5 g shrimp, which are then stocked into grow-out ponds at a density of 70-80 shrimp / m 2. Feed conversion ratio (FCR) in raceway is 1.0-1.5 depending on culture time. In the grow-out ponds, shrimp reached 17-18 grams and the FCR was 1.3. The survival rate in the grow-out ponds was 90-95%.

In THAILAND, there were MIXED RESULTS. Succeeded at the nursery stage, but due to the condition of the animals during conversion, the GROW-OUT STAGE SHOWED POOR RESULTS.

Other ideas were put forward like stocking in cages that did not reach the bottom within the first 30 days of culture.

According to the report, this way of avoiding EMS outbreaks.
ANOTHER OPTION is to DIVIDE 20-30% of the pond area with a net, stock the larvae there, and then release them all over the pond after 20 to 30 days.

In Vietnam, the adoption of nursery systems has been hampered by a LACK OF investment capital, TECHNOLOGY and POOR BIOSECURITY.

A success has been reported in central Vietnam, but weak shrimp health during the transition process resulted in limited growth in the pond. Weak health is caused by bad food and poor water quality in nursing.

Farmers in Asia should invest in NEWLY DEVELOPED TECHNOLOGY IN LATIN AMERICA and refine it to SUIT ASIA.

By Srikanth, Maharaja Hatcheries, Nellore

MPEDA Chairman D.V. Swamy visits Salem Microbes

Ramesh explaining a point to MPEDA Chairman D.V. Swamy

Dear Shri D.V. Swamy IAS, As you conclude your distinguished tenure as Chairman of MPEDA, the entire team at Salem Microbes wishes to express our sincere gratitude for the support and vision you have provided to the aquaculture industry.

We fondly remember your visit to our factory and Research Centre. It was a privilege to showcase our efforts in Bacteriophages and Probiotics to you. Your keen interest in our R&D and your appreciation for our tremendous and exhaustive work served as a significant morale booster for our scientists and staff.

Your recognition of how targeted microbial solutions impact the quality and sustainability of Indian shrimp produce has reinforced our commitment to driving innovation that strengthens India's position in the global export market.

We thank you for your leadership and for championing the cause of sustainable aquaculture. We wish you the very best in all your future endeavours and your next prestigious assignment.

A view of Salem Microbes team with MPEDA Chairman D.V. Swamy

Uni-President

AQUACULTURE PROBIOTICS EXPERT

Nu Ri

NET 200 g **BSL**

Probiotics for water treatment

1. WATER QUALITY CONDITIONING

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

2. HIGH ACTIVITY OF SPORES

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

3. DECREASE AMMONIA CONTENT

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

4. IMPROVE WATER COLOR

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

5. ESTABLISH BALANCED POND BACTERIA SYSTEM

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

6. INCREASE AQUACULTURE PRODUCTION

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

* COMPOSITION:

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

* STORAGE:

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

* DIRECTION OF USE:

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

UNI-LIGHT PSB Funtion:

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

BSL Dosage:

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

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

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Bhimavaram, Andhra Pradesh to host Aquaculture Expo 2026 on June 12 & 13

Aqua International will present Excellence Awards to individuals, institutions and companies who have excelled their performance and also contributed to the development of aquaculture sector

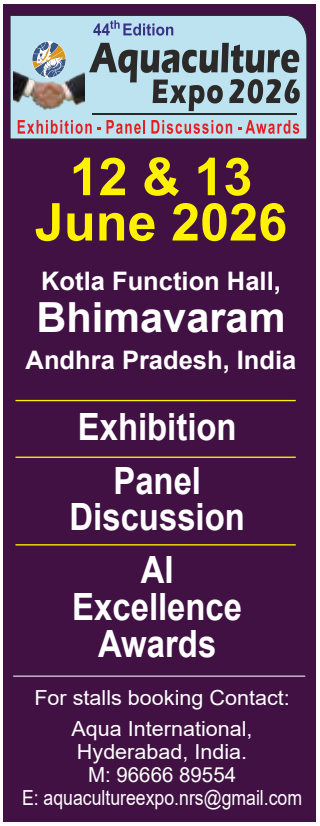
Bhimavaram: A 2-days Exhibition on aquaculture titled Aquaculture Expo 2026 will be held at Kotla Function Hall, Undi Road, Bhimavaram, Andhra Pradesh on 12 & 13 June 2026. During the Expo, there will be "Panel Discussion and Experts - Farmers Interaction Meet" with the theme: Tap the Potential to take Andhra Pradesh and the India's Aquaculture to the next level.

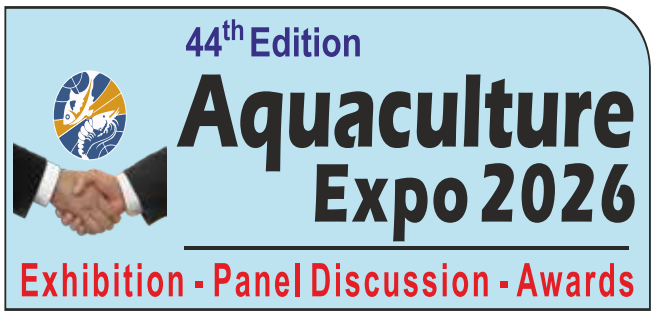
The main objective of the Expo is to bring awareness among aquaculture farmers and other stakeholders on various products, technology, and services available to get better productivity in aquaculture. The Expo is a wonderful opportunity to aquaculture farmers and other stakeholders to update their knowledge on various aspects in aquaculture, informed Mr M.A. Nazeer, Chief Executive of the Expo and Editor, Aqua International. The event is also an opportunity for buyers and sellers as well in the sector, he added.

Companies dealing with manufacture and supply of products and services related to aquaculture sector will display their products and services in the Exhibition. Organizations with research and development on aquaculture would also take part in it. The expo is being organised by Aqua International.

It would be a good platform for farmers and other stakeholders of aquaculture sector to meet, exchange ideas, update knowledge and develop business opportunities.

On this occasion, Aqua International will present Excellence Awards to the individuals, institutions and companies on aquaculture sector who have excelled their performance and also contributed to the development of aquaculture sector.





Panel Discussion
Experts - Farmers Interaction Meet

Aqua International Excellence Awards 2026
For Excellence & Contribution to Aquaculture sector

Invitation

44th Edition
Aquaculture Expo 2026
Exhibition - Panel Discussion - Awards

12 & 13 June 2026
Bhimavaram, Andhra Pradesh, India

Exhibition, Panel Discussion &
AI Excellence Awazrds 2026 presentation on Aquaculture Sector
to Update Knowledge and for Better Business Opportunities

Organized by NRS EVENTS

Aqua International
English Monthly since 1993

12 & 13 June 2026
Bhimavaram, A.P., India

Venue: Kotla Function Hall, Undi Road, Bhimavaram, Andhra Pradesh, India

Exhibition Timings: 10 AM to 6 PM

Panel Discussion & Interaction Meet

Experts and Consultants in Aquaculture are invited to take part in Panel Discussion and answer to the queries and issues of the farmers during the meet on 12 June 2026

EXHIBITION • PANEL DISCUSSION • AWARDS

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.

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 June 12 & 13

For Stalls booking and information, please contact:

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Hyderabad - 500 004, Telangana, India.
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Stalls Booking in progress
Rush to Reserve your choice of Stalls

ENTRY FREE INTO EXHIBITION

A pond bottom-up approach to improving shrimp welfare

Sustainable Shrimp Farming in India is helping smallholders in Andhra Pradesh improve shrimp welfare – and their own livelihoods – through a variety of simple, yet effective, interventions.

SSFI's field lead Satvik and farmer engagement officer Mr Srinivas with the sludge removal team next to a pond

For thousands of India's smallholder shrimp farmers, the accumulation of sludge at the bottom of their ponds is gradually undermining animal welfare, water quality and financial stability.

Left unmanaged, this mixture of shrimp faeces, shed shells, uneaten feed and dead shrimp produces toxic gases, disease outbreaks and mass mortalities that can push already vulnerable farmers to the brink.

This is the problem that Sustainable Shrimp Farming in India (SSFI) has set out to address, armed with nothing more sophisticated than industrial pumps, excavators and the testaments of an ever-growing number of farmers who have benefitted from the organisation's simple interventions.

Formed as a key component of non-profit Shrimp Welfare Project (SWP), SSFI works directly with smallholders in the vicinity of Serepalem village to improve shrimp welfare while stabilising livelihoods. Its flagship initiative – subsidised sludge removal – is already delivering measurable improvements in pond conditions, shrimp survival and farmer confidence.

"Our intervention is primarily focused on smallholder farmers," explains Srirang Kavali, SSFI's director of India operations. "When we say smallholders, we mean farmers with less than two hectares [five acres], and very often they don't even own the ponds – they lease them."

Why is sludge a problem?

Sludge is an unavoidable by-product of shrimp farming. While in well-managed systems it is periodically removed, in many parts of coastal India, where finance is tight and many farmers have nowhere to deposit this waste, ponds are restocked for multiple cycles without being cleaned.

"In some farms, shrimp have been cultured in the same pond for five, six, even seven years," Kavali explains. "In a pond that's six feet deep, the bottom three feet can be pure sludge."

As the organic load builds up, oxygen demand rises and anaerobic conditions take hold. Hydrogen sulphide (H_2S) and ammonia levels spike, creating an environment that is acutely stressful – and often lethal – for shrimp.

"When we first tested these areas, they ranked very high for hydrogen sulphide and ammonia," says Kavali. "Farmers were reporting mass mortalities very frequently."

The consequences are severe. As Kavali notes, some farmers were attempting as many as

The SSFI team uses an excavator for sludge removal at a shrimp pond

A team of workers with SSFI remove sludge from a shrimp pond

six or seven crops per year, due to repeated mass mortality events – a situation that a welfare-focused non-profit like SSFI was desperate to avoid.

Practical, farmer-first intervention

Rather than asking farmers to invest in expensive infrastructure for ponds that they will never be able to own, the organisation covers all or part of the cost of sludge removal.

"There are two methods," Kavali explains. "Wet de-sludging uses industrial pumps, and we can clean about one acre in three days with workers. Dry de-sludging involves drying the pond and using an excavator – in those cases we often cover the machinery costs fully or partially. We also ensure that sludge is removed and disposed of responsibly, preventing contamination of canals, neighbouring ponds and surrounding ecosystems."

Priority is given to the most at-risk farms: those with high hydrogen sulphide levels, repeated crop failures and limited financial resilience. Since launching the programme, SSFI has worked with around 70 farmers across nearly 200 acres, with demand sometimes outstripping capacity.

"At the beginning we were in push mode – convincing farmers that desludging mattered," reflects Kavali. "Now we get daily calls. We've moved from push to pull."

It's not all been plain sailing, however, with the punitive US tariffs on Indian shrimp imports making some farmers less willing to stock their ponds with fresh post-larvae, while the extended and severe nature of the last monsoon season meant that there were fewer opportunities for SSFI's team to carry out sludge removal.

"The target that we have set for ourselves for this year is close to 250 acres. Last year it was 300, but because of the Trump tariff and the monsoon for about seven months in India, that impacted our operations very negatively," Kavali reflects.

Welfare gains and farmer resilience

Despite these setbacks, early indicators of the organisation's impact are encouraging. Indeed, according to Kavali, in ponds that they have de-sludged, hydrogen sulphide levels have typically dropped from dangerously high thresholds (around 0.05 ppm and above) to near zero, while farmers consistently report improved survival and fewer catastrophic losses.

"Anecdotally, survivability has increased significantly," Kavali says. "And importantly, the number of [attempted] crops has come down – from six or seven a year to a more regular three."

The reversion to longer grow-out cycles suggests fewer crop failures, less chronic stress for shrimp and reduced financial risk for farmers operating on margins made even thinner by the impact of US tariffs.

"Even a five-rupee drop in price can mean a huge loss for the crop," Kavali notes. "These farmers live on the edge."

Going beyond sludge

While de-sludging remains SSFI's core intervention, the organisation is actively testing better approaches that could further improve shrimp welfare, as well as diversify farmer incomes.

One area of focus is improved aeration, particularly during the early-morning hours when dissolved oxygen levels are lowest.

"We're exploring whether better aeration between 1 am to 5 am – using venturi

Kavali speaks with Shrimp Welfare Project co-founder and board chair, Andrés Jiménez Zorrilla, at a shrimp farm in Andhra Pradesh

or surface aerators – can reduce stress during critical periods," Kavali says.

SSFI is also piloting duckweed and seaweed cultivation as alternative or supplementary income streams, to help buffer farmers against the volatility of the shrimp market.

"In our trial ponds, duckweed or seaweed can generate around US$1,500 per acre per year," Kavali explains. "That's less than shrimp, but it's predictable. It gives farmers something to fall back on."

Duckweed, with protein levels approaching 40 percent in some species, has potential as both animal feed and human food. Seaweed species such as Gracilaria and Kappaphycus have value when exported for carrageenan production.

There is also potential for a degree of bioremediation, as duckweed and seaweed can both absorb nutrients from sludge-rich water, potentially creating a circular system that improves water quality, while also generating income.

"We're even exploring whether sludge itself could be used as fertiliser for these crops," Kavali adds

Going solo

Since its spin-out from Shrimp Welfare Project in January, SSFI now operates independently on the ground, while maintaining a close relationship with its parent organisation for strategic support, oversight and shared learning – aligning with Shrimp Welfare Project's broader mission to improve shrimp welfare globally. And Kavali hopes that SSFI's emergence as a standalone entity will allow for greater operational freedom and scalability.

"Spinning out was a necessity," he reflects. "It gives us more freedom, but also more responsibility."

In 2026, SSFI aims to scale its de-sludging programme to 250 acres of ponds, while developing its pilot projects on aeration, alternative crops and humane slaughter practices such as chill killing, although Kavali describes the latter as a longer-term, multi-stakeholder challenge.

For now, the organisation remains focused on improving pond environments – both to ensure better shrimp welfare outcomes, and to create financial stability for the smallholder farmers of Andhra Pradesh.

Courtesy: The Fish Site

District-level Bengal Fish Fest organized at Purba Medinipur and other districts, West Bengal

The one-day District-level Bengal Fish Fest - 2026 programme was organized by Department of Fisheries, Aquaculture, Aquatic Resources and Fishing Harbours, Government of West Bengal on 27th and 28th February, 2026 at the district headquarters at Alipurduar, Hooghly, Dakshin Dinajpur, Birbhum, Malda, Murshidabad, Jalpaiguri, Bankura, Purba and Paschim Bardhaman, Coochbehar, Siliguri (including Darjeeling and Kalimpong), Purba Medinipur districts all separately under the leadership of Assistant Director of Fisheries (ADFs) of respective districts and other officers. In addition to active participation of progressive fish farmers by profession, beginners & young fish farmers, professional fishermen, members of Primary Fishermen Cooperative Societies (PFCSs), Fish Production Groups (FPGs) and SHGs in technical sessions and discussions (who gathered in the programmes and interacted with senior District-level officers) - there were various stalls which were put up to showcase the particulars of various schemes of Fishery Department. Also, various fish-based value-added edible products and valuable byproducts, local fishery products produced by skillful persons were showcased at the stalls.

As an important part of the programmes, the topics and subject matter of technical-cum-awareness sessions (Seminars) included Maintaining Good Management Practices in aquaculture, Sustainable fish production, Need of conservation of local freshwater fish species, Prospects and possibilities of fish culture in small village ponds, Culture of diversified fish species for employment generation and importance of diversification in aquaculture, Expansion of aquaculture and fishery activities for livelihood generation in rural and sub-urban areas, Protection of ecosystem health of State's rivers, Conservation of local riverine fish species diversity & their fisheries, Promotion of responsible and sustainable fishing practices in open water bodies, Means to support fishermen communities, Responsible fishing and management of fisheries of natural freshwater wetlands (Beels), Participation of rural underemployed youths in aquaculture-related livelihoods, Conservation and farming of rainbow trout (at Siliguri) and other topics having region-specific importance. It was a very good platform for learning on the part of participants, their motivation and sharing of knowledge on recently-developed aquaculture practices.

The district-level programme organized at Meen Bhaban, Contai town, Purba Medinipur on 28/02/2026 on National Science Day got little more importance as it was marked by the august presence of

Sri B. Roy Chowdhury, Hon'ble Minister-of-State (Independent Charge), Department of Fisheries, Government of West Bengal. Purba Medinipur district holds the distinction of highest amount of production of farmed table-sized Indian major carps and *Litopenaeus vannamei* every year in West Bengal. Freshwater, brackishwater and marine – all three sectors of aquaculture in this district holds very good promise, potential and prospect. The hygienic dry fish production sector is also mention-worthy which involves the association of considerable number of district's coastal population for livelihood. In addition to fish farmers, fishermen, members of PFCSs, FPGs - dry fish workers also gathered in this programme. Sri U. Barik, Sabhadhipati, Purba Medinipur Zilla Parishad in his address mentioned about the importance of fishery and aquaculture vocations in employment generation in this district. West Bengal Government has been trying its best to extend all sorts of appropriate services towards welfare and development of fish farmers, fishermen and others as beneficiaries in different schemes and enhance the State's fish production. He mentioned that the Department stands beside fish farmers and supports them, looks into the problems faced by them in fish farming, how to overcome them, adoption of newer scientific methodologies and means to increase fish production.

Sri T. K. Jana, Karmadhyaksha, Matsya o Prani Sampad Bikash Sthayee Samity, Purba Medinipur Zilla Parishad stated that fish farmers should think about how to increase production and facilitate more development. This is a platform for exchange of ideas between high-rank District-level officers and progressive farmers, so to ensure development. We should think about development of the state-of-being of small-scale, resource-poor, marginal fish farmers and increase in fish production from their ponds. Farmers should give emphasis on scientific aquaculture, they need training for strengthening self-employment opportunities through fish and prawn farming. We have to see how we can give more facilities to fish farmers and fishermen in days to come.

Sri B. Roy Chowdhury, Hon'ble Minister-of-State (Independent Charge), Department of Fisheries, West Bengal enlightened the participating fish farmers and fishermen with his valuable words. He mentioned about importance of maintaining honesty in commercial aquaculture, means of performing in better manner, training as an important means of educating farmers and enriching their knowledge, eagerness on the part of farmers to learn improved methods of fish farming. Farmers should not just stock fish seeds randomly and wait for harvest – supplementary feed should be given routinewise, fish health and important pond water parameters should be checked, its suitability judged, proper stocking density should be maintained. Techniques of improved fish farming should be extended and reach to more number of villagers young and old in age. West Bengal has attained almost self-sufficiency in fish production, we can now supply fishes to neighbouring states. Fish farmers should practice fish and prawn farming following scientific principles for better production. Sri Roy Chowdhury mentioned that there is no end to knowledge, there is always scope to learn; the Department is organizing training programmes for those fish farmers who wish to learn and gain more knowledge. We have to produce fishes having superior taste. The more we learn with eagerness, the more we will be able to prosper and progress. With everybody's efforts, fish farmers will be able to achieve heightened state of good quality fish production, dignity and stand with their head held high.

Dr M. K. Sahoo, Deputy Director of Fisheries, Government of West Bengal also spoke on this occasion. Technical discussion on Best Management Practices in Aquaculture and a short expert-farmers' interaction were held in afternoon hours. Dr S. N. Jana, ADF, Purba Medinipur; Sri N. Kayal, ADF (Brackishwater) and Sri S. Saha, ADF (Marine), Purba Medinipur jointly coordinated the entire programme. Progressive fish farmers in Purba Medinipur in marine fishery, *L. vannamei*, Small Indigenous Fish, Indian major carp and ornamental fish farming (woman) sectors were felicitated and awarded in this programme, allowed to share their experiences and road to success. Matsya Jeebi Credit Card (MJCC) beneficiaries who successfully obtained loan from bank to initiate fish farming and Fishermen Old Age Pensioners were allowed to express their feelings. There were total eight well-maintained stalls set up at the premises of this programme, including that of Purba Medinipur Fisheries Department, Govt of West Bengal (where there were leaflets, information brochures and stand Flex(s) in Bengali language on fish and shrimp culture methodologies, shrimp feeding management, tackle disease problems, etc). Reputed companies associated with production of aquaculture products and fish medicine had their stalls set up. Interestingly, women belonging to Kalagachhia SHG and Dakshin Ajaya Maa Nachinda SHG displayed home-made beautiful products and items in separate stalls for exhibition and sale which were prepared using fish scales. There were stalls exhibiting hygienic sun-dried marine fishes for human consumption and value-added edible products prepared from fishes and shrimps. News communicator Subrato Ghosh was present in this district-level programme at Purba Medinipur.

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AI Beneath the Surface: Industrial-Scale Smart Aquaculture for Disease-Free Production

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HIGHLIGHTS:

- 90-99% AI diagnostic accuracy for shrimp, finfish, shellfish diseases.
- 30-50% reduction in disease losses + feed wastage.
- Asia/India case studies + ROI analysis for farm managers.
- IoT sensors, computer vision, edge AI trends.

Aerial view of extensive fish cage aquaculture farm on a lake

Executive Summary
Artificial intelligence (AI) and smart sensing technologies are rapidly transforming aquatic animal health management from reactive treatment to proactive, real-time disease prevention in commercial farms. Global experience shows that well-designed AI systems can achieve diagnostic accuracies above 90 percent, reduce disease-related economic losses by up to half, and improve feed and resource efficiency at scale. For an industry-facing audience, the core message is clear: AI is no longer a laboratory concept but a practical productivity tool that can be deployed in shrimp ponds, fish cages, hatcheries, and recirculating aquaculture systems.

This article reframes current scientific knowledge into an industrial perspective tailored for decision-makers, farm managers, technologists, and investors in aquaculture.

It focuses on business value, operational workflows, and adoption strategies rather than algorithms alone, with case-led explanations from Asia and India where smart aquaculture is expanding fastest.

1. Aquaculture's Disease Challenge: Why AI Matters Now

Aquaculture already contributes more than half of global fish consumption and remains the fastest-growing food production sector, but disease continues to be the single largest constraint on profitability and sustainability. Annual global losses from aquatic animal diseases are estimated in the billions of dollars, driven by mortality, growth depression, rejected consignments, and emergency harvests.

Traditional diagnostic workflows rely on farmer observation, sampling, microscopy, and laboratory tests such as PCR or histopathology.

While robust, these steps are slow, expensive, and typically detect problems after an outbreak is underway, when treatment options are limited and trade damage is already occurring.

AI-enabled systems fundamentally change this timeline by:

- Continuously monitoring stock behavior, body condition, and water quality.
- Detecting subtle deviations long before clinical signs are obvious to the human eye.
- Prioritizing ponds or cages for sampling and expert attention.
- Supporting timely management decisions on feeding, aeration, and chemotherapeutant use.

For industrial producers operating hundreds of ponds or offshore cages, this shift from episodic testing to continuous intelligence is strategically significant.

2. Technology Building Blocks for Smart Health Management

Behind every "AI-powered" solution is a stack of complementary technologies that convert raw farm data into actionable insights.

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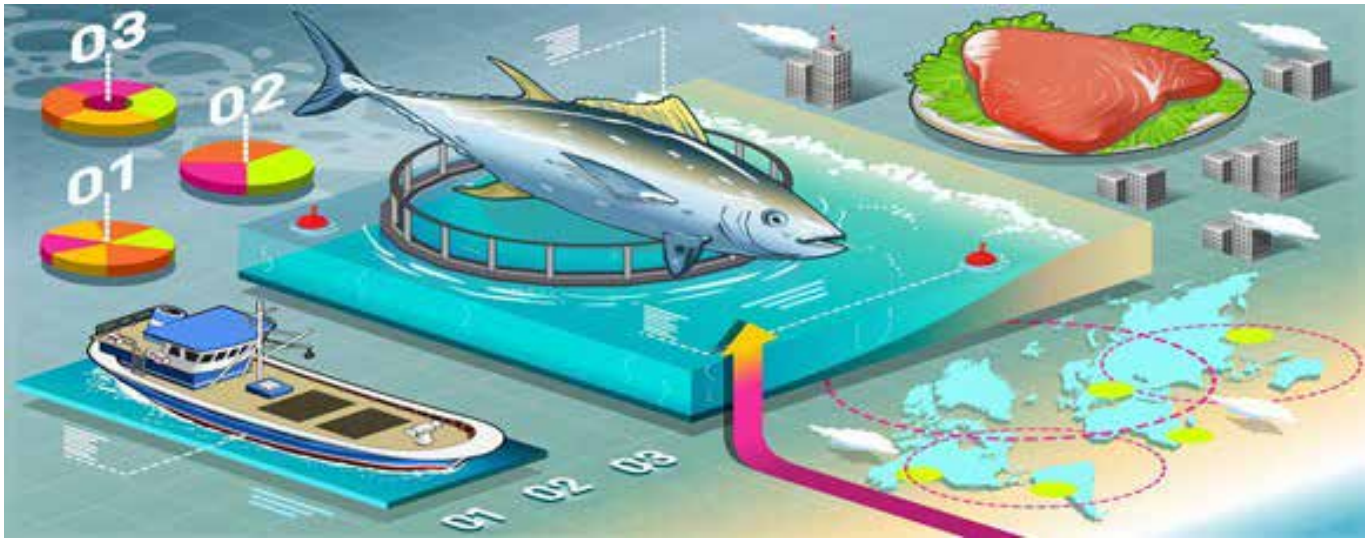

3D illustration of AI-enhanced fish farming process from boat to market

Understanding this stack helps farm managers evaluate products and vendors

Layer	Key Technologies	Role in Aquaculture Health
Data capture	Underwater and surface cameras, drones, fixed CCTV, wearable sensors, IoT probes for dissolved oxygen, temperature, pH, ammonia	Collect continuous visual and environmental data from ponds, cages, RAS units, and hatcheries.
Connectivity	LoRa, Wi-Fi, cellular networks, edge gateways	Transmit data securely from remote farms to local servers or cloud platforms in near real time.
AI/ML models	Convolutional neural networks (CNNs), YOLO detectors, recurrent networks (RNN/LSTM), transformers, classical ML (SVM, Random Forest)	Analyze images, video streams, and time-series sensor data for disease signatures and risk patterns.
Applications	Dashboards, mobile advisory apps, automated alerts, decision-support systems	Present results to farm staff and veterinarians in simple, actionable formats.

Deep-learning models such as CNNs routinely reach more than 90 percent diagnostic accuracy in image-based fish and shrimp disease classification, with hybrid or ensemble models sometimes exceeding 99 percent on research datasets. Real-time object detection models like YOLO have demonstrated mean average precision above 94 percent while processing more than 90 frames per second, allowing live monitoring of cages and raceways.

3. Asia and India: Where Smart Aquaculture is Scaling First

3.1 Regional leadership in production and innovation

Asia accounts for over 90 percent of global aquaculture production and has become the natural epicenter for AI-driven innovation in aquatic animal health.

High stocking densities, competitive export markets, and recurring disease problems in shrimp and finfish have created a strong business case for better monitoring tools.

China, India, Indonesia, Vietnam, and other regional leaders are seeing rapid growth in:

- AI-based image diagnosis platforms for shrimp and finfish diseases.
- IoT-enabled pond and cage monitoring systems.
- Integrated farm management apps combining health, feeding, and inventory.

For international buyers and retailers, farms that adopt such systems can demonstrate stronger biosecurity, traceability, and compliance with sustainability standards, creating market differentiation.

3.2 India's smart aquaculture ecosystem

India's fisheries sector has expanded rapidly under supportive government policies and dedicated schemes for fisheries and aquaculture infrastructure.

At the same time, a vibrant aquatech startup ecosystem is delivering practical AI and IoT solutions specifically suited to Indian pond-based systems and coastal farming clusters.

Examples of industrially relevant applications include:

- IoT platforms that continuously track dissolved oxygen,

temperature, and pH, providing automated alarms and feeding recommendations.

- Mobile-based decision-support systems that allow farmers to upload images of diseased fish or shrimp and receive AI-assisted diagnosis plus advisory messages in local languages.
- Cloud platforms that integrate pond health, growth, and input records to support credit assessment, insurance, and certification.

These developments show that AI is not limited to large corporate farms; it can be adapted to the realities of small and medium farmers in Asia through low-cost sensors and mobile connectivity.

4. How AI Sees Disease Before Farmers Do

4.1 Computer vision for early lesion and behavior detection

Computer vision systems use cameras mounted above or below water to continuously watch fish and shrimp, analyzing frames for characteristic signs of stress or disease. Instead of relying on occasional sampling, AI looks at thousands of images and video frames per day, extracting subtle patterns linked to health problems.

Typical indicators include:

- Lesions, fin rot, discoloration, exophthalmia, or skin ulcers.
- Changes in swimming patterns: lethargy, erratic movement, crowding, or surface gasping.
- Abnormal feeding responses: slower approach to feed, feed remaining uneaten, or asymmetrical distribution around feeders.

CNN-based models trained on annotated image datasets have achieved classification accuracies as high as 99.7 percent across multiple disease categories in controlled studies.[1]

Real-time detection frameworks such as YOLO can flag affected individuals or clusters within seconds, enabling on-the-spot investigation by farm staff.

Floating IoT feeding and propulsion device on shrimp pond

4.2 Shrimp and mollusk case applications

Shrimp farming has been an early adopter of AI solutions because of high disease risk and strong export orientation.

AI models trained on shrimp images and farm records have demonstrated more than 93 percent accuracy in detecting White Spot Syndrome Virus (WSSV) based on external signs and behavioral cues, even before severe mortality occurs.

In oyster and mussel farming, AI-assisted grading systems now help identify shell deformities, color changes, and potential pathogen-related anomalies, which supports both disease control and product quality assurance.

These systems improve sorting speed and consistency while reducing manual labor in processing plants.

5. Behavior, Water Quality, and IoT-Driven Risk Prediction

Diseases rarely appear without early warning signals in behavior and environment. AI systems leverage IoT infrastructure to fuse multiple data streams fish behavior, feed intake, and water parameters—into an integrated risk score for each pond or cage.

Key components include:

- **Behavioral analytics:** Automated observation of activity levels and spatial distribution to detect reduced movement, crowding in corners, or unusual surfacing.
- **Water-quality sensing:** Continuous measurement of dissolved oxygen, temperature, pH, ammonia,

Group of men examining fish tank with submerged sensor in aquaculture facility

turbidity, and salinity using networked probes.

- **Predictive models:** Algorithms that learn the relationship between historical water-quality profiles, management actions, and disease outcomes, then flag combinations associated with elevated risk.

Field deployments such as AquaSense-type systems have reported prediction accuracies close to 97 percent for water suitability and risk classification, allowing managers to intervene early through aeration, water exchange, or stocking adjustments.[1] For large estates, this supports centralized monitoring of multiple sites from a single control room.

6. AI Architectures, Tools, and Data Requirements

From an industrial buyer's perspective, the choice of specific AI architecture is less important than reliability, explainability, and service support. However, understanding the main categories helps in technical due diligence.

Commonly used approaches include:

- **CNNs and Vision Transformers** for classifying images of diseased vs. healthy animals.
- **YOLO and similar object-detection networks** for locating lesions or abnormal individuals in real-time video feeds.
- **RNNs, LSTMs, and temporal models** for analyzing time-series sensor data and predicting future water-quality or health risks.
- **Classical machine-learning models (SVM, Random Forest, Gradient Boosting)** for risk scoring based on combined farm records and environmental variables.
- **Generative AI** to create realistic synthetic images or time-series segments in under-represented disease classes, improving training where field data are limited.

Performance is typically evaluated using metrics such as accuracy, precision, recall, F1-score, mean average precision (mAP), and inference speed. For farm managers, these metrics can be translated into business outcomes such as earlier diagnosis, reduced sampling needs, and fewer false alarms.

Robust AI solutions require large, well-annotated datasets covering multiple species, life stages, seasons, and farming systems.

Fragmentation of data across farms and regions remains a bottleneck; emerging approaches such as federated learning and privacy-preserving data sharing are being explored to pool knowledge without exposing confidential farm-level data. [1]

7. Cross-Species Case Snapshots

Evidence from research and pilot deployments demonstrates that AI-based diagnostics are feasible across a wide range of aquaculture species.

These results underline that AI is a platform technology: once data pipelines and models are established, the same framework can be adapted across new species, farm designs, and geographic regions.

8. Integration with Veterinary Services and Laboratories

AI does not replace aquatic veterinarians or diagnostic laboratories; rather, it reshapes their workflow.

In a modern smart-farm setup, AI acts as a frontline filter that screens ponds, cages, and tanks, then escalates only the highest-risk cases for expert review.

Practical integration points include:

- AI platforms prioritizing which ponds require sampling and what type of tests (PCR, culture, histopathology) should be conducted.
- Digital case records linking images, sensor data, and lab reports to build rich datasets for retraining models and auditing decisions.
- Explainable AI modules that highlight which image regions or water parameters most influenced the model's decision, improving trust and regulatory acceptance.

This division of labor reduces diagnostic turnaround time, optimizes

Species	Representative AI Application	Reported Performance Outcome
Shrimp	CNN-based detection of WSSV and other viral or bacterial syndromes from images and behavior patterns	More than 93 percent diagnostic accuracy and earlier detection relative to visual inspection alone.
Tilapia	Mobile phone apps where farmers upload images for on-device or cloud-based disease classification	Real-time, farm-level diagnosis and advisory, reducing dependence on distant laboratories.
Salmon	Fixed-camera monitoring of cages with AI analysis of body condition, lesions, and sea-lice loads	Approximately 91–96 percent accuracy in classifying health status and parasite presence.
Carp and catfish	Automated image analysis systems for common bacterial and parasitic diseases	Greater than 99 percent accuracy on curated datasets, demonstrating strong potential for hatcheries and nurseries.
Oysters and mussels	Vision-based grading and pathogen risk flagging for shellfish destined for human consumption	Improved grading speed, consistency, and food-safety assurance at processing plants.

use of laboratory capacity, and allows specialists to focus on complex or novel cases rather than routine screening.

9. Economics and Business Case for Industry

For commercial producers and investors, the central question is not whether AI is technically impressive, but whether it pays back.

Economic analyses suggest that AI-based monitoring and decision-support can reduce disease-associated losses by up to 50 percent when combined with good husbandry and biosecurity practices.

Key financial levers include:

- **Lower mortality and morbidity:** Earlier intervention prevents catastrophic crop failures, especially in shrimp and high-value finfish.
- **Feed-cost optimization:** AI-guided feeding based on behavior and biomass estimation can reduce feed wastage by up to 30 percent, directly improving feed conversion ratio (FCR).
- **Improved survival and uniformity:** Better environmental control and health surveillance support higher survival rates and more uniform harvest size, enhancing processing efficiency and market returns.
- **Reduced unplanned harvests and trade disruptions:** Early detection helps avoid emergency partial harvests and shipment rejections, protecting brand value.

When evaluating solutions, farms should consider both direct returns (reduced losses, improved yield) and indirect benefits such as enhanced data for certification, financing, and insurance.

10. Practical Considerations and Challenges

Despite strong potential, several implementation challenges must be acknowledged for realistic planning.

Major limitations include:

- **Data scarcity and bias:** Many models are trained on limited datasets that may not capture local strains, husbandry practices, or environmental conditions.
- **Environmental variability:** Turbidity, lighting, biofouling, and weather can degrade image quality and sensor reliability, requiring robust hardware design and periodic maintenance.
- **Model transferability:** AI trained in one region or production system may perform poorly elsewhere, highlighting the need for localized calibration and continuous model updating.
- **Explainability and trust:** Black-box deep-learning models can be difficult to interpret, which complicates regulatory oversight and farmer acceptance.
- **Skills and service support:** Successful deployment requires not only software but also training, field support, and integration with existing management routines.

Addressing these issues demands collaboration between technology providers, farmers, veterinarians, regulators, and academia.

11. One Health, Regulation, and Sustainability

AI-enabled disease surveillance aligns closely with the One Health framework, which links animal, human, and environmental health.

By making early, more accurate diagnoses, farms can avoid unnecessary or prophylactic antibiotic use, reducing the risk of antimicrobial resistance and residue problems in aquatic foods.

Regulators are beginning to consider how AI-based tools fit within national aquatic animal health frameworks, including requirements for validation, data governance, and accountability.

Transparent performance benchmarking and clear documentation of model limitations will be critical to regulatory and market acceptance.

From a sustainability perspective, AI-driven optimization of feeding, aeration, and water use reduces resource footprints, greenhouse-gas emissions, and effluents per unit of production.

This strengthens the position of aquaculture as a climate-smart alternative to wild capture fisheries.

12. Future Directions: Multimodal, Edge, and Explainable AI

The next generation of smart aquaculture systems will integrate multiple data types images, video, acoustic signals, sensor streams, and textual farm logs into unified multimodal AI platforms.

Such systems can capture complex relationships between behavior, environment, and health that are not visible in any single data channel.

Key trends for industrial stakeholders to watch include:

- **Edge AI at farm level:** Running AI models directly on cameras, drones, or pond-side devices to deliver instant alerts without relying on unstable network connections.
- **Foundation models for aquaculture:** Large pre-trained models that can be fine-tuned for specific species, diseases, or farming systems using relatively small local datasets.
- **Explainable AI (XAI):** Tools that visualize why a model flagged a pond as high risk, improving confidence among farmers and regulators.
- **Integration with digital twins and scenario simulators:** Virtual replicas of farms that allow managers to test the impact of stocking density changes, feed strategies, or infrastructure upgrades before implementation.

These capabilities will further lower the barrier to adoption and expand AI's role from disease diagnosis to full-farm optimization.

13. Action Points for Industry Stakeholders

For readers of industrial aquaculture magazines and decision-makers in the sector, the strategic question is not whether AI will come, but how to adopt it intelligently. Based

on current evidence, the following action points can guide practical implementation:

- **Start with pilot projects:** Select a subset of ponds or cages and deploy a limited AI-IoT setup to generate local evidence on performance and payback.
- **Co-design with farmers and technicians:** Involve on-ground staff in defining alert thresholds, reporting formats, and workflows to ensure tools fit daily reality.
- **Invest in data quality:** Standardize sampling protocols, incident reporting, and equipment maintenance to provide clean input for AI models.
- **Choose partners, not just products:** Prioritize vendors who can offer long-term support, training, and model updates rather than one-off hardware sales.
- **Align with veterinarians and regulators:** Ensure that AI outputs are compatible with official diagnostic frameworks and certification schemes.

Adopting AI in aquatic animal health is a journey rather than a single purchase. Farms and companies that begin building their data and digital capabilities today will be best placed to compete in an increasingly technology-driven global seafood market.

Conclusion

AI-driven disease diagnosis and health management have moved from experimental trials to commercially viable solutions across multiple aquaculture species and production systems.[1]

By enabling continuous monitoring, early risk detection, and smarter decision-making, AI can materially reduce losses, improve resource efficiency, and support compliance with stringent market and regulatory requirements.

For industrial stakeholders from farm owners and hatchery managers to equipment suppliers, feed companies, and policymakers the opportunity lies in integrating AI thoughtfully into broader strategies for biosecurity, sustainability, and market differentiation.

The question is no longer whether aquaculture can afford to invest in smart health management, but whether it can afford not to.

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Opinion of fishery experts and former CIFRI Directors on Ganga Innovation Meet – 2026

Subrato Ghosh, Kolkata, West Bengal; Email: subratoffa@gmail.com

Highlight points

The ICAR-Central Inland Fisheries Research Institute, Barrackpore organized the Ganga Innovation Meet - 2026 programme during 13/1/2026 - 15/1/2026 at this premier fisheries research institute of our country under National Mission for Clean Ganga Project 'Namami Gange' focusing on conservation of fish diversity of the mighty river Ganga. The Meet was entirely a three-day programme, devoted to special theme 'Biodiversity conservation, stock enhancement and small-scale fisheries in Ganga river basin'. The inaugural session of Ganga Innovation Meet was held on 13/1/2026. In this communication, thoughtful opinions of invited fishery experts on this subject and of former CIFRI Directors have been presented.

Introductory words by Dr B. K. Das

With financial assistance from the Ministry of Jal Shakti, Department of Water Resources, River Development and Ganga Rejuvenation, Government of India, the National Mission for Clean Ganga (NMCG) through ICAR-CIFRI has played a key role in monitoring and assessing the ecology and fish diversity, fish catch, fishers' livelihoods and river habitat of river Ganga (Source: ICAR-CIFRI and River Ganga Association; namamigangacifri.com). On 13/1/2026, Dr B. K. Das, Director, ICAR-CIFRI elaborated on the achievements of this institute in NMCG Project since 2016 (Phase-1 to Phase-5), its integrating components, success and impact, consolidated efforts in achieving the desired objectives. He uphold the dedicated service and leadership of previous Directors of this institute, the innovations that have taken place in last 79 years. Associated components of NMCG Project include in-situ fish conservation, river ranching, conservation of *Hilsa ilisha*, protection of river Ganga for future. We came to know that NMCG Project has been recognized as a Fish Protection Site by UNESCO. Dr Das appreciated the field work carried out and contributions of Project technicians, research scholars working at different regions of the river.

Opinion of Former Directors of ICAR-CIFRI

Dr K. K. Vaas, Former Director, ICAR-CIFRI opined that the institute was involved in Ganga Action Plan initiated by Ministry of Environment, GoI since early 1990s, spoke about maintaining good river health, complexities of dimensions of river conservation under NMCG (a mandate of ICAR-CIFRI) as we have water quality, biodiversity at macro and micro levels and other features. Different economic activities, livelihood support system for fishermen, water usage in cities on both banks of entire Ganga are involved. River ranching programme (Indian major carps, Mahaseer, *Hilsa ilisha*) of ICAR-CIFRI is very significant to restore the declining riverine fish population. We need to investigate on entire food spectrum of Ganga on all trophic levels, whether it is declining or not. Ecological functions and fish species diversity alter from place to place in Ganga right from its origin till Bay of Bengal. In context of Vikshit Bharat 2047, we need to investigate on impact of changing climate on Ganga ecosystem at community and exploitation levels, fish breeding behaviour in Ganga, water quality and its flow, impact of harsh environmental events on Ganga biodiversity implications by year 2047, our preparations and fish adaptation strategies.

Dr M. R. Sinha, Former Director, ICAR-CIFRI gave importance on glorious past of ICAR-CIFRI, about the long history of fisheries research in India, praised the initiative of Dr Das in organizing the Ganga Innovation Meet as freshwater fisheries in Ganga have to survive. It is the most important river in India biodiversitically and has been exploited intensively over the years. Government has developed many reservoir projects and hydro-electricity projects in Ganga, common people have exploited it for fisheries. Dr Sinha suggested on re-initiating studies on present state of ecology and fisheries of Ganga which was previously done during 1995-2000 under his leadership. Re-survey of whole river system is required to gather scientific data. We now face problems due to increasing pollution load and exploitation levels. He complimented Dr Das on choosing and considering the appropriate theme for this Meet, and deliberations in this Meet will help to address and formulate strategies in improvement of Ganga fisheries as well as its environment.

Dr A. P. Sharma, Former Director, ICAR-CIFRI opined that innovation calls for thinking, and also for impact.

Much impactful research has been done over the years on national river Ganga. ICAR-CIFRI has recorded 215 fish species in Ganga till Hooghly estuary since 2016 and appearance of few exotic fish species have been noted, which pose a threat to native species. He highlighted about IUCN red list of threatened riverine fish species, that previous data shows existence of 266 species and thus a change in fish biodiversity structure in Ganga has taken place. Fish ranching in Ganga is being done by the institute since 2016 which has resulted in 12% increase in fish share of Indian major carps in total country's fish production. It should continue. Ganga is now a stressed ecosystem as the dams and barrages constructed on it has led to change in its water regime, fish and fisheries. Certain river stretches should be declared as sanctuaries, strict monitoring of the river system should be done. From research studies, we will be able to address the threats caused to Ganga in terms of pollution, overfishing, climate change, habitat modification. Sensitization of inland riverine fishermen will help in river restoration - finally we will have enhanced fish stock, biodiversity conservation, sustenance and strengthened small-scale fishery across the river basin.

Opinion of well-known fishery experts

Dr Kuldeep K. Sharma, Former Vice Chancellor, Himalayan University, Itanagar mentioned that the economically-important cold water fish Mahaseer has drastically declined in upper reaches in river Chenab, ranching is a technique by which we can rejuvenate the degraded riverine systems Indus and Ganga. We should look into different aspects associated with riverine fish biodiversity, as use of bleaching powder and chemicals in Himalayan region to catch fishes degrade Ganga water quality and food chain of inhabiting fishes. In addition to doing more research to address this challenge, Dr Sharma expressed opinion on developing innovative programmes on dolphin conservation in Ganga, importance of developing AI tools in in-situ conservation of riverine fish species, in monitoring different components of riverine ecosystem in future. We need to assess what impact the unprecedented changing climate is causing to fish breeding phenomenon, breeding period, plankton production in water, and the kind of impact the retreating glaciers are causing to fish population in Ganga.

Dr B. N. Pandey, President, Zoological Society of India, Gaya expressed utmost respect and honour for 'Mata Ganga', spoke high about Directors of ICAR-CIFRI who have brought the institute to great heights. Bioresources are the wonderful gift of Ganga given free of cost for humanity. It has great potential. Huge numbers of people depend on Ganga for their livelihoods. According to Dr Pandey, we have to conduct research on unexplored areas like medicinal and therapeutic values of finfishes and molluscan species of Ganga, active ingredients of which can treat and cure diseases like cancer in humans. Importance should be given on research in ethno-zoology. Many aquatic weeds of Ganga contain certain trace and rare elements beneficial for human health. According to him, the food, health, energy and livelihood security provided by bioresources of Ganga can fulfill the shortcomings that we are facing today.

Dr (Mrs.) V. L. Saxena, Former General President, Indian Science Congress Association opined that vision of this Meet is to clean and rejuvenate mother Ganga. It is not merely a river or water body, it is our mother; lakhs of people are getting job through Ganga. It is our individual responsibility to tackle Ganga pollution and conserve water. Throwing garbage and plastics in Ganga is our fault, we shouldn't make it dirty. AI and robotics have contributed in cleaning waste materials from it. Dr Saxena expressed concern that some poor people on the river bank try to catch the released fingerlings using nets after ranching is done, fishes aren't allowed to grow upto table-size fish and mature. It is good that many women, who have been associated with and benefitted from ICAR-CIFRI's women empowerment programmes, have taken steps for betterment of Ganga on their own. She appealed that in addition to developmental schemes on fisheries implemented by Govt of India, we need to understand that Ganga is our lifeline; it is our duty to keep it clean. Together we will make Ganga clean one day in near future.

On 13/1/2026, four books titled 'Fish Nutrient Atlas of river Ganga', 'Book of Abstracts of Ganga Innovation Meet', 'Aquatic Biodiversity and Environmental Variables of river Rupnarayan', 'Nutrient Card of twelve fishes of Ganga' were released during inaugural session. Before commencement of this Ganga Innovation Meet programme, a river ranching programme was organized. Healthy big-sized fingerlings of Indian major carps and *Labeo bata* were released in Ganga water in close proximity to the institute by Dr Das and invited dignitaries using aluminium Hundi from the edge of jetty facing the river at Dui Poisar Ghat, Barrackpore. On late evening of the same day, 'Ganga Aarti' (*Aaroti*) ceremony was organized by ICAR-CIFRI on the river bank at the edge of jetty of this Ghat as a mark of paying reverence to Ganga in presence of Dr Das and others. Sacred Vedic Shanti mantras (hymns) were chanted by elderly priests in a holy, divine manner; flame of large Diya(s) waved to invite blessings of Almighty for the well-being of thousands of people who are dependent on Ganga and of the river environment itself.

Next-Generation Ornamental Fish Farming in India: From Backyard Units to High-Tech Production Systems (Aquatic Rainbow Technology Parks)

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Advanced Hatchery unit with RAS facility

The Highlights of the Article:
The future of ornamental aquaculture in India depends on its ability to transition from traditional, cottage-based systems to organized, bio-secure, and technology-driven production models. The Aquatic Rainbow Technology Park and Mall represent a holistic approach integrating production, training, and marketing under one framework.

Ornamental aquaculture in India has long been rooted in small-scale, backyard operations often referred to as cottage-level production systems. These decentralized units have played a crucial role in sustaining rural livelihoods and supporting local markets. However, with rapidly increasing domestic demand and the expanding global ornamental fish trade, the sector now stands at a critical transition point. To remain competitive and meet international standards, India must shift from fragmented, low-volume production to organized, bio-secure, and intensive aquaculture systems.

The Need for Transformation
India possesses immense biodiversity, particularly in the Western Ghats and the North Eastern region both recognized as global hotspots for endemic ornamental fish species.

Yet, despite this natural advantage, the country's contribution to the global ornamental fish trade remains modest. The key challenges include:

- Lack of standardized production systems
- Poor biosecurity measures
- Inconsistent quality and survival rates
- Limited traceability for export markets
- Inadequate infrastructure for scaling up

To address these constraints, a paradigm shift toward technology-driven, bio-secure, and scalable production systems is essential.

The "Aquatic Rainbow Technology Park": A Model for the Future


Advanced Grow out Culture Facility


Advanced Nursery Unit with RAS facility

A promising solution lies in the development of integrated ornamental aquaculture hubs such as the Aquatic Rainbow Technology Park. Designed over a 5-acre area, this model facility integrates advanced aquaculture technologies with training, production, and market linkage systems.

Key Components of the Technology Park

1. Bio-secure Production Units (10 Sets)

Fully enclosed and controlled systems designed for intensive ornamental fish production. These units ensure disease-free culture conditions and optimal growth environments.

2. Hatchery (RAS-based)

Equipped with glass and FRP tanks operating on Recirculating Aquaculture Systems (RAS), the hatchery enables high survival rates, efficient water use, and continuous production cycles.

3. Nursery Raceway Systems

Raceway units integrated with 15-ton capacity tanks facilitate early-stage rearing with better water flow, oxygenation, and waste removal ensuring uniform growth and reduced mortality.

4. Grow-out Section (Biofloc Systems)

Cement tanks of 30-ton capacity operating under biofloc technology support high-density fish culture while maintaining water quality through microbial processes.

5. Laboratory Facilities

Dedicated labs for disease diagnostics and water quality monitoring are essential for maintaining biosecurity and ensuring compliance with export standards.

6. Live Feed Production Units

Facilities for culturing Daphnia and Moina ensure a consistent supply of high-quality live feed, which is critical for larval and juvenile stages.

Aquatic Rainbow Mall: Bridging Production and Markets

Complementing the production hub is the Aquatic Rainbow Mall, a commercial ecosystem designed to enhance market access and consumer engagement.

Features of the Mall

- 50 retail outlets dedicated to ornamental fish and accessories
- Centralized water supply and life-support systems
- Food courts and recreational spaces
- A children's park to promote awareness and tourism

This integrated marketplace not only supports direct sales but also promotes entrepreneurship and public engagement with the ornamental fish sector.

Empowering Farmers through Technology Adoption

One of the most significant advantages of this model is its potential to train and empower farmers. By operating within such technology parks, farmers can:

- Manage a complete production cycle independently
- Gain hands-on experience with RAS, biofloc, and raceway systems
- Understand biosecurity protocols and traceability requirements
- Develop confidence to establish their own start-ups

With government support in the form of subsidies and training programs, these farmers can replicate similar systems, thereby scaling up production across regions.

Regional Expansion Potential

The Aquatic Rainbow model is highly adaptable and can be replicated across:

- **Western Ghats:** Leveraging endemic species and favourable climatic conditions
- **North Eastern States:** Capitalizing on biodiversity and water resources

Establishing such parks at the district level in these regions can create clusters of high-quality ornamental fish production, enhancing both domestic supply and export potential.

Ensuring Biosecurity and Traceability

Modern export markets demand strict compliance with biosecurity and traceability standards. Intensive systems like RAS and biofloc offer controlled environments that minimize disease risks and enable:

- Batch-wise tracking of fish production
- Certification and quality assurance
- Reduced antibiotic usage
- Improved survival during transport

Aquatic Rainbow Technology park at Chennai

These features are critical for accessing high-value international markets.

Conclusion:

The future of ornamental aquaculture in India lies in its ability to transition from traditional, cottage-based systems to organized, bio-secure, and technology-driven production models. The Aquatic Rainbow Technology Park and Mall represent a holistic approach integrating production, training, and marketing under one framework.

By empowering farmers, ensuring quality and traceability, and creating strong market linkages, such models can significantly enhance India's position in the global ornamental fish trade. With strategic investments and policy support, India can unlock its full potential and emerge as a leading exporter of ornamental fish, meeting both domestic aspirations and international demands.

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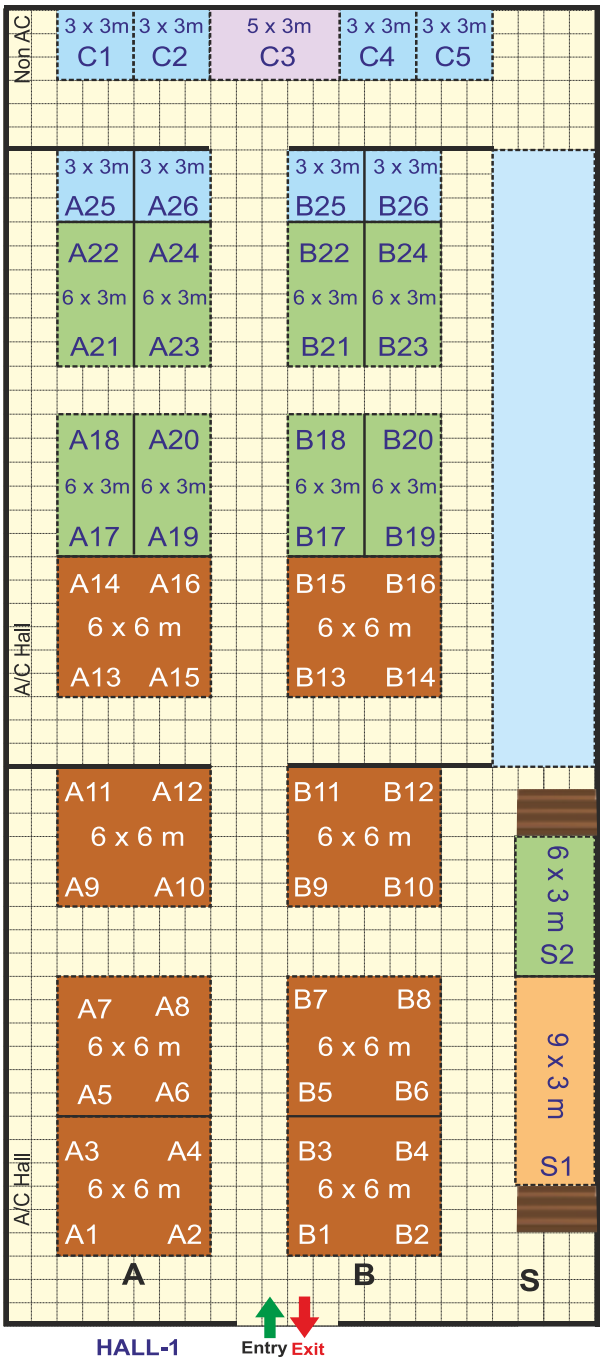

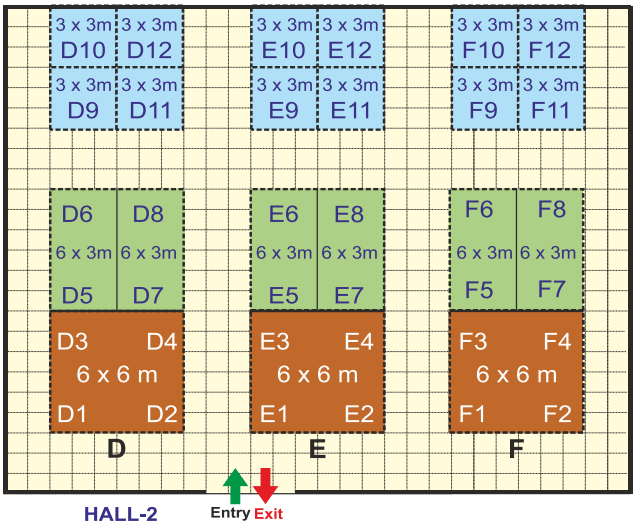

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