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Next Gen Shrimp Farmers Talk

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At Delta Marine in Sumbawa, Indonesia; Rizky Darmawan and Chodpipat Limlertwatee with Chaimate Chuenchom. P16.

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Zuridah Merican

The Good, Bad and Ugly in 2025

This year started with worries on the shrimp oversupply situation. Prices improved in the latter part of 2024, although demand did not catch up with supply. At TARS 2025 in August, the 2025 production forecast from Ecuador was 1.65 million tonnes and in November, at a SAP meeting in Hyderabad, the claim was one million tonnes from India. Beginning in March, discussions focused on US tariffs and China's role as an import market for Asian shrimp.

How did the supply chain change? There was a lot of front loading with announcements of major tariffs for the US market. India's strength is in the value-added segment, but it faces 50% tariffs on imports to the US. At GSF 2025, it was said that Ecuador with only 10% tariffs, may be able to take over, but it will take 18 months. Indonesia has the capacity but recently, the debacle with Cs137 dampened this potential, for the short term at least. As of now, the best bet is Vietnam.

The good news was lower feed ingredient prices. Fishmeal prices, fuelled by a higher anchovy fishing quota in Peru, which supplies 20-30% of global volumes, dropped to USD1,580/tonne in January but rose to USD1,768/tonne in October. IFFO says that the supply increase was 8% compared to the same period in 2024. Soybean meal prices dropped 13% since January 2025 due to strong stocks and weak demand by China. Corn prices are expected to ease as this harvest will be the best since 2019. Therefore, aquafeed prices are expected to ease.

This has an effect on alternative ingredients such as single cell proteins, insect meals etc. One SCP producer indicated that the strategy is to market as functional ingredients. Could this mean scaling is not a major bottleneck anymore?

The debate on optimal genetics continues, as Ecuador's success with all-pathogen-exposed broodstock draws attention. Although suppliers are promoting robust options for growth, Asian farmers still struggle with low success rates. The holy grail is achieving SPT with SPF status, a point emphasised by Ravi Kumar Yellanki at TARS2025.

Vietnam's pangasius industry experienced a strong rebound in 2025, with production and exports rising sharply. According to VASEP, export revenue has increased by 11% compared to last year, and production is expected to reach 1.65 million tonnes. However, prices remain low, especially in China's bulk markets. Vietnam is the cheapest producer but when production increases, prices could drop affected by the demand supply equilibrium. Conversely, if tariffs provoke inflation, pangasius may become the preferred choice for the mass market.

Vietnam hit a 5-year high in the first 8 months of 2025 for its tilapia exports, with 70% shipped to the US. It is capitalising on US tariffs on Chinese tilapia, which have reached up to 125%, creating a rare opening for alternative suppliers. Export volumes are still small, estimated at 50,000 tonnes. During Tilapia 2025 in November, the Tilapia Association of Thailand announced that its producers also wish to increase exports.

The bad news is that we do not see any movements in the Asian seabass industry. No single country has the lead, despite its potential as the Asian salmon. We believe that there can be a win-win with a collaborative ecosystem along the whole value chain. This means investing in R&D and knowledge-based segments in Singapore such as genetics and vaccination for fish production in neighbouring countries such as Indonesia and Malaysia, where cost of production is competitive

In March, Vietshrimp 2025 highlighted transparent post larvae disease (TPD) which had impacted the hatchery segment in Vietnam. Although TPD began in China, the extent of damage from this disease remains an enigma. Disease continues to rage in farms across Asia, bringing down success rates. Particularly in India, white spot syndrome virus (WSSV) and running mortality syndrome (RMS), have been more aggressive. The Prawn Farmers Federation of India (PFFI) has called for more structured and collaborative disease surveillance.

Finally, the ugly. The US FDA detected Cs137 contamination in Indonesia shrimp has triggered recalls, import alerts, and consumer distrust. While the full impact in US seafood sales is still unfolding, farmgate prices dropped by up to 35% in several regions while production costs remain high. This has a ripple effect on the entire Indonesia shrimp aquaculture industry.

Despite this, aquaculture still has a promising future as shown by the number of enthusiastic next generation farmers entering this industry.

If you have any comments, please email: zuridah@aquaasiapac.com

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First farmer-led targeted disease investigation program in India

This is the first structured, farmer-led shrimp health study in India – uniting scientific institutions and grassroots farming organisations to jointly generate field-level evidence and long-overdue clarity.

In India, running mortality syndrome (RMS) has recently intensified, leading to ongoing losses and frequent crop failures. Farmers often cannot sustain crops beyond 70–75 days. RMS is typically associated with white muscle and pinkish discolouration. Along with white faeces disease (WFD) and the age-old WSSV, these conditions contribute to chronic production losses.

In August, the Prawn Farmers Federation of India (PFFI) launched the pilot phase of a historic farmer-led targeted disease investigation program at Velankanni in Tamil Nadu. This initiative brings together farmers, scientists from the Central Institute of Brackishwater Aquaculture (ICAR–CIBA) and the Rajiv Gandhi Centre for Aquaculture (RGCA–MPEDA), industry supporters, and international experts from the University of Arizona, including Professor Arun K. Dhar and his team. The program aimed to tackle the persistent disease-related mortalities and crop failures that continue to threaten Indian shrimp farming.

Balasubramaniam V, General Secretary of the Prawn Farmers Federation of India (PFFI), said, "We desperately needed to understand the disease and to figure a way out of this terrible situation. For the first time, farmers and scientists are working hand in hand under a structured framework, using each other's strengths. PFFI will be the coordinator for field visits, farmer data and sample collection, while the researchers focus on the disease investigation in the laboratories. I am privileged to initiate and coordinate this effort, with overwhelming support from the industry and farming communities across the country."

Technical and marketing teams from feed and input suppliers are coordinating with farmers and project field coordinators to regularly visit farms and collect data and samples, especially during disease outbreaks. Activities follow a structured and coordinated program.

The inaugural session brought together more than 150 farmers, industry stakeholders from across the country, and key government bodies. For the first time, eight national organisations are working under one umbrella.

As General Secretary of the Prawn Farmers Federation of India, Balasubramaniam feels privileged to have taken the lead. He said, "We desperately needed to understand the disease and to figure a way out of this terrible situation."

- PFFI – Prawn Farmers Federation of India – Lead farmer organisation driving the program.
- ICAR–CIBA – Central Institute of Brackishwater Aquaculture – National aquaculture research institution & key investigator.
- MPEDA–RGCA – Rajiv Gandhi Centre for Aquaculture – National aquaculture research & demonstration centre under MPEDA; key investigator.
- NFDB – National Fisheries Development Board (funding agency).
- CAA – Coastal Aquaculture Authority (regulatory agency).
- AISHA – All India Shrimp Hatchery Association.
- SAP – Society of Aquaculture Professionals.
- SEAI – Seafood Exporters Association of India.

The pilot phase focuses on two commonly reported but insufficiently studied conditions: rapid mortalities associated with white muscle, and chronic production challenges linked to white faeces.

Over the next two years, the study will combine: a case–control epidemiological survey to identify risk factors, continuous farm-level monitoring and field investigations, and laboratory-based challenge trials to assess suspected causative agents and triggering conditions.

EHP marker algorithm for early detection of EHP in shrimp aquaculture

EHP is a microsporidian parasite linked to white faeces disease, which silently reduces shrimp growth and farm profitability, causing annual losses exceeding hundreds of millions of dollars across Asia.

KYTOS has launched a breakthrough, its EHP marker algorithm, a powerful new feature on its microbial analytics platform that allows shrimp farmers to detect and manage mature *Enterocytozoon hepatopenaei* (EHP) spore risk with precision and speed.

Using Kytos proprietary single-cell analysis and AI technology, its EHP marker quantifies mature, infectious spores directly from pond water and shrimp samples in under a minute.

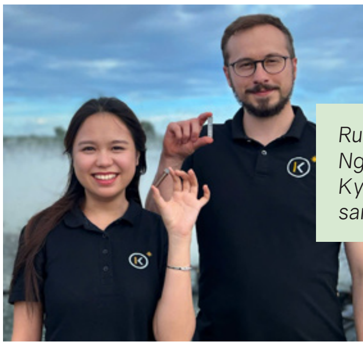
Using data from more than 600 million single-cell data points, the model achieves high accuracy and provides real-time, actionable insights through the digital dashboard. This innovation enables farmers to identify rising EHP pressure before symptoms appear, supporting proactive water management and more sustainable production.

"Delivered through the Kytos platform, our dedicated EHP dashboard transforms complex microbiome data into clear, actionable insights. Spore density trends are visualised and benchmarked against an extensive country-specific database, and contextualised to distinguish background levels from regional thresholds." said Ngoc Minh Ngan Bui, Laboratory Manager, Kytos Vietnam.

Marc Indigne, COO at Kytos added, "While existing methods for EHP detection focus mainly on diagnosing EHP in shrimp tissue, they cannot distinguish between different phenotypes and are hard to use for waterborne infection pressure. At Kytos, we put water management first. Our EHP Indicator uniquely quantifies the mature spores that actually drive infection. Combined with our extensive health toolbox, this empowers farmers to act before clinical symptoms appear. By shifting disease management from reactive treatment to proactive prevention, we help safeguard crop performance, reduce economic losses, and promote more sustainable aquaculture."

The EHP marker was developed by Kytos teams in Belgium, Thailand, and Vietnam, with support from the Flanders International Climate Action Programme (FICAP). See related articles on pages 37-39.

Kytos is a pioneering startup in the development of microbiological management solutions for the aquaculture industry. Its technology is built on decades of leading research in microbiome management and was developed at the Center for Microbial Ecology and Technology (CMET) at Ghent University (Kingdom of Belgium).



Ruben Props, CEO, Kytos and Ngoc Minh Ngan Bui with the KytoVial, conducting water sampling at a shrimp farm.

First ASC Feed Standard certification in India

Sandhya Marines, one of India's leading seafood producers, has been certified by **DNV** to the ASC Feed Standard for its feed production facility in Andhra Pradesh. The certification, formally awarded at World Aquaculture India 2025 in Hyderabad, makes Sandhya Marines the first shrimp feed miller in India to achieve this milestone.

Sandhya Marines' customer base includes more than 25 customers in over 10 countries, and its products – primarily frozen shrimp – are sold to retail chains, stores, restaurants, and food service distributors across North America, Europe, and Asia. The ASC Feed Standard provides a comprehensive framework for responsible aquafeed production, setting stringent requirements in key areas including social and labour rights, health and safety, environmental stewardship, and responsible sourcing of raw materials.

From left, Jibandip Mandal, F&B, India and Balamurugan Sambasivam, Area Manager, India and Middle East; K. Arun Kumar, Whole-time Director and Madan Mohan Meegada, CEO, Feed Division, Sandya Marines Limited; and Puspendra Prasad Roy, Seafood Manager, India, DNV.

Sandhya Marines' certification was granted following a thorough independent audit conducted by DNV, verifying compliance with the standard's strict requirements. The certification demonstrates Sandhya Marines' commitment to producing feed in an environmentally, socially, and ethically responsible way – building trust, promoting long-term sustainability, and creating value for customers, employees, and the wider community.

"We are proud to be the first shrimp feed miller in India to obtain ASC certification. The DNV certification mark is respected worldwide for its association with safety, quality, and sustainability," said K. Arun Kumar, Whole-Time Director, Sandhya Marines. "Producing feed responsibly is crucial to us, as it ensures transparency and traceability across our supply chain and supports the reduction of our environmental footprint. The certification process has strengthened our systems for responsible sourcing and allows us to show our commitment to global sustainability standards."

"The ASC Feed certification reinforces Sandhya Marines' commitment to be a responsible aquaculture producer, enhancing customer confidence, expanding market opportunities and demonstrating sustainable practices. As the first ASC-certified shrimp feed miller in India, Sandhya Marines sets an example within the industry and reinforces the growing importance of transparent and ethical feed production in the region," said Balamurugan Sambasivam, Area Manager, India and Middle East, DNV.

Sri Lanka's first GlobalG.A.P Aquaculture Standard certification

Taprobane Seafoods, a leading seafood producer in Sri Lanka, has been certified by **DNV** under the GlobalG.A.P. Aqua standard. The certification, formally awarded at World Aquaculture India 2025, makes Taprobane Seafoods the first company in Sri Lanka to achieve this recognition.

Taprobane Seafoods operates 16 processing facilities and employs more than 2,000 people across the North-Western and Northern Provinces of Sri Lanka, producing responsibly farmed shrimp. The certification reinforces the company's leadership as a responsible aquaculture producer, positioning it to access premium export markets that demand verified sustainability credentials.

"At Taprobane Seafoods, sustainability is part of who we are. Achieving the GlobalG.A.P. certification marks an important milestone in our sustainability journey. As the first certified company in Sri Lanka, we have validated our efforts through a globally recognised standard that ensures transparency, traceability, and ethical sourcing across the entire supply chain," said Dilan Fernando, Director, Taprobane Seafoods.

Responsibly produced shrimp play an important role in ensuring that aquaculture operations protect ecosystems and the environment, support ethical labour practices, and contribute positively to communities while meeting global animal welfare requirements.

Internally, the certification strengthens Taprobane's environmental governance and aligns feed management practices with global best practices and standards. Externally, it enhances credibility among buyers, consumers, and partners seeking ethically sourced, low-carbon seafood.

"I congratulate Taprobane Seafoods on achieving this certification, which reflects their strong commitment to sustainability, circular resource use, animal welfare, and continuous improvement in aquaculture practices. This milestone also complements their broader initiatives, including renewable energy integration and carbon footprint assessments," said Balamurugan Sambasivan, Area Manager, India and Sri Lanka, DNV.

This certification journey prompted Taprobane Seafoods to strengthen its feed procurement systems, enhancing supplier monitoring and data transparency. The company targeted improvement of its traceability system to track the origin and sustainability status of feed ingredients, fostering closer collaboration with feed producers to explore low-carbon formulations that improve shrimp health and welfare.

"We deeply value DNV's role in helping us set new benchmarks for sustainable and ethical shrimp farming in Asia. DNV's extensive experience in aquaculture certification, technical expertise and approach enabled us to complete the certification efficiently while upholding the highest standards of accuracy and transparency," added Fernando.

From left, Puspendra Prasad Roy, Seafood Manager, India and Balamurugan Sambasivam, Area Manager, India, DNV, with Dilan Fernando, Director and T Charitha Subasinghe, Quality Head at Taprobane Seafoods Pvt Ltd and Jibandip Mandal, F&B, India, DNV.

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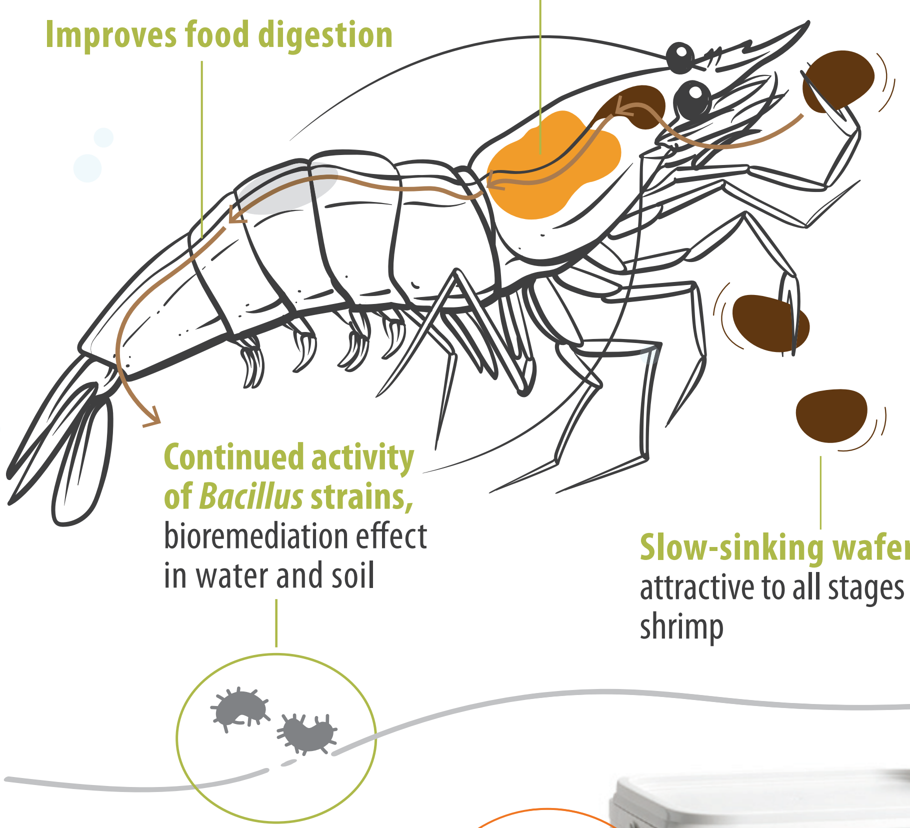

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Navigating an unstable world at GSF 2025

The 2025 edition of the Global Shrimp Forum (GSF) set a record with 580 participants from 280 companies across 35 countries. Since 2022, the mission of the Global Shrimp Forum Foundation (GSFF) has been to have a platform for knowledge sharing, collaboration, innovation and to discuss the most pressing issues and develop a long-term strategy towards the creation of a resilient and sustainable industry. The fourth edition took place on September 3-5 in Utrecht, The Netherlands.

Willem van der Pijl, Board Member and Managing Director at GSFF, announced this on the final day of the conference. He shared that GSF 2024 delegates requested greater involvement from the retail sector and increased participation from China, the top consumer of farmed shrimp. Both needs have now been met. He added that GSF continues to grow stronger each year. Some statistics on the conference participants were: 20% seafood retailers and importers; 15% feed manufacturers; 10% involved in feed ingredients and additives, another 10% in technology and innovations, and 25% comprising investors, NGOs, R&D etc.

The inspirational presentation covered "Geopolitics and Macro-Economics—Navigating an Unstable World." Jan Lambregts, Rabobank's Head of RaboResearch Global Economics & Markets enlightened the audience on the most important developments impacting the global economy and trade landscape. Macroeconomics is part of business strategy. Lambregts said, "In the past 12 months, it is not only macroeconomics but integrated with political elements to be grand macroeconomics." He explained that the end game for the latter is for national interest. "Tariffs are inflationary, but the country can take revenues to subsidise domestic industry. Once a country generates these revenues it will be hard to reverse."

Tariff rates for top sources of shrimp in the US market.

Country	Total value (USD)	Total Ad Valorem Tariff Rate % (As of September 2, 2025)*
India	2.24 billion	59
Ecuador	1.28 billion	19
Indonesia	1.02 billion	23
Vietnam	691 million	23
Thailand	304 million	19
Argentina	186 million	10
Mexico	149 million	0
Canada	25 million	0
Peru	22 million	10
China	17.5 million	55-168**
Saudi Arabia	17 million	10

*Incorporates all applicable duties, including AD/CVD duties at the "all others" rates.

**This range reflects the wide variance of AD margins that apply to specific China exporters, in the absence of an "all others" rate.

Table 1. Tariff rates for top sources of shrimp in the US market. Adapted from the presentation at Global Shrimp Forum 2025, by Robert DeHaan, National Fisheries Institute, September 3-5, Utrecht, The Netherlands.

Tariffs and more

In the next session, Robert DeHaan, Executive Vice President and General Counsel, National Fisheries Institute, listed the tariff rates for the top sources of shrimp to the US and their value (Table 1). Angel Rubio, Principal Reporter and Economist, Urner Barry by Expana, discussed the possible impact of the tariffs on supply and demand dynamics. Some 50% of US shrimp is for retail and comes in as peeled deveined and the other 50% goes to food service mainly as headless shell-on (HLSO) product.

Even before the last quarter of 2024, Rubio said that there was already frontloading. The current per capita consumption is now back to pre-pandemic levels. With the tariffs, cost will increase. Using the example of the tilapia into the US, with a 25% tariff, 24% was passed to the next stage, the consumer. With a 10% change in prices, 3-5% decrease in shrimp consumption can be expected. On the sidelines of the conference, Indonesian participants discussed the market crisis with caesium (Cs137) found in recent shipments by the US FDA in August.

State of the industry

Bastiaan van Tilburg, Nutreco CEO began his presentation on state of industry by identifying areas of change – technology revolution and AI and geopolitical and trade disruptions which could accelerate progress. Sustainability could be seen as a challenge or opportunity and cost or profitability driver.

Zooming into shrimp farming in LATAM versus that in Asia, van Tilburg noted that challenges and starting points are completely different in terms of farm sizes, number of cycles etc. The farming system has changed in Ecuador, with more attention to health issues, technification and sonic feeding, feed extrusion and finally investments to increase capacity.

The CAGR was 20.3% since 2014 in Ecuador versus only 7.9% since 2015 for India. Some performance metrics for Ecuador following technification are 10-20% reduction in FCR; 5-20% increase in survival; 8-15 days reduction in the cycle, 10-25%increase in growth and 20-25% decrease in size variation. It has successfully reduced production cost while the cost in India, Vietnam and China is 35% higher. Ecuador was driven by technification and innovation with 4-6 cycles, as compared only 2-4 cycles in India. A game changer for India would be higher domestic consumption which now stands at 0.5kg/capita/year whereas it is 2-2.3kg/capita/year in the US.

Export and import statistics for 2024 and forecast 2025

Putting on his other hat as Founder of Shrimp Insights, a leading intelligence platform focused on global shrimp industry trends, trade data, and market transparency, van der Pilj presented data on imports and exports as of July 2025.

Exports

The major producer Ecuador ended 2024 at close to 1.2 million tonnes similar to the previous year due to a slow down. India and Vietnam increased exports by 2.8% and 6.3% to 733,000 tonnes and 347, 000 tonnes, respectively. While H2 2024 was slow, growth accelerated in H1 2025 (+17%), as Q2 hit a record 392,740 tonnes.

In May 2025, **Ecuador** for the first time exported more than 150,000 tonnes in one month. The forecast for 2025 is 1.37 million tonnes. Average export values slightly recovered mid 2024 but have declined again since early 2025 amidst strong growth rates, ending June 2025 at under USD5.40/kg. There was relatively slow growth in China, but the EU, other Asian markets and to some extent the US, absorbed most of Ecuador's growth.

In H1 2025, Europe's market share increased to 22%, while the US's market share remains at 19%. Ecuadorean shrimp has been particularly strong in France, the UK, Spain and Belgium. In H1 2025, China represents just below 50% and other Asian markets, 6% of total exportsIn 2024, Santa Priscila exceeded 300,000 tonnes in exports. Consolidation continues and new players are joining (Figure 1).

Figure 1. Consolidation in Ecuador. Source: Shrimp trade statistics: Status and future prospects. Presented by Willem van der Pijl, Shrimp Insights at Global Shrimp Forum 2025, September 3-5, Utrecht, The Netherlands.

In 2024 the total farmed shrimp exports from **India** increased by 3%. In H1 2025, exports are 3% ahead again but growth seems to have stagnated and forecasted to end 2025 at 744,000 tonnes. While the overall trend is stabilising, trends vary between species and product types. The 2025 average export value shows a downward trend and volatility ending June 2025 at under USD8.00/kg. India's exports to the US recovered slightly while exports to other major markets remained stable.

Vietnam's exports to the nine biggest markets in 2024 recovered 10% year-on-year and was 14% up in H1 2025. If this growth continues, Vietnam could finish with a record export of 396,000 tonnes. Vietnam has the most diversified export markets, selling 50% of its products within Asia and Oceania.

Indonesia's export volumes have been recovering since H2 2024, with strong growth in H1 2025. While outlook may have signalled a recovery to around 230,000 tonnes, the Cs137 contamination will slow growth in H2 and end the year with 220,000 tonnes. Indonesia remains largely dependent on the US and the share of value-added, continues to grow.

Imports

Total imports since 2022 have been relatively stable at around 3.5 million tonnes. This year, an increase is expected. The **US** market slightly contracted in H2 2024, but increased YoY in H1 2025 which could be frontloading due to tariffs. If H2 import levels equal last year's, 2025 total is expected to be below 800,000 tonnes. Average import values increased since mid-2024 but started to decline in H1 2025 ending in June 2025, with a peeled price of USD8.25/kg. In 2024 only HLSO imports dropped while in H1 2025 peeled and cooked imports surged. In 2024, volumes declined for all major suppliers except for Vietnam. In H1 2025, all major suppliers increased due to front loading (Figure 2).

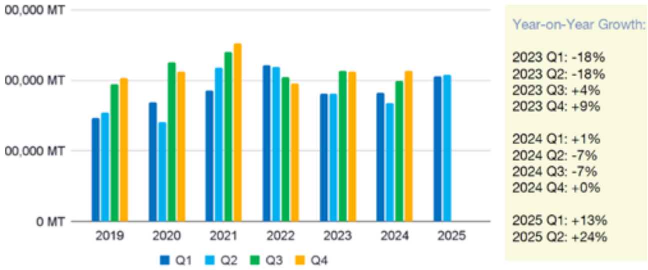


Figure 2. The US market and frontloading due to tariffs. Source: Shrimp trade statistics: Status and future prospects. Presented by Willem van der Pijl, Shrimp Insights at Global Shrimp Forum 2025, September 3-5, Utrecht, The Netherlands.

In the **China** market, imports stabilised between 200,000 and 230,000 tonnes quarterly. Imports are likely to reach just below 900,000 tonnes for 2025. Prices dropped in Q1 2025 and only showed slight signs of recovery in Q2 2025. By June 2025, Ecuador is likely to see another year with a slight decline. India, after stabilising in 2024, may see a small drop this year.

Total imports in the **EU-27** in 2024 were at 550,000 tonnes, just below its peak in 2022. Raw *Penaeus* and value-added imports were at par with 2022. H1 2025 imports of raw *Penaeus* from Asia, Latin America and Africa drastically increased. If H2 continues on the same growth trajectory, the EU's imports of raw *Penaeus* may come close to 400,000 tonnes.

Both Latin America and Asia showed an upward trend growing 20% year on year. The surge of imports in H1 2025 has come at a downward average price trend ending June 2025 at EUR 6/kg. Value added imports are dominated by Asian suppliers with Vietnam maintaining its dominant market share.

Phatanee Leksrisompong, Executive Vice President (middle) and her team from Charoen Pokphand Group with Esther Luiten, Global Director Programme Development, Aquaculture Stewardship Council (ASC, right). Second left is Zuridah Merican, Editor, Aqua Culture Asia Pacific.

The Phileo by Lesaffre team, from left, Gildas Joalland, Strategy & Partnerships Director, Alban Caratis, Aquaculture Manager; Romain Grosjean, SEA Area & Strategic Accounts Manager, and Jean-Benoît Darodes de Tailly, Global Shrimp Business Development.

The dsm-firmenich team. From left, Abung Simanjuntak, Technical Manager Aquaculture - Region GAPAC; Thiago Soligo, Sales Manager LATAM; Benedict Standen, Head, Aqua Marketing Global and Louise Buttle, Sustell Lead for Aqua & Global Key Account Manager.

Japan's imports stagnated after a drop from 300,000 tonnes in early 2000's and in 2025 may reach 220,000 tonnes. The ratio between raw frozen and value-added products remains relatively stable at 70:30. Value-added shrimp are mainly imported from Thailand, Vietnam and Indonesia.

Asian shrimp at GSF

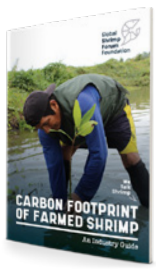
Several Asian producers supplied shrimp for the walk-in dinner on day one at GSF. Shrimp for Indonesia's Delos' dish came from the Dewi Laut farm. Delos stated that the post larvae came from PT STP Anyer hatchery using Kona Bay Genetics and is mangrove free farmed in West Java. The shrimp is BAP certified.

Prakan Chiarahkhongman, Vice President (right) and Suphol Phantumaophas, Head of Aquatic Feed Research and Development (left) at Charoen Pokphand Group, with Parinda Kamchum, Sales Director Thailand & Philippines at Kemin Aquascience.

Publications

Chris Ninnes, Chairman, GSFF, announced that the surplus from the previous GSFs have been used for the following reports. These are available for download from shrimp-forum.com

Author: Roxanne Nanninga & Anton Immink



Author: Arnd Jan Gulmans

View of a pond at the ASC-certified Sarika Farm in Bang Pakong district, Chachoengsao province.

Chalee's Way

Sarika Farm in Chachoengsao province is regarded as a model farm, and its owner, Khun Chalee Jitprasong, has diligently developed it to be the first ASC-certified farm in Thailand

By Zuridah Merican, Daranee Seguin, Jarin Sawanboonchun and Niran Warin

When we speak to shrimp industry stakeholders in Thailand, Khun Chalee's name often comes up among the country's most recently successful farmers. One of his farms, Sarika Farm in Bang Pakong district, Chachoengsao province, is regarded as a model farm that Chalee has diligently innovated, post-COVID, to achieve the Aquaculture Stewardship Council (ASC) certification. In 2024, his farm produced 150 tonnes in an area of 27 rai (4.32ha).

However, before the COVID pandemic (2020-2021), his success rate was low. The turning point came when he began to adopt a different culture model: small one-rai ponds for easier management, a closed system with no water exchange, the use of pond water probiotics, and direct stocking with vannamei post larvae (PL9) from fast-growth genetics at a density of 187PL/m^2. Probiotics were also added to feeds through top dressing.

Chalee Jitprasong (left) and Somprasong Natetip, Director, Lukkungsetthi Company (LST), who is a leading player in Thailand's all-male giant freshwater prawn farming.

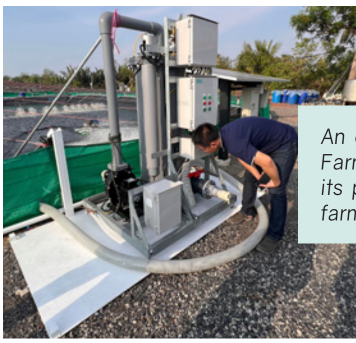
Successful farming model

Khun Chalee is humble in saying that if survival rate is a measure of success, then other farms, such as Khun Tawi's farm in Surat Thani, produce 4,000 tonnes annually. There, the survival rate is stable at 90%, achieved by using pond probiotics and a low stocking density of 31PL/m^2 in large 6-rai (0.96ha) ponds. The difference is that Khun Chalee's model is intensive farming, harvesting smaller-sized shrimp of 80/kg. His productivity/ha is high and biomass control is managed via partial harvests.

The farm has 9 culture ponds, with stocking densities ranging from 200,000–300,000PL/rai (125-187PL/m^2). Only the pond dykes are lined with HDPE, while the bottom is covered with gravel stones to prevent shrimp from stirring up sludge and to help control carbon and ammonia levels.

Recycled water

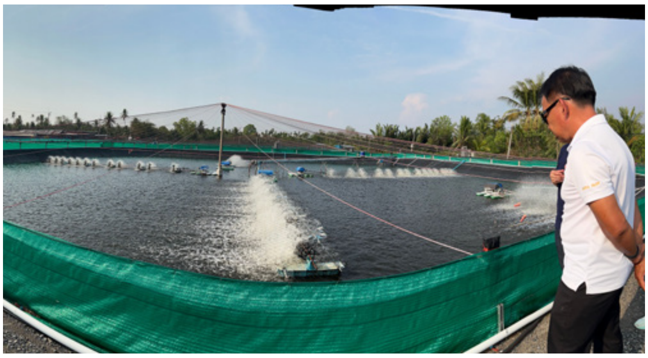
In the main reservoir pond, various freshwater fish, cichlids, clarias, tilapia, rohu and pangasius, act as biofilters. Water is disinfected using chlorine, and consequently, wastewater is recycled. Pond water depth is maintained at around 1.8m, with top-up water when necessary. No chemicals are used during the culture cycle. The spread of viral pathogens is rigorously controlled through strict biosecurity, while probiotics maintain pH balance and control algae bloom. Pond water salinity ranges from 8-12ppt.



An oxygen generator at Sarika Farm. There is a trial to evaluate its potential to improve overall farm performance.

Drone view of the Sarika Farm layout and setup of aerators. Photo credit: Sarika Farm.

This is a smart farm, using startup HydroNeo's technology to obtain accurate water quality measurements using high-quality sensors. High-efficiency motors reduce energy costs by 30%. The farm employs biofloc technology and maintains a pH range of 7.5-8, carefully keeping a 0.2 difference between day and night. The feed conversion ratio (FCR) is 1.1, and the average daily growth (ADG) is 0.2g, measured until the shrimp reach 30g. Khun Chalee continues to seek and remains open to innovations. He recently conducted a trial using pure oxygenation technology to evaluate its potential to improve overall farm performance and to assess the economic feasibility of adopting this technology.



How probiotics are helping to improve crop success

Due to an effective campaign in Thailand discouraging the use of antibiotics, shrimp farmers have increasingly turned to probiotics. Additionally, inconsistent crop cycles prior to the pandemic led many farmers to seek alternative approaches. Success rates—measured by the proportion of crops reaching profitable harvests in regions such as Chachoengsao—had generally remained low.

To address this, the Chachoengsao Shrimp Farmers Club began producing five probiotic strains in-house to help reduce organics, ammonia, nitrate, and harmful bacteria linked to early mortality syndrome (EMS) and white faeces syndrome. Most farmers use these probiotics primarily to control ammonia levels as a preventive measure.

Today, many farmers attribute their success to probiotic use. The club has invested in staff training for three months at the Department of Fisheries, focusing on product quality monitoring, reformulating products with new bacterial strains and quality control. Certification is granted by the Department of Fisheries. The probiotics produced at the Club's centres are exclusively for members. "If we do not come together, we will not survive in this industry," said Chalee.

"If we do not come together, we will not survive in this industry," said Chalee.

Although primarily formulated for pond application, these probiotics can also be used as a top dressing for feed. However, due to their lack of heat tolerance, these products are not recommended for incorporation during feed milling. The probiotics are available in both liquid and powder forms.

Data from the centre indicate that nearly 90% of farms in Chachoengsao currently utilise probiotics. Farmers typically submit water samples, after which centre technicians provide guidance on selecting appropriate probiotic products. The probiotics market remains highly competitive, with numerous suppliers. However, the centre benefits from member-driven product testing.

Five types of probiotics, available in liquid and powder forms, have been developed by the Chachoengsao Shrimp Farmers Club for the exclusive use by its members.

A recent harvest. The farm focuses on vannamei shrimp. Photo credit: Sarika Farm.

All testing and registration activities are facilitated by Mahidol University, while BIOTEC, Thailand's National Center for Genetic Engineering and Biotechnology, leads probiotic development work. BIOTEC collaborates with universities and companies to isolate and characterise Thai-native probiotic strains, such as *Lactobacillus paracasei* and *Bifidobacterium animalis*.

In Chachoengsao, shrimp ponds typically measure approximately one rai, with stocking densities ranging from 50 to 100PL/m^2. The province plays a major role in Thailand's overall shrimp production, which reached 300,000 tonnes in 2024. Chachoengsao is expected to produce about 108,000 tonnes, with daily sales to the local market averaging 300 tonnes. Harvested shrimp tend to be small-size at 80/kg. In March, farmgate prices were around THB 140/kg (USD4.3) for size 80/kg and THB 220/kg for size 50/kg (USD6.8) aligning favourably with prevailing production costs.

During discussions at the centre, Khun Chalee and Khun Somprasong reported a 7% increase in production following the implementation of shrimp health monitoring via PCR testing and regular water quality assessments. The Department of Fisheries (DOF) supports these water quality analyses. Previously, the success rate stood at approximately 3-5 out of every 10 ponds. With the introduction of probiotics, this figure has risen to 8 out of 10 ponds.

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A bridging solution toward sustainable, intensive vannamei farming systems

The BIOSIPEC Standard simplifies system design and standardises operational protocols for small and medium-scale farmers yet delivers the core benefits of the original model

By Nguyen Hoang Bao Tran, Chau Thanh Phong, Truong Ngoc Thao and Pham Minh Anh

The BIOSIPEC Standard at Nha Be showing the nursery and reservoir.

The outbreak of diseases, including white spot virus syndrome (WSSV), acute hepatopancreatic necrosis disease (AHPDND or early mortality syndrome – EMS), and *Enterocytozoon hepatopenaei* (EHP), has inflicted severe losses on shrimp farmers across Asia since 2010.

These outbreaks led to significant declines in productivity and profitability across the region, particularly in countries such as China, Malaysia, Thailand and Vietnam, where the total collective losses during 2010–2016 were estimated at USD23.6 billion (Shinn et al., 2018). Controlling diseases proved extremely difficult in traditional farming models that relied heavily on water exchange and lacked effective biosecurity protocols (Subasinghe et al., 2023). The resulting loss of confidence led many farmers to abandon their ponds, causing considerable economic damage and disrupting the aquaculture industry's supply chain.

This crisis underscored the urgent need for a transformative approach to shrimp farming, one that could effectively mitigate disease risks. ADM's aquaculture division introduced the BIOSIPEC technology (Biosecurity Intensive Shrimp Production with Environmental Control), which demonstrated high effectiveness in intensive vannamei (*Litopenaeus vannamei*) production through the integration of a closed system, zero water exchange, and rigorous biosecurity measures. However, high investment requirements and technical complexity rendered this BIOSIPEC technology inaccessible to many small and medium-scale producers.

Meet farmers' needs

Recognising the need to extend these innovations to a broader farming community, ADM subsequently developed the BIOSIPEC Standard. This derivative model was designed to deliver the core benefits of the original model —namely reduced disease risk, lower investment cost, and more stable yields with a more accessible and scalable framework. Piloted in Nha Be Aqua R&D Center, Ho Chi Minh City, this model incorporates recirculating aquaculture system (RAS) principles and key elements of the original version. By simplifying system design and aligning operational protocols with local farming conditions, BIOSIPEC Standard enables a gradual transition toward modern, biosecure, and sustainable shrimp production.

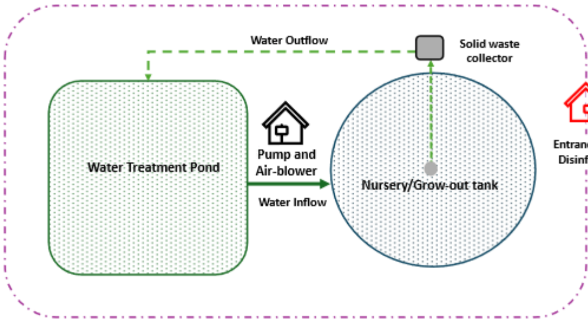

Figure 1. Layout of the BIOSIPEC Standard system. With a recirculating loop, it maintains stable water quality throughout the production cycle, minimising environmental fluctuations and disease exposure.

PARAMETERS	NURSERY	GROW-OUT
Stocking density	1-3 PL/m³	100 - 150 juveniles/m³
Tank/pond volume	100m³	500m³
Day of culture	24 days	67 days
Initial body weight	8.2mg/PL	1.2g/juvenile
Final body weight	1.2g/juvenile	25.4g/shrimp (40 pcs/kg)
Average daily growth	45.3mg/day	0.4g/day
Feed conversion ratio (FCR)	0.81	1.41
Survival rate	93%	87%
Biomass	1.13kg/m³	2.28kg/m³
Feed	MEM	VANALIS
Probiotic	BACTOSAFE P	BACTOSAFE P
Production cost	USD10.3/1,000 juveniles	USD3.6/kg (excluding depreciation)
Success rate	89%	78% (up to date)

Table 1. Summary of the results achieved from BIOSIPEC Standard.

This model empowers farmers with a proactive and adaptive strategy for sustainable shrimp cultivation. Its streamlined infrastructure consists of three primary components: a nursery tank, grow-out tank, and treatment ponds (Figure 1). This compact recirculating loop maintains stable water quality throughout the production cycle, minimising environmental fluctuations and disease exposure.

Supported by standardised operating procedures (SOPs) for daily management and biosecurity, the model employs a flexible, multi-phase culture approach. Strict quarantine measures and the application of beneficial bacteria (BACTOSAFE P) are implemented to maintain microbial balance and water stability. This solution reduces the dependence on chemical treatments and eliminates antibiotics while enhancing robustness of vannamei post-larvae, improving feed conversion ratio (FCR) and survival rates, even under high stocking densities and unfavourable farming conditions (Figure 2).

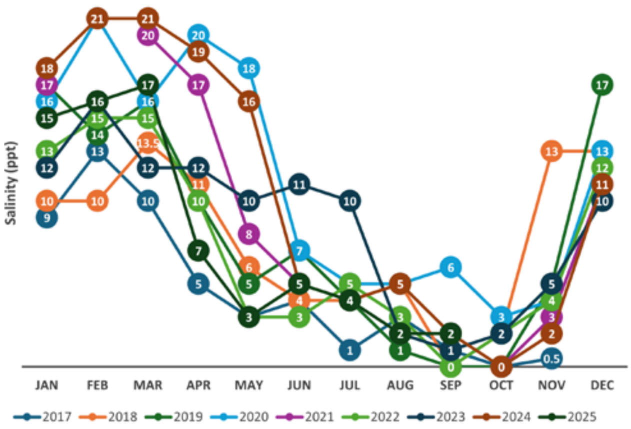

Figure 2. Salinity records of the water source in Nha Be

The BIOSIPEC Standard expands access to sustainable solutions and supports the long-term resilience of the shrimp sector. As presented in Table 1, over 30 farming cycles have validated the model's reliability and efficiency, yielding notable outcomes: 93% survival and 89% success rate in the nursery phase, and 87% survival with a success rate of 78% in the grow-out phase. Furthermore, its design allows farmers to leverage most of their existing infrastructure, minimising capital investment and facilitating adoption at farm level.

The cost structure of the BIOSIPEC Standard illustrates clear operational differences between the nursery and grow-out phases (Figure 3).

- The nursery phase focusses on investment in high-quality PL (58.1%). Controlled rearing conditions ensure strong early growth, with feed (18.4%) and electricity (8.2%) representing smaller cost shares.
- In the grow-out phase, feed (41.3%) becomes the major cost due to increased feed consumption, while power cost (18%) rises sharply to support continuous aeration and water circulation for intensive culture.
- This cost distribution highlights that feed and energy management are the key drivers of production efficiency and profitability in this technology. Optimising these inputs directly contributes to improved yield stability, and lower operating costs.

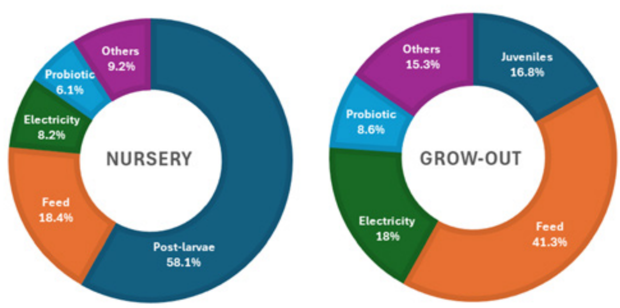

Figure 3. Production cost structure in BIOSIPEC Standard

Additionally, a key operational advantage of the BIOSIPEC Standard lies in its highly efficient production rhythm, engineered to maximise asset utilisation and annual yield. The system features a dedicated nursery that consistently supplies high-quality post-larvae to multiple grow-out tanks. The shortened nursery phase ensures a steady supply of juveniles for immediate restocking, effectively eliminating idle time and maintaining near-continuous operation.

With this configuration, one nursery can support as many as five grow-out tanks, enabling farmers to achieve up to five cycles per year (Figure 4) and produce a maximum 110 tonnes of shrimp/ha/year. This high production frequency offers a significant competitive edge by increasing annual yield, enhancing revenue potential, and delivering a higher return on investment compared with conventional shrimp-farming systems.

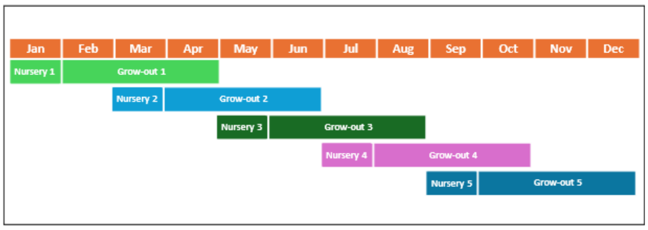

Figure 4. Production plan in BIOSIPEC Standard for a 12-month rotation.

It is important to note that while simplified, the BIOSIPEC Standard is not a "self-operating" system. Consistent, high-yield performance requires strict adherence to biosecurity measures and full compliance with established SOPs. To ensure effective implementation, ADM's technical team provides comprehensive support, guiding farmers through system setup, operation, and troubleshooting. This training-based, participatory approach enables a practical and incremental pathway toward sustainable shrimp farming practices.

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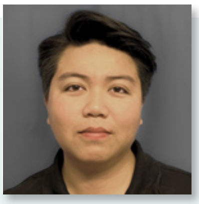

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The next wave: How Asia's young farmers redefine shrimp aquaculture

Rizky Darmawan, Delta Marine Group, Indonesia (left), curated and moderated The Pondside Chat at TARS 2025, featuring (from second left), Chodpipat Limlertwatee, L.K. Feeds, Thailand; Mayank Sharma, Mayank Aquaculture Pvt Ltd, India; and Hai Nguyen, EcoSeafood Group, Vietnam.

For Asia's shrimp farmers, the ponds represent their livelihood and inheritance. Yet for a new set of second-generation entrepreneurs, taking over the family farm is not just an act of filial duty; it is also an experiment in modernising one of the region's most traditional industries.

At TARS 2025 on Shrimp Aquaculture in Chiang Mai, Thailand, a spirited panel of next-generation shrimp farmers shared their insights. The Pondside Chat featured **Rizky Darmawan**, CEO of Indonesia's Delta Marine Group, who curated and moderated this chat; **Chodpipat "Op" Limlertwatee**, Chief Farming Officer of Thailand's L.K. Feed Co Ltd; **Mayank Sharma**, Technical Director of India's Mayank Aquaculture Pvt Ltd; and **Hai Nguyen**, Co-founder of Vietnam's EcoSeafood Group.

What brought this group into shrimp farming?

All of them belong to the generation that grew up watching their parents navigate the volatile fortunes of shrimp aquaculture, such as disease outbreaks, fluctuating prices, and the constant evolution of technology. Yet they represent something new: educated in science, finance, and technology, they see farming as both a business and a field of innovation.

The inevitable for Chodpipat

For Chodpipat, shrimp farming was less of a choice than an inevitability. "My father planned for me," he quipped. "He took me to the farm when I was young." Trained in aquaculture at Kasetsart University, Chodpipat soon discovered the mathematical and scientific allure of shrimp farming. There is the economic potential – 'revenue equals quantity times price'. In shrimp, both factors can be engineered. "You can make however much money you want; it just depends on your ability to control and manipulate this formula."

A gradual conversion for Mayank

India's Mayank Sharma went through a more gradual conversion. As a child, he followed his father to the ponds as a weekend recreation. Curiosity turned into a passion to know more. He completed a master's degree in aquaculture biotechnology, and during the pandemic, returned home to make the family business both sustainable and profitable.

Rewarding for Rizky

Even Rizky Darmawan's story carried a note of destiny. Initially studying computer science, he switched to fisheries midway through his degree. "I wanted to do business, and the easiest way was to continue my family's business," he said. When he returned to Indonesia, he took over farm operations himself, and that forced him to learn every aspect of production. Today, he enjoys farming as "it's a good break from city life."

Hai Nguyen: Opportunities in shrimp farming

Hai Nguyen's path was different. As the second generation managing 30 contract shrimp farms around Bac Lieu, South Mekong, he grew up immersed in the opportunities and challenges of the shrimp aquaculture industry. "In 2022, I saw the shrimp crisis as serious, while my parents assumed it would pass quickly. I sought out some solutions."

However, as a finance graduate, he had no intention of joining the family's shrimp venture. He said, "I did not have a chance to take over a farm," unlike the other panellists. So instead, he decided to start one himself. Hai went on to partner with Dr Loc Tran of the ShrimpVet Group as a co-founder of EcoSeafood Group, driving a greenfield shrimp aquaculture project in Ca Mau.

How difficult was it to work with the older generation?
Recounting how Thailand's devastating EMS (early mortality syndrome) crisis in 2015 became his moment of liberation, Chodpipat said, "I asked my father to give me one farm, and I would do everything my own way," he said. "That's how I started." He managed everything from nursery to harvest. When it came to dealing with his dad's expectations, he responded with action by "doing it himself."

For Rizky, it was a rocky start, but it has been rewarding. "Remember, whatever the son says, the father says no," Rizky laughed. "Even when you have studied this in school. The senior generation tends to be hesitant with new ideas. Only after a few proven successes did my father begin to agree with me."

Mayank admitted that working alongside his father who is "a good but strict coach" was not without tears. "There were times I thought I should go back," he confessed. "Five years on, I am proud to have learned so much and that my father allows me to innovate."

Above is the farm in Chumphon Province that was given to Chodpipat Limlertwatee to manage everything from nursery to harvest. L.K. Feed Co Ltd has nine farms, producing 3,000 tonnes/year of vannamei shrimp in one to two phases at a stocking density of 125-180 PL/m² from 200 ponds (250ha).

"We aim to move from reactive to predictive farming by using AI and software that can simulate pond conditions and support execution with precision" - Chodpipat Limlertwatee

A young Mayank's weekend recreation at the farm.

"We are happy farming premium-size black tiger that commands high prices. Better to harvest fewer larger shrimp than overstock" - Mayank Sharma

A tour of farms and challenging each other on some operational aspects

Rizky led the group to discuss the farms, how each farm presented a distinct model shaped by geography, economics, and philosophy. The group revealed how no two shrimp farms are alike. They also challenged each other on some operational aspects.

Environmental responsibility in Vietnam

Hai Nguyen's EcoSeafood Group (ESG) embodies pragmatic sustainability. The farm, located in Ca Mau, Vietnam, operates on a simple premise: profitability and environmental responsibility must coexist.

When shrimp prices fall, Hai explained, most farmers respond by increasing stocking density and harvesting more to offset margin losses. ESG takes the opposite approach: lower costs, not higher densities. The farm invests in biotechnology. It uses carefully bred shrimp post larvae, in-house probiotic cultures, and minimal water exchange.

"Every technology must be tested for ROI (return on investment) before adoption," Hai said. "We build simple ponds, easy to operate."

Rizky noted on the large area dedicated to mangroves. "Only half of the land is used for production, and 30% for wastewater mangrove ponds. Instead of investing in water treatment equipment, we use natural systems. It saves cost and it is sustainable," explained Hai.

They also have their own hatchery so they can control the cost of post larvae. He claims that his control over post larvae quality has contributed to their high success rate. The farm's integrated multi-trophic system, raising tilapia, mangrove trees, and seaweed alongside shrimp, absorbs nutrients and turns waste into value. Furthermore, his family's 10,000-tonne annual feed purchases give him leverage with suppliers.

Expanding horizons in Indonesia

Across the Java Sea on Sumbawa Island, Delta Marine Group operates on a larger scale. Rizky's ponds comprise several circular ones and are highly productive. He has begun converting some of these ponds into nurseries, achieving "some success" with a two-phase model. "From nursery to grow-out is a short distance," he explained. "It makes logistics easier." There are 3-4 partial harvests to produce 20-count vannamei shrimp over 140 days.

A balancing act in India

While India's aquaculture production has boomed, Mayank Aquaculture's approach remains conservative. In total, the company manages about 500ha of ponds in South Gujarat. It operates 200 ponds by combining traditional earthen ponds with modern feed management, producing around 600 tonnes of black tiger and 300 tonnes of vannamei shrimp.

What distinguishes Mayank Aquaculture is its bet on black tiger shrimp *Penaeus monodon*. "I'm scared of the production glut," he admitted, referring to the current vannamei shrimp oversupply. "I'm very happy farming black tiger."

Each ha of pond yields 4-5 tonnes of shrimp, averaging 70-80g and premium sizes that command high prices in domestic and export markets. "We believe in carrying capacity," he explained. "Better to harvest fewer, larger shrimp than overstock." He has other ponds that are 0.4ha in size, where a second crop is for vannamei shrimp. The maximum size for his vannamei shrimp is 10-15g in the off-season, earmarked for the local market.

"Every technology must be tested for ROI before adoption. We use natural systems that save costs and are more sustainable" - Hai Nguyen.

At this 30ha farm in Ca Mau, Vietnam, EcoSeafood Group uses half of the land for production and 30% for wastewater with mangrove ponds. Smaller ponds can be used as nurseries, experimental ponds and grow-out ponds producing 1.2 tonnes/pond. The target production in 2025 is 2,000 tonnes/ year, with stocking at <200PL/m².

Mayank Aquaculture operates 500ha of ponds across South Gujarat, India, producing both 1,000 tonnes of monodon and vannamei shrimp. The strength is three-phase farming with an indoor and outdoor nursery system. See article in issue July/August https://issues.aquaasiapac.com/view/572986027/20/

Mayank's two-crop strategy, black tiger followed by vannamei shrimp, keeps production flexible. His domestic sales during off-season months provide steady cash flow, reducing exposure to export volatility. Mayank's earthen ponds perform reliably. "What works for one farmer may not work for another," he said. "In the end, we all do business for profit."

Precision farming in Thailand

Thailand's shrimp farmers, once decimated by EMS, have re-emerged leaner and more sophisticated. Chodpipat's operation exemplifies the transformation. His redesigned farm replaced ten small ponds with four one-hectare units, each producing around 40 tonnes per crop.

The key to his success is the use of long-arm aerators, a Thai innovation that keeps sludge suspended and water oxygenated. The central drains or shrimp toilet, collects waste efficiently while reducing disease risk. The aerators are calibrated precisely: outer paddles spin at 100 rpm, inner ones at 70-80 rpm to guide sludge toward the centre.

At the heart of his system is what Thai farmers call "strategic farming". "We are survivors of EMS," Chodpipat added. "Every successful farmer in Thailand now follows the same method."

Chodpipat has also built his own farm-management software that tracks feed conversion ratios (FCR), costs, and performance in real time. "I wrote the software myself," he said proudly.

Delta Marine Group operates four farms on Sumbawa Island, with a production of 4,000 tonnes/year. The main farm (above) has 70 lined ponds, circular tanks and raceways. Rizky explained that he has been testing a two-phase farming model using circular tanks for nursery rearing.

Exchanging challenges with the nursery phase and the transfer process

It is a 3-phase model at Hai's farm, with nursery for 20-25 days and capping at 1.2 tonnes/pond for partial or full harvest. This low-technology efficiency extends to logistics.

Responding to Rizky's query on transferring juveniles over a long distance, Hai said, "Over the last two years, ESG has pioneered a method to transport juvenile shrimp between farms, dipping shrimp in ice-chilled water, a technique that slows metabolism and preserves survival rates up to 95%. We can move shrimp over 30km safely."

Chodpipat noted that juvenile shrimp survival during transfer at this farm is around 50%.

"AI will just be a guide, in the end, human wisdom needs to be in the lead"
– Rizky Darmawan

Navigating the AI revolution

How does the group view using artificial intelligence on their farms?

All four were optimistic, but pragmatic. Mayank said that he would rather have "his father's experience as his software."

Chodpipat and Hai are excited about the prospect of integrating AI into farm management systems, capable of drawing on historical data to suggest feed regimes or treatments, or to solve financial calculations. Yet the group was united in their caution.

"Every crop is a new story," said Mayank, noting that unlike industrial processes, aquaculture operates in a living, unstable ecosystem. The promise of AI, he says, is in guidance, not control. It can help farmers detect patterns and anticipate risks, but it cannot replace a human judgement.

There was also an undercurrent of resistance to full automation. "There needs to be a human soul and touch at the farms," said Mayank, rejecting the notion of running ponds remotely from a screen. Rizky believes that AI will just be a guide. "In the end, it's human wisdom that needs to lead."

The others noted that many biological variables in shrimp culture remain poorly understood, and that technological overreach, too fast, too soon, could amplify errors.

What are their visions for the next five years?

This next generation of shrimp farmers seeks scale, sustainability, and sophistication. Hai Nguyen's goal is expansion. He aims to build 50 more farms since Vietnam's fragmented coastal tenure system makes it difficult to acquire large tracts. The strategy is possibly a partnership: building new farms jointly with existing operators and replicating its low-cost model. "If one farm succeeds," Hai said, "we can apply the model to others." He also aims to move into processing, giving Vietnamese shrimp farmers greater control over quality and branding.

Mayank, in contrast, emphasised marketing over acreage. "Five years is too far ahead to think about," but India's domestic demand, he believes, is the key.

"The future is market, market, market," he declared. "We need to build domestic consumption, not depend entirely on exports." Operational efficiency through better feeding, automation, and crop scheduling remains his other priority. But in the future, if he can sell 1,000 tonnes of shrimp in the domestic market, he might be keen to adopt intensive systems for further efficiency.

Chodpipat's next phase is to shift more towards B2C sales. Next is predictive farming, turning data into foresight. "We can now simulate pond conditions—water flow, aeration, elevation," he said. By feeding these variables into his software, he hopes to predict outcomes before they happen. "We will move from reactive to predictive farming."

The company has upgraded its farm standards from GAP to BAP and currently to ASC—ensuring global trade compliance and positioning the business for international export.

Finally, Rizky Darmawan's ambitions are practical. "In five years, I hope to move into processing," he said. "We already have enough raw material." He too believes software and automation will be crucial as fewer young people enter the industry. "This industry may not look glamorous," he said, "but the profit is good."

His peers agreed. Profit margins, they estimated, hover between 30–35%, with ROIs occasionally higher. "At some point," Rizky added, "We can compete with Ecuador's production costs per kilogram."


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Innovative sustainable ingredients to strengthen shrimp health

This strategy offers a forward-looking alternative to conventional ingredients to ensure health, quality, and operational efficiency in shrimp farms

By Héctor Monterde

Shrimp ranks among the most widely traded aquatic species globally. In 2024, farmed shrimp production reached 5.9 million tonnes, with projections for 2025 estimated at 6.1 million tonnes. Ecuador, China, India, Vietnam, and Indonesia together accounted for 74% of global output in 2024. Most of this production—primarily from intensive and semi-intensive farming systems in Latin America and Asia—is destined for high-income markets such as the United States, Europe, and Japan. Over the past few decades, shrimp exports have surged dramatically, rising from USD1.2 billion in 1976 to an impressive USD24.7 billion today (FAO, 2022; Jory, 2018).

Global shrimp production: Challenges and strategic responses

The global shrimp aquaculture industry is undergoing a period of transformation, driven by a complex mix of biological, economic, and environmental challenges. Across leading production regions, Asia and Latin America, producers are grappling with disease outbreaks, rising feed costs, tariff uncertainties, market volatility, and shifting consumer preferences.

Common challenges across regions

Disease management remains a universal concern. Viral pathogens such as white spot syndrome virus (WSSV) and acute hepatopancreatic necrosis disease (AHPND) have caused billions in losses globally (Jory, 2018). The lack of a robust immune system in shrimp has limited vaccine development, pushing producers to adopt alternative strategies such as specific pathogen free (SPF) breeding lines. Feed costs are variable due to fluctuations in raw material and energy prices, and are further affected by supply chain disruptions, geopolitical tensions, and climate-related events.

Feed accounts for up to 65% of total production costs, prompting the industry to explore innovations in ingredients and technology aimed at improving cost-efficiency and overall performance. Although feed costs have begun to stabilise in 2023–2024 after a period of inflationary pressure from 2019 to 2023, largely due to improved availability of key ingredients such as fishmeal and soy, the industry remains cautious due to ongoing biological and market uncertainties.

Market volatility is another pressing issue. Shrimp prices have fluctuated sharply in recent years due to oversupply, inflation, and changing demand patterns. The COVID-19 pandemic accelerated shifts in consumer behaviour, with increased demand for frozen and ready-to-eat seafood but also exposed vulnerabilities in global trade logistics.

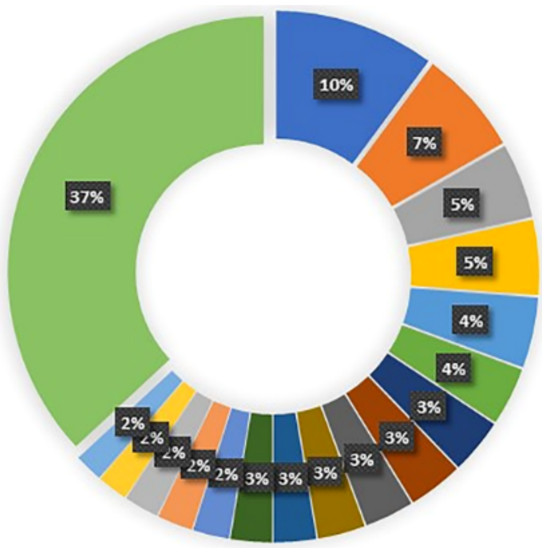

Figure 1. Current contribution of major species to global aquaculture production (FAO 2022).

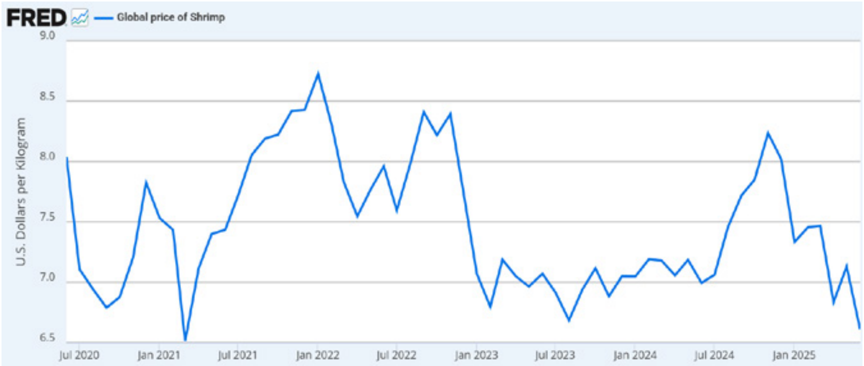

Figure 2. Global price of shrimp. Source: International Monetary Fund via FRED®.

Regional perspectives

Across the world's leading shrimp-producing countries—China, India, Indonesia, Vietnam, Thailand, and Ecuador, feed supply and efficiency have become central to production outcomes. While disease, environmental stress, market volatility and updated trade duties remain critical challenges, feed-related factors increasingly determine the sustainability and profitability of shrimp farming. China's feed industry is led by major players investing in smart technologies to stabilise yields and improve feed conversion ratios.

Across all regions, the shrimp feed industry is undergoing rapid transformation. Consolidation among manufacturers is increasing, and global players are investing in smart farm management, automated feeding, and functional nutrition. These innovations are not only improving cost-efficiency but also helping producers adapt to biological and environmental pressures. As feed represents up to 65% of total production costs, advancements in formulation, delivery, and monitoring are becoming essential to maintaining competitiveness.

The global shrimp industry is at a crossroad. While each country faces unique challenges, the overarching themes—disease, feed costs, market dynamics, and sustainability—are shared across borders. Collaborative innovation, investment in resilient farming systems, and strategic market positioning will be key to ensuring the long-term viability of shrimp aquaculture worldwide.

Emerging bioactive compounds in shrimp nutrition and health

Unlike other species, shrimp face additional challenges as they lack an adaptive immune system and rely solely on innate immunity. This invertebrate-specific system is characterised by a generalised immune response involving physical barriers, cellular and humoral components, and recognition of molecular patterns from various pathogens.

Many of these pathways are relatively well understood and involve pattern recognition receptors that interact with serine proteases to initiate encapsulation, phagocytosis, and an antimicrobial cascade based on the prophenoloxidase (PPO) enzymatic system, leading to the release of molecules stored in haemocytes (e.g., lysozymes, antimicrobial peptides, and agglutinins). The complement system, microRNAs, and RNA interference also play roles in shrimp immunity (Darodes de Tailly, 2024; Makesh & Rajendran, 2022; Soderhall & Cerenius, 1998).

Notably, the sophistication of this innate response is becoming increasingly apparent. Recent studies suggest the existence of adaptive and memory-like immunity in shrimp (Makesh & Rajendran et al, 2022).

Given these inherent characteristics of the shrimp immune system, in line with global trends in enhanced production efficiency and restricted use of antibiotics, there is a need for strategies that enhance shrimp immunity and productivity in a cost-effective and environmentally friendly manner.

This article focuses on the effects of alginate, β-glucans, fucoidans, nucleotides, polyphenols and triterpenes, bioactive compounds derived from brown algae of the *Macrocystis integrifolia* genus, yeasts of the *Saccharomyces cerevisiae* genus and extracts of *Olea europaea* (olive) tree. All these compounds play a role in strengthening shrimp health.

- **Alginate** is a polysaccharide composed of two types of uronic acids, found in brown algae and some bacteria. It is known to stimulate the shrimp immune system by enhancing gene expression related to immunity and activating non-specific immune responses. A study by Yudiati et al. (2019) showed that alginate increased resistance to WSSV (Gisbert et al., 2017).

- **β-glucans** are carbohydrate polymers linked by β-1,3, 1,4, or 1,6 bonds; their role is to protect shrimp against pathogens and prevent disease. They bind to β-glucan receptors, stimulating various cellular and humoral mechanisms such as phagocytosis, reactive oxygen species production, antimicrobial peptide synthesis, and activation of the PPO system. For example, β-glucans interact with haemocyte surfaces, triggering granule release in the presence of calcium, which activates PPO. This contributes to reducing pathogen loads by supporting the shrimp's innate immune system (Vargas-Albores & Yepiz-Plascencia, 2000; Guluarte et al., 2023).

- **Fucoidans** are among the most prevalent sulfated polysaccharides found in the extracellular matrix of brown algae. They exhibit anti-inflammatory, antiviral, and antimicrobial properties, which are closely linked to their structure—particularly sulfate and uronic acid content. Studies have shown that fucoidans can be beneficial in treating inflammatory diseases (Murphy et al., 2023).

  In aquaculture, they are used as immunostimulants and to enhance productivity. Fucoidans promote haemocyte degranulation, increase PPO activation, boost phagocytic activity, and stimulate superoxide anion production (Salenpour et al., 2021; Kitikiew et al., 2013; Sinurat et al., 2016.)

- **Nucleotides** are the building blocks of DNA and RNA. They play vital roles in physiological processes and act as immunomodulators (Andrino et al., 2012). During stress conditions, such as rapid growth or pathogenic challenges that cause cellular damage, having an exogenous source of bioavailable nucleotides is beneficial for optimising cell proliferation and tissue function, especially in rapidly replicating tissues like the gut and immune system, which cannot synthesise nucleotides *de novo* (Andrino et al., 2012; Alvarez et al., 2007).

  A study by Burrells et al. (2001) suggests that, unlike β-glucans, nucleotides stimulate both non-specific and specific immune responses, enabling faster and more precise immunity. There is also evidence supporting their use in diets high in plant protein and antinutritional factors, where nucleotides help counteract negative effects and improve performance and disease resistance (Novriadi et al., 2022).

- **Polyphenols** are natural plant compounds with aromatic ring structures that exhibit potent anti-inflammatory activity, helping protect aquaculture species from inflammation triggered by various stressors encountered during the farming cycle, such as suboptimal diets, elevated water temperatures, and high pathogen loads (Gisbert et al., 2017; Salomon et al., 2021).

- **Triterpenes** are naturally occurring compounds found in plants, fungi, and some animals, known for their diverse biological activities such as anti-inflammatory, antioxidant, and antimicrobial effects. These are well known to preserve the integrity of the gut and improve lipid metabolism (energy accumulation in the fillet) in aquaculture species. (Gisbert et al., 2017; Salomon et al., 2021).

These bioactive compounds are naturally present in various yeast, algae species and olive trees, particularly in their cytoplasm and cell walls. Among structural polysaccharides, brown algae of the *Macrocystis integrifolia* genus stand out due to their high fucoidan-to-alginate ratio, greater alginate content compared to other algae, and the presence of laminarin—a β-glucan polysaccharide with β-1,3 and β-1,6 bonds that offers superior immune stimulation (Murphy et al., 2023; Salenpour et al.,2021; Kitikiew et al., 2013; Sinurat et al., 2016). Nucleotides are primarily sourced from yeasts such as *Saccharomyces cerevisiae*. Olive trees contain numerous phytochemicals across their different parts.

Importantly, the method used to extract these bioactive compounds significantly affects their potency and effectiveness as functional ingredients in animal feed.

Synergistic effects of bioactive compounds on white shrimp

To explore alternatives that enhance growth and productivity of Pacific white shrimp (*Litopenaeus vannamei*), and to investigate the immune response and survival of shrimp under pathogenic challenges, the R&D team at Bioiberica Animal Nutrition (Spain) designed a study to evaluate the synergistic combination of three ingredients rich in bioactive compounds.

These comprised the following:

- brown algae meal *Macrocystis integrifolia*;
- a free nucleotide concentrate from *Saccharomyces cerevisiae*, and;
- an olive tree extract with specific concentration on polyphenols and triterpenes.

The study focused on the effects of feeding shrimp with different combinations of the compounds and their effect on shrimp growth and survival when exposed to a *Vibrio parahaemolyticus* immersion challenge. This gram-negative *Bacillus* is the causative agent of AHPND, characterised by severe hepatopancreas atrophy and capable of causing sudden and massive mortalities of up to 100% within 30 to 35 days after stocking (De la Peña et al., 2015; Tran et al., 2013).

The trial was conducted at ShrimpVet, a leading shrimp research centre in Vietnam. The feeding trial assessed the effects of nucleotides, alone or in combination with other products, on shrimp growth performance in a recirculating aquaculture system (RAS). The challenge trial measured the effects of nucleotides, alone or in combination with other products, on shrimp disease tolerance to a *Vibrio parahaemolyticus* challenge under laboratory conditions.

In the feeding trial, a total of 1,250 *L. vannamei* (0.57±0.11g) were used in the study. After a 2-day acclimation period, shrimp were divided into five groups (5 replicates per group; 50 shrimp per 90L tank) and received different treatments over a period of 56 days (Segarra et al., 2025a & 2025b, Table 1).

In the challenge trial, a total of 600 *L. vannamei* (0.57±0.11g) were used in the study. After a 2-day acclimation period, shrimp were divided into five groups (4 replicates per group; 30 shrimp per 90L tank) and four groups were challenged by immersion with *V. parahaemolyticus* and supplemented with different diets over a period of 28 days (Segarra et al. 2024. Table 1). Post-challenge monitoring was carried out for 10 days to quantify and compare survival rates across the different treatment groups.

Groups	Challenge (*Vibro parahaemolyticus*)	Details
Negative control (CN)	NO	Commercial diet for Pacific white shrimp in Vietnam
Native control (CN)	YES	Commercial diet for white shrimp in Vietnam
NF	YES	Control + 500ppm Nucleoforce Aqua*
AL	YES	Control + 500ppm seaweed meal*
AO	YES	Control + 500ppm of olive extract*
NFAL	YES	Control + 1,000ppm Nucleoforce Immunity**
NFAO	YES	Control + 1,000 ppm Nucleoforce Performance***
*Nucleoforce Aqua is a yeast-based product; **Nucleoforce® Immunity is a product that contains yeast and brown algae meal; *** Nucleoforce® Performance is a product that contains yeast and brown olive extract, Bioiberica, Spain.		

Table 1. Feeding and challenge test groups against *Vibrio. parahaemolyticus* used a commercial diet for white shrimp in Vietnam as the control diet and treatment diets supplemented with nucleotides, alone or in combination with other products.

Groups	Initial mean weight (g)	Final mean weight (g)	Final biomass (g)	Mean weight gain (g)	ADG (g/day)	SGR (%/day)	Feed consumption (g)	FCR
CONTROL	1.23 ± 0.05^{a}	22.03 ± 4.25^{a}	858.80 ± 23.53^{a}	20.80 ± 0.55^{a}	0.37 ± 0.01^{a}	5.15 ± 0.09^{a}	1,032.16 ± 10.91^{a}	1.30 ± 0.05^{a}
NF	1.21 ± 0.05^{a}	23.43 ± 4.23^{b}	988.04 ± 26.71^{bcd}	22.22 ± 0.89^{b}	0.40 ± 0.02^{ab}	5.29 ± 0.11^{ab}	1,052.27 ± 0.42^{bc}	1.13 ± 0.06^{bc}
AO	1.22 ± 0.03^{a}	23.06 ± 4.9^{b}	922.44 ± 78.75^{ab}	21.85 ± 0.64^{b}	0.39 ± 0.01^{b}	5.25 ± 0.64^{b}	1,057.54 ± 5.69^{ab}	1.24 ± 0.11^{bc}
AL	1.21 ± 0.04^{a}	23.44 ± 4.68^{b}	1,046.60 ± 91.86^{ab}	22.33 ± 1.28^{b}	0.40 ± 0.02^{b}	5.29 ± 0.14^{a}	1,067.26 ± 14.06^{bc}	1.09 ± 0.11^{c}
NFAO	1.22 ± 0.03^{a}	23.74 ± 4.7^{b}	1,014.43 ± 21.83^{cde}	22.51 ± 0.72^{b}	0.40 ± 0.01^{b}	5.29 ± 0.05^{b}	1,058.45 ± 0.80^{bc}	1.09 ± 0.05^{c}
NFAL	1.22 ± 0.03^{a}	24.09 ± 4.83^{b}	962.54 ± 29.76^{bc}	22.87 ± 0.87^{b}	0.41 ± 0.02^{b}	5.33 ± 0.08^{b}	1,086.45 ± 0.00^{d}	1.21 ± 0.05^{ab}

Table 2. Results from the feeding trials. Treatment diets were supplemented with 500ppm Nucleoforce Aqua (NF); 500ppm seaweed meal (AL), 500ppm of olive extract (AO); 1,000ppm Nucleoforce® Immunity (NFAL) and 1,000ppm Nucleoforce® Performance (NFAO). Data with the same letter indicates no significant differences at $p < 0.05$.

Changes in final biomass, SGR, feed intake and FCR

After 56 days, all supplemented groups showed significantly (p<0.05) higher final mean weight, final biomass, mean weight gain, average daily gain and specific growth rate, compared to the control group (Table 2).

Marked improvements (p<0.05) in final biomass, specific growth rate (SGR), feed intake and feed conversion ratio (FCR) were observed in the NF500 and NFAO groups, compared to Control. Remarkably, shrimp in the NFAO group achieved the best production efficiency, with an FCR significantly lower (p<0.05) than that of the Control, NU and AO groups (Figure 3).

Additionally, shrimp in the NFAL group featured a significantly higher (p<0.05) feed intake (1,086.00 ± 14.26g) compared to the Control group (1,032.16 ± 10.91g) and compared to the NF (1,052.27 ± 0.42g) and AL (1,067.26 ± 14.06g) groups (Table 2).

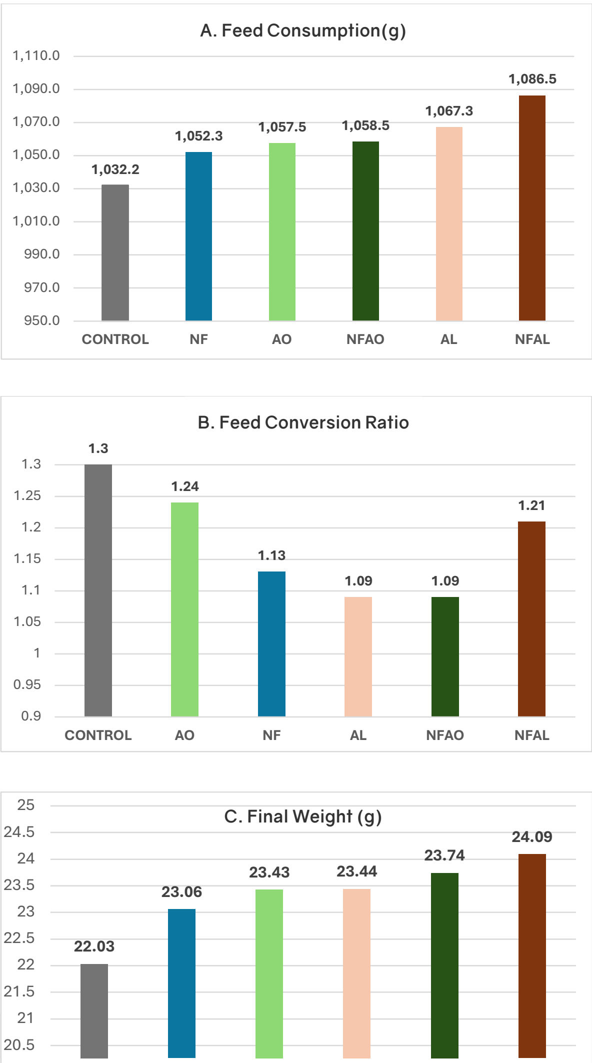

Figure 3. Results from the feeding trial in RAS over 56 days. A. Feed consumption, B. Feed conversion ratio (FCR) and C. Final weight. Treatment diets were supplemented with 500ppm Nucleoforce Aqua (NF); 500ppm seaweed meal (AL), 500ppm of olive extract (AO); 1,000ppm Nucleoforce® Immunity (NFAL) and 1,000 ppm Nucleoforce® Performance (NFAO).

Improvement in survival rates post challenge

Shrimp were monitored for 10 days post-challenge. After the 10-day challenge period, the Positive control (CP) group showed a significantly lower survival rate (30.63±4.70%) compared to the Negative control (CN) group (88.29±2.73%; p<0.05). The groups treated with nucleotides at 500ppm (33.95±9.62%), brown algae meal (41.02±5.82%) and olive extract (40.98±5.82%) showed a numerical improvement in survival rate compared to the CP group, while the combination of nucleotides + olive extract and nucleotides + brown algae showed a significantly higher survival rate (55,80±9.55% and 59.61±9.55%) compared to the CP group (Segarra et al. 2025, Figure 4.)

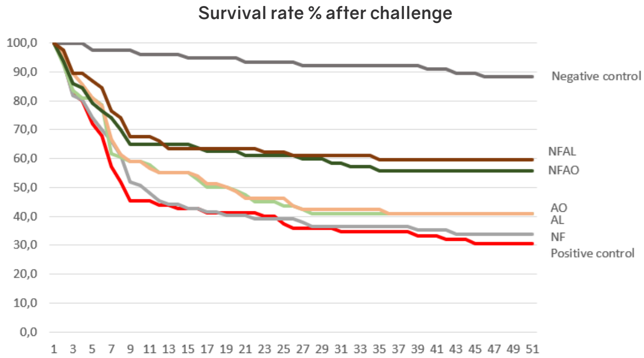

Figure 4. Changes in survival rate following the challenge with *Vibrio parahaemolyticus* (immersion method) over 10 days.

Following these results, Bioiberica has submitted a patent application, opening a very interesting line of research for the application of these compounds in the nutrition of other animal species.

We establish that supplementation with a specific combination of bioactive compounds derived from *Saccharomyces cerevisiae*, *Macrocystis integrifolia*, and *Olea europaea*, formulated to enhance shrimp performance and immunity, effectively improves growth parameters and reduces mortality in shrimp challenged with *V. parahaemolyticus*.

These functional nutrients support the health and resilience of Pacific white shrimp, contributing to more efficient and sustainable farming practices. The use of innovative, naturally derived ingredients supports a more sustainable approach to shrimp farming and promotes the utilisation of natural-origin raw materials that are aligned with the principles of a circular economy. This strategy offers a forward-looking alternative to conventional ingredients, reflecting the industry's dedication to health, quality, and operational efficiency throughout the value chain.

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Use of corn fermented protein in shrimp diets

Fishmeal-free diets showed feed cost per kg of shrimp decreased with increasing CFP content of the diet

By Scott Tilton, Julia Green, Callum McAree and John Hagios

Corn fermented protein is the newest feed product being produced by the fuel ethanol industry in North America. Historically, corn-based ethanol production resulted in the production of corn distillers dried grains with solubles (DDGS), and distillers corn oil as their animal feed co-products. However, a little over a decade ago the United States ethanol industry started to develop a technology to physically separate residual proteins from fibre to create improved animal feed products. Today, there are 17 plants in North America capable of producing a product that the industry is referring to as corn fermented protein.

Benefits of corn fermented protein

The industry term corn fermented protein (CFP) is being used to identify distillers dried grains that are above 48% crude protein (CP) on an as fed basis. The term CFP was developed by the Distillers Technology Council as one of the industry terms to better define products that fit under the current AAFCO feed ingredient definition 27.5 Corn Distillers Dried Grains. Products under this feed ingredient definition can currently range from about 26% CP to over 60% CP. For other distillers feed product terms refer to https://distillersgrains.org/distillers-grains/.

CFP is typically much higher in inactive yeast content than traditional distillers dried grains, as yeast is concentrated during the fibre separation process of CFP. This results in yeast making up approximately 20 to 24% of the product by weight, compared to 5-6% yeast in traditional DDGS. This increase in yeast content is due to yeast separating with the protein fraction during the process when fibre is removed.

Secondary benefits of the increased yeast concentration are improved amino acid profiles compared to other corn-based ingredients. For example, CFP contains about 80% more lysine, 55% more tryptophan, and 30% more arginine than corn gluten meal even though CFP only contains 50% protein compared, to typical US corn gluten meal which contains 60% protein.

CFP also has key advantages to offer compared to soybean meal. In addition to not containing antinutritional factors, it is slightly higher in protein (50% vs 44% to 48% for soybean meal). Corn products are also inherently higher in sulphur containing amino acids, such as methionine and cysteine than soybeans on a percent of protein basis. As such, corn fermented protein has about 50% more methionine and 35% more total sulphur containing amino acids than soybean meal.

Compared to many of the novel proteins entering the aquafeed market, such as single cell proteins and insect larval meals, CFP also has the advantage of scalability, as well over a million tonnes per year are being produced through the combined efforts of ethanol plants in North America.

Corn fermented protein in Pacific white shrimp diets

Due to the decreased fibre content, and high protein content of these CFP products, they have become widely used in aquafeeds for a variety of species including, but not limited to, Atlantic salmon, rainbow trout, European sea bass, tilapia, catfish, and Pacific white shrimp.

Extensive research has been conducted with 50% protein CFP products in *Litopenaeus vannamei*, with studies consistently showing equal or better growth performance and survival rates when replacing a variety of more expensive ingredients. Initial research with CFP was conducted by Qui et al. (2017), who evaluated a product from Flint Hills Resources in a series of three experiments either as a replacement for soybean meal or its combination with fish meal. Their work found that up to 30% CFP could be used in diets when exclusively replacing soybean meal, but when replacing a combination of fish meal and soybean meal only 18% CFP could be used before growth was reduced.

Focus on replacing ingredients other than fishmeal

Nazeer et al. (2022) evaluated feeding up to 20% CFP, ANDVantage™ 50Y (The Andersons, USA), in place of corn protein concentrate with no significant differences in growth, feed conversion ratio, or survival rates in an aquarium-based system. This 50% CP ingredient contains 80% more lysine and 30% more arginine than corn gluten meal, as well as 50% more methionine and 35% more total sulphur amino acids than soybean meal.

More recently the work of San Andres et al. (2025), evaluated replacement of a combination of soybean meal, and corn gluten meal in both a green-water large tank-based production system, and in a pond system. Diets contained 0, 5, 10, or 20% ANDVantage™ 50Y, a source of CFP. This was accomplished by reducing inclusion rate of corn gluten and soybean meals. Corn gluten meal decreased from 8% in the control diet to 6, 4, and 0%, and soybean meal decreased from 50% to 47%, 44% and 38% in the 0, 5, 10, and 20% CFP diets, respectively.

Diets were fishmeal-free and manufactured in a commercial feed mill. These diets were fed for 56 days in the tank system and 82 days in the pond-based production system. No differences were observed in final weight, weekly weight gain, percent weight gain, specific growth rate (SGR) or feed conversion ratio (FCR) in the tank study (Table 1). Similarly, no differences were observed in the pond-based production system, with shrimp increasing in individual weight from 0.032g to over 35g each during the 82-day feeding period. No differences were observed for final weight, growth per week, feed conversion ratio, survival, or yield per hectare (per Table 2). Due to reduced diet costs, feed cost/kg of shrimp produced decreased with increasing CFP content of the diet but was only statistically significant at the 20% inclusion level.

> "Multiple studies have shown that use of CFP to replace higher cost proteins or reduce fishmeal usage have significantly reduced feed cost with no change in growth performance."

Growth Performance		Inclusion rate of corn fermented protein, ANDVantage™ 50Y			PSE[1]
	Basal	5%	10%	20%	
Final average weight (g)	20.08	20.59	20.02	20.01	0.286
Average weight gain (%)	10,074	10,389	10,104	9,989	172
Weekly weight gain (g)	2.49	2.55	2.48	2.48	0.035
Survival (%)	98.35	94.18	99.18	99.18	2
Specific growth rate (SGR%)	8.25	8.31	8.26	8.24	0.03
Feed conversion ratio (FCR)	0.98	1	0.98	0.98	0.021
[1]PSE = pooled standard error					

Table 1. Growth performance of white shrimp (*Litopenaeus vannamei*) cultured in a green-water recirculating system fed diets with various levels of ANDVantage™ 50Y corn fermented protein over an 8-week experimental period. Shrimp were stocked at 30 per tank with an initial weight of 0.19 ± 0.006g.

	Basal	Inclusion rate of corn fermented protein, ANDVantage™ 50Y			
		5%	10%	20%	PSE[1]
Weight (g)[2]	35.12	36.43	35.14	35.38	0.697
Growth (g/week)	3.02	3.13	3.02	3.04	0.058
Feed conversion ratio	1.07	1.09	1.12	1.04	0.026
Survival (%)	97.67	88.75	91.95	97.23	2.72
Yield (kg/ha)	8,602	8,206	8,090	8,618	234
Total feed fed (kg/ha)	9,2122	8,899	9,042	8,918	167
Feed cost USD/kg	$1.23	$1.18	$1.16	$1.09	
Feed cost, USD/kg shrimp	$1.36[a]	$1.34[a]	$1.34[a]	$1.18[b]	0.031
Note: One-way ANOVA was run by diet type. Values with different superscripts within the same row are significantly different based on Tukey Pairwise Comparisons. [1]PSE = Pooled Standard Error					

Table 2. Performance of Pacific white shrimp (*Litopenaeus vannamei*) reared for 82 days in outdoor ponds stocked at 25 shrimp/m^2 and fed diets containing increasing levels of corn fermented protein. ANDVantage™ 50Y. Average initial weight of shrimp was 0.032g

Summary

While a recent entrant in the high protein ingredient market, CFP volumes have reached a point where they are a viable alternative ingredient for use in shrimp and aquaculture diets. They are high in inactive yeast content, resulting in a vastly improved amino acid profile compared to conventional DDGS or corn gluten meal. Multiple studies have shown that use of CFP to replace higher cost proteins or reduce fishmeal usage have significantly reduced feed cost with no change in growth performance. This has resulted in significant commercial interest in the use of the product.

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Know Your Animals: Feeding programs for optimising growth of balance line shrimp

By matching feeding programs to growth patterns, farmers can unlock the full potential of balance line shrimp for large harvest sizes

By Natthinee Munkongwongsiri and Craig L. Browdy

Success in shrimp farming depends not only on good management and water quality, but also on understanding the animals themselves. Shrimp from different genetic programs grow at different rates, respond differently to stress, and require tailored management strategies. A "one-size-fits-all" approach to feeding can lead to poor growth or unnecessary risk.

Balance line shrimp have been developed to combine resilience with strong growth potential. To unlock their full performance, farmers must understand how growth, resistance, and feeding programs interact — and adapt their management accordingly.

Growth and resistance: The biological trade-off

There is always a biological trade-off between fast growth and disease resistance. Shrimp that are pushed for rapid growth early in life may appear impressive in size, but this can come at a cost. The reason lies in how shrimp allocate energy among competing needs.

To grow, shrimp must go through a moulting process which consumes tremendous metabolic resources. Freshly moulted shrimp are more vulnerable to damage and infection. The faster the shrimp grow, the more they moult. The smaller the shrimp, the more often they moult. On a relative basis, small shrimp increase in size at a much faster rate than larger shrimp.

From post larvae to adult, shrimp have limited energy resources that must be shared between **growth, immunity**, and **stress response**. If too much energy is directed toward tissue growth, less is available for building and maintaining strong immune defenses. Shrimp rely solely on innate immunity, which can be easily suppressed by environmental, physical and physiological stressors.

The first month after stocking is a critical period where shrimp grow at a logarithmic pace, frequently doubling in size. It is a period of intense, cumulative stress that weakens the immune system, making shrimp more vulnerable to opportunistic pathogens. Early mortality syndrome (EMS) and diseases like highly virulent vibriosis occur during the first phases of shrimp culture.

Balance line genetics

Balance line shrimp have been selected for larger harvest weight. Moreover, the selection program emphasizes survivability as well as final weight. Selection indices focus on resistance to EMS at small sizes. After many years of selection running multiple batches of families per year, the program has resulted in today's balance line shrimp that are robust and grow more slowly at early stages when they are most vulnerable.

In the early stages — particularly during the first month after stocking, they follow a slower growth pattern enhancing their robustness and enabling the channelling of more energy into resilience. Once they reach around 7–8g, their physiology is stronger and more robust. At this stage balance line shrimp can accelerate growth rapidly. This physiological shift is clearly reflected in their growth curve and should guide feeding program design (Figure 1).

Growth curves and feeding programs: Linking the shrimp's needs to management.

Feeding is not simply about providing nutrition; it is about matching needs of the shrimp at each stage of development. A key to a successful crop is managing the pond environment. When shrimp are fed properly, water and pond bottom quality are better maintained, enabling improved overall outcomes.

Shrimp growth follows a predictable curve. In the early phase, growth is logarithmic. As they grow larger, the pattern becomes more linear and predictable.

- **Early stages (PL to ~3g):** At this stage, shrimp are vulnerable to disease. Feeding should prioritise resistance and metabolic stability with feeds emphasising digestibility, balanced nutrients, and consistent rations to avoid stress. Overfeeding can harm pond conditions and does not necessarily improve growth.
- **Transition phase (3–8g):** A critical turning point. Balance line shrimp begin to accelerate growth. Feeding rates should be adjusted upward and feed availability ensured to unlock genetic potential.
- **Grow-out phase (>10g):** Shrimp now convert feed into biomass very efficiently. When fed properly, a period of compensatory growth can be achieved followed by growth of 3-5g/week when fed effectively. Feeding programs should aim to maximise average daily gain (ADG). However, ever larger quantities of feed are going into the pond daily requiring careful feed management to maintain pond health.

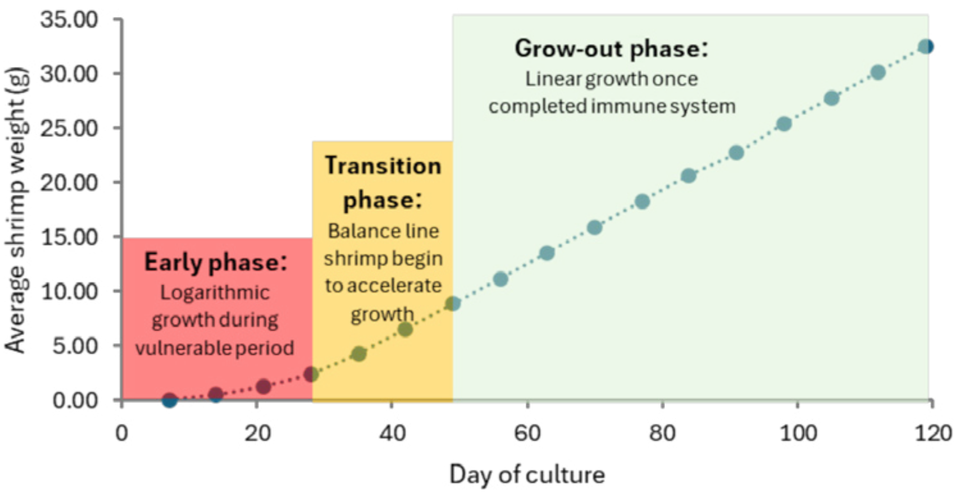

Figure 1. SyAqua's growth curve

Day of Culture	Average Body Weight (g)	Average Daily Gain (day)	%Body Weight	Feed (Kg) per day	Accumulated feed (Kg)	Estimated FCR
7	0.11	0.02	25.8	2.8	8	0.75
14	0.55	0.04	13.0	6.9	44	0.83
21	1.34	0.06	8.7	11.1	109	0.86
28	2.47	0.09	6.7	15.4	203	0.88
35	4.32	0.12	7.3	28.7	369	0.93
42	6.58	0.16	5.2	30.4	578	0.98
49	8.85	0.18	4.0	31.3	794	1.02
56	11.20	0.20	3.4	33.1	1,022	1.06
63	13.57	0.22	3.0	34.0	1,257	1.10
70	15.94	0.23	2.6	34.9	1,499	1.13
77	18.31	0.24	2.4	35.8	1,747	1.16
84	20.67	0.25	2.2	36.7	2,001	1.19
91	22.70	0.25	2.1	37.4	2,224	1.22
98	25.41	0.26	1.9	38.4	2,528	1.26
105	27.78	0.26	1.8	39.1	2,800	1.30
112	30.14	0.27	1.7	39.8	3,076	1.33
119	32.51	0.27	1.7	40.5	3,358	1.37

View the feeding guidelines.

Note: Feed requirements were calculated based on stocking of 100,000 post larvae.

Table 1. Relationship between growth and feed requirements by % body weight (%BW).

Feeding shrimp

Feed requirements can be calculated according to body weight. A simple procedure for farmers is to use body weight to estimate feed demand, standardised to account for both metabolic energy and growth. Since larger shrimp use energy more efficiently, their daily feed requirement as a percentage of body weight decreases (Table 1).

Although larger shrimp utilise feed energy more efficiently on a per-unit-weight basis, the total feed input to the pond increases as biomass accumulates. The percentage of feed relative to % body weight (% BW) decreases with size. However, total feed consumption per pond continues to rise. This growing metabolic load increases oxygen demand, waste production, and organic accumulation, all of which can affect water quality.

Consequently, even though feed conversion may appear efficient, feed conversion ratios (FCRs) gradually increase as ponds approach harvest size. This reinforces the importance of tight feed management, aeration capacity, and sludge removal during the later grow-out phase.

Implications for farmers

Here are some simple feed demand calculations.

- Simple feed demand calculation
  Daily feed (kg)
  = (body weight × %BW × shrimp number) ÷ 1,000
  Therefore for 100,000 shrimp averaging 15g:
  Daily feed = (15 x 2.8%) x 100,000) ÷ 1,000 = 42kg

Feed conversion ratio (FCR)

FCR can appear better or worse depending on the harvest size (Table 1). Comparing ponds harvested at different sizes can be misleading. To compare accurately, it is better to normalise FCR to a fixed target harvest weight.

Economic decisions

Knowing that growth of balance line shrimp accelerates after 8g helps farmers adjust feeding programs and harvest schedules to capture maximum performance. These principles form the basis for broader management strategies, where accurate shrimp growth feed consumption and health monitoring, tracking of water quality and pond conditions, and harvest planning – all these must remain aligned.

Management strategies for optimising performance

This brings together genetics, growth, and feeding leading to practical management guidelines for farmers.

Monitor growth benchmarks: Weekly weight checks to guide ration adjustments.

Feed adjustments: Match feed to shrimp size to avoid overfeeding while maintaining water quality.

Health monitoring: Even resilient lines need routine health checks to prevent setbacks.

Harvest planning: Consider market demand and target weight but remember that balanced line shrimp yields the best FCR and profitability when grown to larger harvest sizes.

By combining these practical strategies with an understanding of growth patterns, farmers can unlock the full performance of balanced line shrimp.

Conclusion

Shrimp farming is most successful when farmers truly understand their animals. By recognising the relationship between growth and resistance, understanding shrimp growth curves, and tailoring feeding programs accordingly, farmers can achieve stronger performance and better profitability.

"Know your animals" is more than a slogan; it is the foundation for optimising shrimp farming results.

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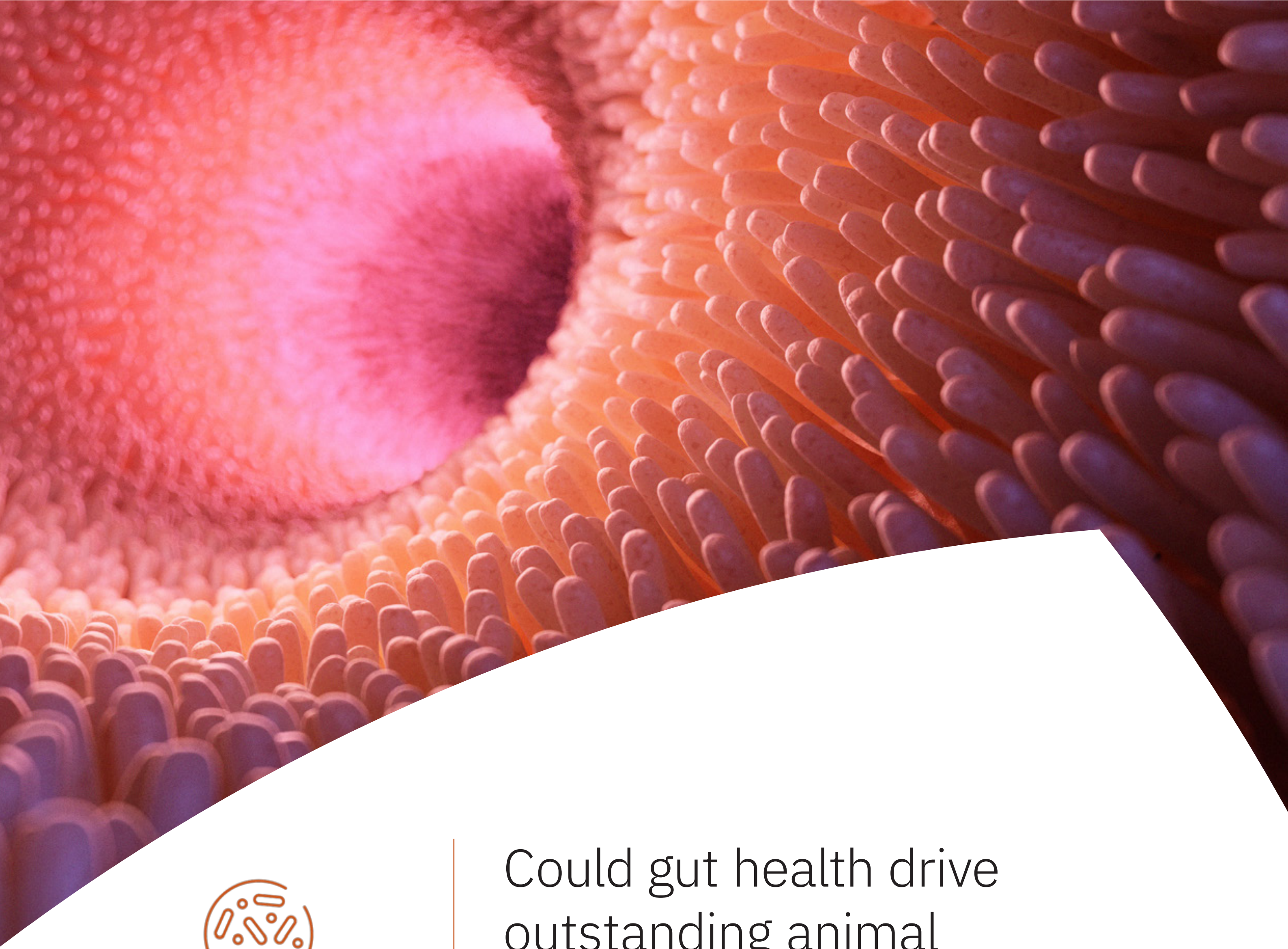


Tailoring probiotic strategies for *Vibrio* management in shrimp larviculture

Strategic probiotic use can dramatically reduce pathogenic bacteria while accelerating larval development in Pacific whiteleg shrimp

By Siriwan Khidprasert, Chanadda Kasamechotchung, Rungkarn Suebsing, Kallaya Sritunyalucksana, Olivier Decamp, Andrew P. Shinn, Ratchakorn Wongwaradechkul and Barbara Hostins

In the high-stakes world of shrimp aquaculture, where disease outbreaks can devastate entire production cycles, hatchery managers face a constant battle against pathogenic *Vibrio* bacteria. New research on a commercial probiotic formulation from INVE Aquaculture offers promising evidence that the right probiotic strategy can significantly reduce these disease-causing organisms while simultaneously improving larval development without compromising shrimp health or survival.

The *Vibrio* problem

For shrimp producers worldwide, *Vibrio* species represent an ever-present threat. These opportunistic pathogens that are responsible for devastating diseases including acute hepatopancreatic necrosis disease (AHPND) and translucent post larvae disease (TPD), can cause mortality rates exceeding 70-100% in affected facilities. The larval development period is particularly vulnerable, as larval and juvenile shrimp are highly susceptible to changes in environmental conditions, feed quality, and bacterial infections - all factors that can lead to poor development, mass mortalities, and significant economic losses.

Antibiotics are no longer used in shrimp aquaculture because of concerns over antimicrobial resistance, residue contamination, and export restrictions that demand antibiotic-free production. Concerns regarding antimicrobial resistance and sustainability have driven the industry to seek alternatives. Probiotics - beneficial bacteria that can improve water quality, maintain healthy gut microbial communities, and inhibit pathogenic bacteria - have emerged as a leading candidate. Yet questions remain about optimal dosing strategies and the benefits producers can expect at different application rates.

Evaluating probiotic dosage strategies in shrimp hatcheries

A recent investigation conducted in Thailand assessed the impact of multiple concentrations of Sanolife® MIC (S-MIC), a commercial probiotic formulation comprising *Bacillus subtilis*, *B. licheniformis*, and *B. pumilus*, on Pacific whiteleg shrimp, *Penaeus vannamei* development from the nauplius stage to post larval stage 15 PL15. This 23-day period represents the most critical phase of larval growth.

Researchers tested three probiotic concentrations against an untreated control group (T1), using twelve 300L- tanks with 50,000 nauplii each. The concentrations represented different industry scenarios.

a) 1g/m^3/day which is the manufacturer's recommended routine dosage (T2);

b) 5g/m^3/day, commonly used during challenge conditions, particularly when managing *Vibrio* outbreaks (T3); and,

c) 30g/m^3/day based on usage reports from Latin American hatcheries facing severe disease pressure (T4).

The breakthrough finding: *Vibrio* control

The most striking and consistent result emerged from microbial analysis: all three probiotic concentrations dramatically reduced *Vibrio* bacterial counts in both culture water and shrimp larvae across all developmental stages. At the crucial PL15 stage, when many post larvae shipments are transferred to grow-out farms, the difference was striking: *Vibrio* levels in probiotic-treated groups were 2.1 to 4.6 times lower than in the untreated control.

"Lower *Vibrio* loads at the end of the hatchery phase mean reduced risk of disease transmission when larvae are transferred to grow-out."

This reduction was not isolated to a single developmental phase. From the zoea stage through mysis and into post larval development, probiotic supplementation consistently suppressed *Vibrio* populations. At the mysis I stage, the highest probiotic concentration (30g/m^3/day) showed significantly lower *Vibrio* counts than the lower concentrations. By PL1 stage, both the 5g/m^3/day and 30g/m^3/day groups demonstrated significantly lower counts compared to untreated controls.

The implications are profound. Lower *Vibrio* loads at the end of the hatchery phase mean reduced risk of disease transmission when larvae are transferred to grow-out systems. Since disease outbreaks often originate from contaminated post larvae, this prophylactic reduction in pathogenic bacteria could significantly decrease the incidence of devastating diseases like AHPND and TPD in production facilities.

Faster development at low doses

Beyond microbial control, the study revealed concentration-specific benefits for larval development. The lowest concentration (1g/m^3/day) significantly accelerated the progression from mysis stage to post larval stage 1 (PL1), a critical metamorphic transition. On day 9 of the trial, only 11% of larvae in the control group had reached PL1, compared to 17% in the 1g/m^3/day group—a statistically significant difference that persisted through day 10.

This acceleration has practical value for commercial operations. Faster development to post larval stages improves production efficiency and reduces the time larvae spend in vulnerable early stages. Every day saved in the hatchery translates to cost savings and reduced risk of disease outbreaks during the most critical development period.

The mechanism behind this accelerated development likely involves enhanced nutrient availability, as *Bacillus*-based probiotics are known to improve digestive enzyme production and nutrient absorption. Additionally, these beneficial bacteria produce antimicrobial compounds including bacteriocins, lipopeptides, and organic acids that can inhibit pathogens while promoting beneficial microbial communities.

Growth benefits at higher concentrations

While the lowest concentration excelled at accelerating development, higher concentrations showed different benefits. At the PL6 stage, larvae treated with the highest concentration (30g/m^3/day) were significantly heavier than those receiving the lowest dose. Although this weight advantage was not maintained through PL15, suggesting some compensatory growth in other groups over time, the early growth boost may still contribute to production efficiency by improving larval uniformity and reducing size variation within cohorts.

This pattern suggests a threshold effect: very low probiotic concentrations may be insufficient to stimulate significant weight gain during early post larval stages, while moderate to high concentrations (5-30g/m^3/day) provide measurable growth benefits.

Safety confirmed across all doses

Importantly, comprehensive quality assessments confirmed that probiotic supplementation posed no risks to larval health. No morphological deformities were observed in any treatment group. The muscle-to-gut ratio - a key indicator of nutritional status and development—showed no significant differences among groups, indicating that probiotics enhanced certain parameters without disrupting normal physiological proportions.

Survival rates at PL15 ranged from 85-87% across all groups, with no significant differences between treatments. When subjected to an industry-standard salinity stress test (transfer from 30ppt seawater to freshwater for 30 minutes), all groups exhibited exceptional tolerance with post-stress survival rates between 98-99.5% - well above the industry benchmark of 75% for high-quality post larvae.

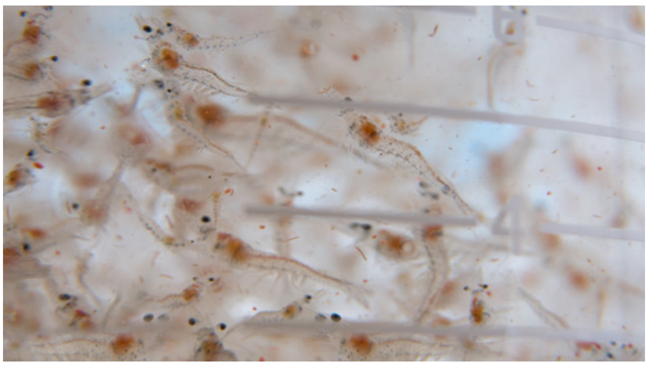
Oil droplet concentrations in the hepatopancreas, an indicator of nutritional status and metabolic health, were similarly consistent across all treatments (98-99.4%). These results demonstrate that S-MIC supplementation provides benefits without compromising the physiological robustness required for successful pond stocking.

Practical applications

The study's findings support flexible, objective-driven probiotic strategies in commercial hatcheries:

- For accelerated development: The 1g/m^3/day concentration effectively speeds progression to PL1 stage, improving production efficiency without additional costs associated with higher doses.
- For enhanced growth and maximum *Vibrio* control: Concentrations of 5-30g/m^3/day provide stronger growth benefits at PL6 and the most substantial reductions in pathogenic bacteria - particularly valuable during high-risk periods or in facilities with recurring vibriosis challenges.

The dose-dependent nature of *Vibrio* control gives hatchery managers flexibility to adjust concentrations based on historical disease pressure and risk assessment. During periods of heightened disease risk, higher concentrations can provide additional protection, while routine operations may achieve adequate benefits with lower, more economical dosing.



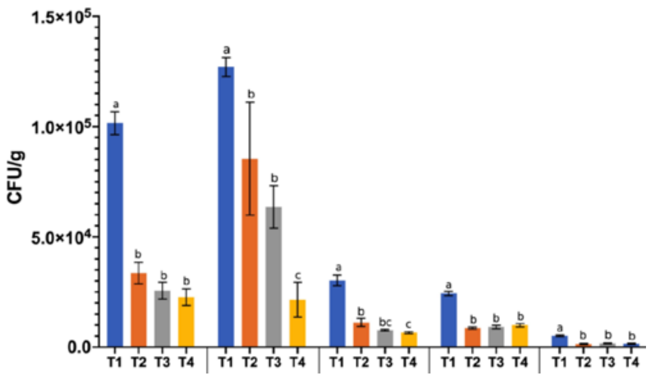


Figure 1. Comparison of total *Vibrio* counts in *Penaeus vannamei* larvae reared in culture water supplemented with different concentrations of Sanolife® MIC, relative to an unsupplemented control, throughout larval development. Treatments: T1 = control (no probiotic); T2 = 1g/m^3/day; T3 = 5g/m^3/day; T4 = 30g/m^3/day.

Understanding the mechanism

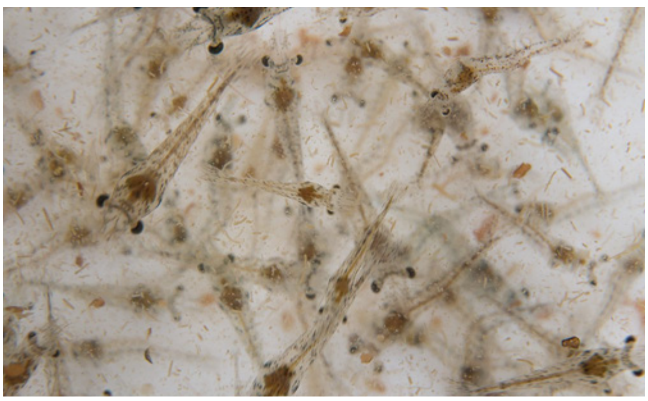
How do these *Bacillus*-based probiotics achieve such consistent results? The answer lies in multiple complementary mechanisms. *Bacillus* species produce diverse antimicrobial compounds that directly inhibit pathogenic bacteria. They also compete with harmful organisms for nutrients and colonisation sites in the larval gut and surrounding water.

Perhaps most importantly, *Bacillus* probiotics stimulate both innate and adaptive immune responses in shrimp, enhancing phagocytic activity, phenoloxidase activity, and antimicrobial peptide production. This immune stimulation, combined with antimicrobial compound production, provides comprehensive protection against disease while supporting overall larval quality.

The probiotics' spore-forming capability offers practical advantages as well: greater survival under varying environmental conditions and longer shelf life compared to non-spore-forming bacterial supplements.

Looking forward

This research provides strong evidence supporting the benefits of probiotic supplementation in shrimp hatcheries, demonstrating how targeted probiotic strategies can enhance larval performance and reduce pathogen pressure. Beyond improving hatchery outcomes, probiotic use also supports a reduction in antibiotic dependence - an increasingly important goal as the aquaculture industry aligns with global efforts to combat antimicrobial resistance and meet consumer demand for responsibly and sustainably produced seafood.



Conclusion

This research demonstrates that strategic probiotic supplementation with Sanolife® MIC offers shrimp hatcheries a practical, safe, and effective tool for improving production outcomes. The dramatic reduction in *Vibrio* bacteria - 2.1 to 4.6 times lower at the critical PL15 stage - addresses one of aquaculture's most persistent challenges. Combined with accelerated development at low doses and enhanced growth at higher concentrations, these benefits can be achieved without compromising survival rates, stress resistance, or physiological health.

For an industry seeking sustainable alternatives to antibiotics while maintaining biosecurity and production efficiency, probiotics represent more than just a supplement – they are a strategic tool for breaking the cycle of disease pressure that has long challenged shrimp aquaculture. The key lies in understanding that different concentrations serve different purposes, allowing producers to tailor their probiotic strategy to their specific operational needs and disease risk profiles.

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EHP risk profiling at scale: Fast and accurate insights

Enterocytozoon hepatopenaei remains a silent yet pervasive threat to shrimp aquaculture worldwide. Now, a new breakthrough brings unprecedented speed and insights to manage its risk

By Ngoc Minh Ngan Bui and Ruben Props

Silent but pervasive threat to shrimp aquaculture

White faeces disease (WFD) has emerged as a significant threat to shrimp aquaculture, characterised by floating white faecal strings and pale midguts in affected animals. One of the causative agents of WFD is *Enterocytozoon hepatopenaei* (EHP), a microsporidian parasite responsible for hepatopancreatic microsporidiosis (HPM). First identified in Thailand in 2004, EHP has rapidly spread across major shrimp-producing regions in Southeast Asia and Latin America.

Although EHP infections rarely result in acute mortality, their chronic impact on shrimp health and farm productivity is profound. Infected shrimp exhibit poor growth performance and reduced feed conversion efficiency. This leads to uneven size distribution, extended production cycles, and diminished harvest value. The economic losses caused by EHP alone were estimated to be USD~560 million in India (2018-2019) and USD~230 million in Thailand (2018). As the pathogen continues to spread, its management has become a focal point for the industry to sustain the viability of shrimp farming operations.

> **"Symptoms are often absent or mild in early stages, infections frequently go unnoticed until performance losses become apparent."**

Persistent and tiny spores

The biological characteristics of EHP add to its threat. Its oval spores, measuring approximately 1.1–1.7µm X 0.7–1.0µm, can persist in pond water, sludge, and organic matter even under harsh environmental conditions. Once a shrimp is infected, (im)mature spores multiply in the hepatopancreas and are shed via faeces, rapidly seeding the pond environment and contributing to pond-wide transmission. Compounding the challenge is EHP's subclinical progression; symptoms are often absent or mild in early stages, which means infections frequently go unnoticed until performance losses become apparent.

A new early-warning tool: EHP indicator

Recent studies suggest that environmental EHP levels in pond water and sediment are linked to infection levels in shrimp. Active outbreaks showed spore loads ranging from as little as 10^1–10^3 DNA copies/mL of pond water. This underscores the potential of pond water monitoring as an early-warning system.

By tracking the mature spore concentrations released via the faeces, over time, farmers can detect rising infection pressure before clinical symptoms appear. However, this proactive approach depends on highly sensitive, rapid and cost-effective tools capable of detecting mature EHP spores in complex pond environments.

As ingestion of mature EHP spores forms the main risk factor for infection, measurements of this specific *phenotype* of EHP, are a crucial piece of information to enable its effective management. Here, we describe the development and application of a new EHP mature spore indicator for rearing environments of hatchery and farm environments in Vietnam and Thailand.

Capturing information on single EHP spore

At the core of the EHP Indicator is KYTOS' proprietary single-cell analysis platform (Figure 1), which merges advanced microbiological profiling with machine learning to create predictive indicators. The process begins with the analysis of purified reference material from infected *Penaeus vannamei*, which is then analysed on the KYTOS platform to capture information on every single EHP spore particle.

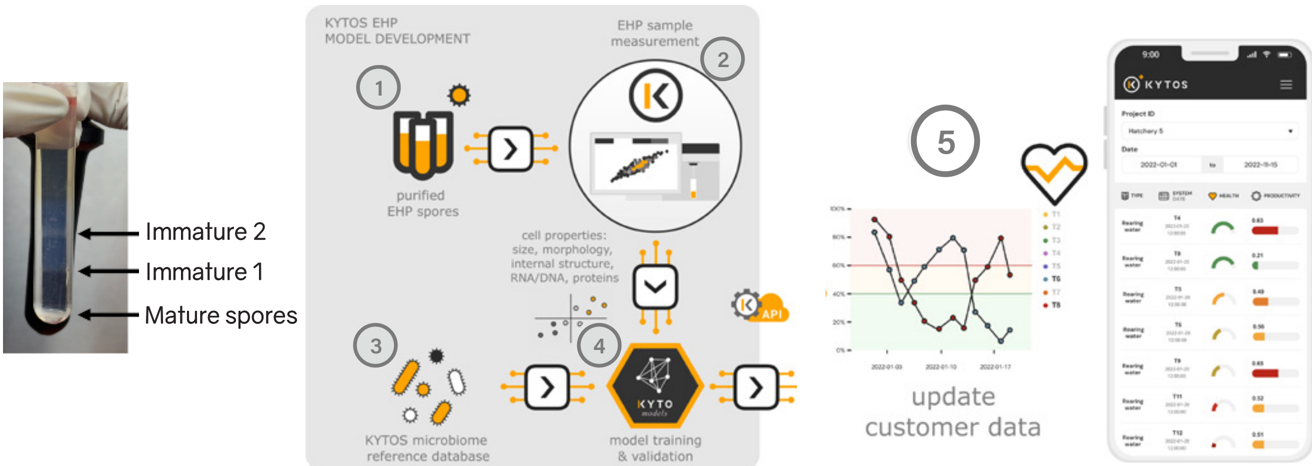

Figure 1. Overview of the machine learning workflow used to train KYTOS KytoML models for detecting mature EHP spores in environmental samples. (1) Purified spores were isolated from diseased animals by researchers at Chulalongkorn University and separated into immature and mature fractions. (2) These spores were labelled and analysed on KYTOS single-cell analysers using proprietary protocols. (3) Reference microbiomes from shrimp aquaculture environments were incorporated into model training. (4) Machine learning models were optimised to classify and quantify mature spores in environmental contexts. (5) Customer microbiome datasets were then updated using the novel EHP detection and quantification algorithm.

Proprietary machine-learning workflows are then used to fine-tune models capable of detecting these mature EHP spores in the presence of naturally occurring microbiota from shrimp ponds and hatcheries. In our case, this training data comprised more than 600 million single-cell data points from shrimp ponds (water, gut and hepatopancreas) and yielded highly robust model accuracy (99.5 %) and overall performance (Table 1).

Performance metrics	Performance value (Water)
Balanced accuracy	99.5% ± 0.08%
F1 score	100.0% ± 0.004%
Precision	100.0% ± 0.007%
Sensitivity	100.0% ± 0.005%
Specificity	99.1% ± 0.15%
Limit of detection (LOD)	81 cells / sample
Limit of quantification (LOQ)	123 cells / sample

Table 1. Performance metrics for KytoML models computed from test folds generated via 10×10 repeated cross-validation.

Rapid insights for farmers

The beauty of this approach is that through a simple software update, these predictions can be made available to all customer data analysed by the Kytos platform. The EHP Indicator quantifies mature spore loads and embeds them within a predictive framework, enabling farmers to detect infection pressure before visible symptoms arise. By providing early warning, it empowers shrimp producers to make informed management decisions, from strengthening biosecurity and adjusting feeding strategies to applying targeted pond interventions.

Delivered through the Kytos platform, the dedicated EHP dashboard transforms complex microbiome data into clear, actionable insights: spore density trends are visualised in real time, benchmarked against an extensive country-specific database and contextualised to distinguish background levels from critical infection thresholds (Figure 2). A continuous monitoring of pond water and shrimp tissue allows producers to detect deviations from baseline microbial conditions, anticipating outbreak risks with time to intervene.

This data-driven approach shifts disease management from reactive treatment to proactive prevention, resulting in improving crop outcomes, reducing economic losses, and enhancing sustainability. Integrated into a broader microbiome analysis service, the EHP Indicator is complemented by more than 25 additional indicators spanning bacterial, algal, and fungal groups, providing a comprehensive view of pond health.

Each sample can be analysed in under one minute, delivering all indicators - including EHP risk markers - with rapid turnaround, automated updates, and seamless digital access. Its strength lies in detecting mature spores rather than residual DNA, leveraging single-cell analysis and AI-powered models trained on over 100,000 aquaculture samples, and validated across thousands of real-world shrimp datasets. Robust to pond variation, geographic diversity, and farming practices, the EHP Indicator delivers accuracy, scalability, and real-time feedback, turning microbiome data into practical tools to achieve more profitable shrimp farming.

Cross-country differences in spore loads

Using this new model, EHP mature spore predictions were made on data of farms in our early-testing program to evaluate differences across geographical and market segments (Figure 3).

Figure 2. As a newly introduced feature among the more than 25 indicators generated by the KYTOS platform, the EHP risk markers are displayed in a dedicated dashboard within the KytoApp. The dashboard uses intuitive colour coding to highlight risk levels, enabling farmers to benchmark their EHP status against country-specific databases and to monitor changes in abundance over time.

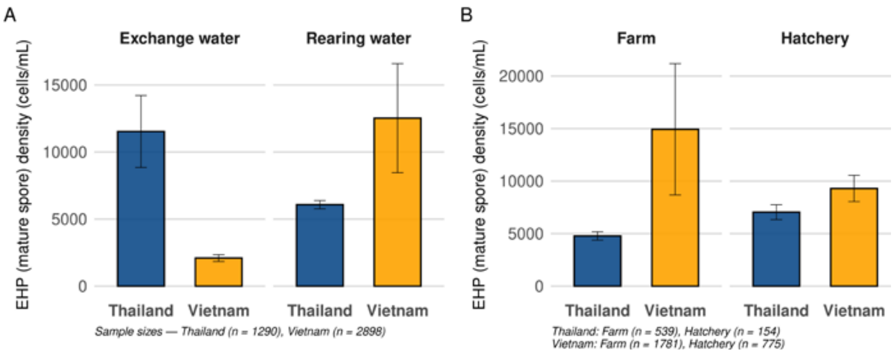

Figure 3. (A) Comparison of average predicted densities of mature EHP spores in exchange water and rearing water from shrimp farms in Thailand and Vietnam. (B) Comparison of average predicted densities of mature EHP spores in rearing water from shrimp farms and hatcheries in Thailand and Vietnam. Data were derived from selected customers participating in the early-testing program. Error bars represent standard deviations on the mean.

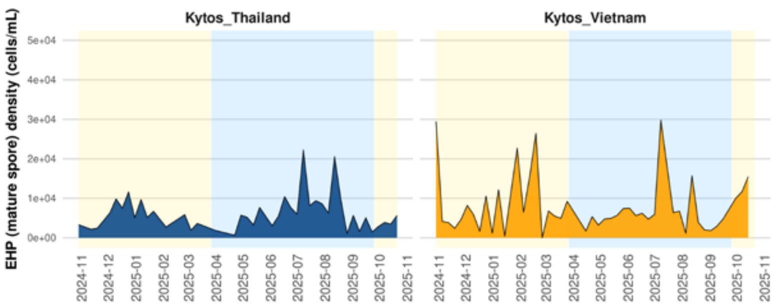

Figure 4. Seasonal trends in weekly average predicted densities of mature EHP spores in rearing water from shrimp aquaculture ponds in Thailand and Vietnam over a two-year period. Areas indicate the absolute abundance of each country to the weekly average. Data were collected from selected customers participating in the early testing program. Coloured background regions highlight dry and rainy seasons.

In Thailand, aggregated data indicated considerably higher EHP levels in exchange water than in rearing water, suggesting that incoming water may serve as an important contamination source. In contrast, Vietnamese farms exhibited much lower EHP densities in exchange water, likely reflecting the widespread application of stronger disinfection and water-treatment protocols. Nevertheless, EHP concentrations increased sharply in rearing water, pointing to internal amplification during culture despite clean water inputs.

At the production stage level, hatchery samples from Vietnam tended to show higher EHP spore densities than those from Thailand, potentially contributing to the elevated loads later observed in farm systems. These patterns underscore the critical link between hatchery biosecurity, post larvae (PL) quality, and the downstream risk of EHP outbreaks in grow-out ponds. Identifying the points at which contamination is most likely to occur provides a basis for targeted preventive measures that safeguard shrimp health and improve production performance.

EHP changes with seasons

Seasonal patterns in EHP spore densities revealed clear geographical differences between Thailand and Vietnam (Figure 4). In both countries, EHP levels fluctuated across dry and rainy seasons, reflecting the influence of environmental conditions and management practices on microbial risks in shrimp ponds. Thailand displayed more stable yet persistent EHP signals throughout the year, whereas Vietnam showed greater volatility during the dry season. These trends highlight the interaction between seasonality and water management in shaping pathogen pressure.

To capture these dynamics more effectively, the Kytos team updates its microbial monitoring database continuously. This growing dataset enables the identification of emerging trends, local risk periods, and region-specific responses to management practices.

By collaborating closely with industry stakeholders, Kytos translates microbial insights into practical recommendations that support early detection and farm management. Continuous monitoring not only reveals how EHP behaves across seasons but also empowers producers to make informed, data-driven decisions that enhance shrimp health, improve production outcomes, and build long-term resilience.

Acknowledgments

The development of the EHP Indicator is the result of the collective efforts of KYTOS teams in Belgium, Thailand, and Vietnam, whose dedication and creativity were instrumental in bringing this innovation to fruition (Ruben Props, Bui Ngoc Minh Ngan, Doan Dang Quynh, Hoang Truc Linh, Waraporn Tongyos and Tita). This work was supported by the Flanders International Climate Action Programme (FICAP) through the project "Sustainable Water Management for Aquaculture in Southeast Asia through Innovative Microbial Management" (IKF 23/059).

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The economic toll of EHP outbreaks in shrimp farming

A deeper analysis shows that the impact on costs goes beyond increases in feeding the shrimp

By B. Ravikumar, Dinewsri Devupalli, Krishna Varma G, Narayana Murthy Kada, Srujana Mogalpuri and Chandhirasekar D

Size variation and retarded growth are the typical symptoms of an outbreak of Enterocytozoon hepatopenaei or EHP.

Shrimp aquaculture has been a pillar of economic growth in several Asian countries, yet beneath the surface lurks a formidable threat, *Enterocytozoon hepatopenaei* (EHP). Unlike pathogens that cause visible mass mortalities, EHP operates quietly, gradually undermining farm profitability through less obvious but significant impacts on shrimp growth and yield.

The nature of EHP and its impact

EHP is a microsporidian parasite that targets the shrimp hepatopancreas, a key organ responsible for digestion and nutrient absorption. Rather than causing immediate death, EHP infections primarily result in stunted growth and large size variations at harvest. These translate directly into economic losses, as farmers deliver smaller shrimp, often missing premium market opportunities.

Economic consequences

The chronic presence of EHP leads to several detrimental outcomes for shrimp farmers, which include:

- Extended crop cycles which increase feed and labour costs.
- Higher feed conversion ratios (FCRs), demanding more input per cycle of shrimp production.
- Uneven shrimp size and shrimp not reaching target market size complicate marketing and reduce overall sales value.
- Additional investments in diagnostics, feed supplements, and pond management further strain financial resources.

Quantitative assessments, particularly from major production zones, such as Andhra Pradesh, reveal economic losses due to EHP which may exceed 20-30% of typical profit margins. This scale of loss sums up to hundreds of millions of rupees annually, threatening both individual farm viability and resilience within the broader industry.

Enhanced management strategies for controlling EHP

Effectively managing EHP requires a comprehensive approach that integrates preventive, regular monitoring, and remedial measures tailored to the unique challenges this pathogen presents. Since EHP is a chronic resilient parasite that rarely causes acute mortality, early detection and proactive management are crucial to minimise economic losses.

Pond preparation and biosecurity

Steps taken to ensure proper pond preparation and biosecurity include:

- Thorough elimination of residual pathogens and minimising infection risks during pond preparation.
- Complete drying and sun exposure during pond dry-out periods to help reduce pathogen load in the sediment.
- Application of lime and appropriate disinfectants to neutralise spores and improve pond water quality.
- Use of biosecurity protocols such as restricting farm access, controlling equipment sharing, and adopting other inputs to minimise contamination risks.
- Management of water source like using filtered or treated water to reduce introduction of EHP spores and other pathogens.

Shrimp size (g)	Frequency of tests	Wet mounts	PCR
0-5	Weekly to once in 2 weeks	Weekly faecal smears or HP/ intestinal wet mounts to check on early signs.	Every 2 weeks during nursery/early grow-out to detect subclinical infections
6-10	Twice weekly to once in 2 weeks	Two times weekly wet mounts (HP squash and faecal/ intestinal smears) for rapid on-farm screening intestinal wet mounts to check on early signs.	Every 2 weeks; increase to weekly if clinical signs are present (e.g., pale HP or reduced feed intake)
11-15	Twice weekly to once in 2 weeks	Twice weekly wet mounts to track onset/progression; confirm any suspicious fields with PCR	Every 2 weeks, maintain high frequency through this growth-sensitive window.
16- 20	Twice weekly to once in 2 weeks	Twice weekly wet mounts: increase frequency if white faecal strings or WFD is present in pond	Every 2 weeks under normal risk; shift to weekly upon signs until stability returns

Table 1. Recommended frequency of shrimp health monitoring and diagnostics during a crop cycle. HP= hepatopancreas

Regular health monitoring and early diagnosis

EHP Infections often remain undetected until harvest, hence, routine monitoring is indispensable. Measures taken include:

- Visual assessments for growth reduction and uneven size distribution, which serve as initial warning signs.
- Scheduled sampling of shrimp hepatopancreas tissues for microscopic observation (wet mount) and molecular testing (PCR/RTPCR) helps in early detection. (Table 1).

Nutritional and functional feed interventions

Nutritional intervention is increasingly recognised as a key component in managing EHP and reducing its economic impact on shrimp farming. Functional feeds not only fulfil the nutritional requirements of shrimp but also deliver bioactive compounds that modulate immunity, enhance gut health, and improve resilience against pathogens.

Recent advances have demonstrated the potential of targeted feed formulations such as Nutriva Plus (Growel, India), which incorporates bioactive ingredients designed to reduce pathogen pressure and improve host defence mechanisms. The functional components of this feed operate through multiple mechanisms, which include:

- Strengthening of intestinal integrity reduces the adverse effects of pathogen-derived toxins.
- Immune system modulation helps to maintain shrimp in a heightened state of readiness against infection.
- Direct antimicrobial action, with certain compounds capable of inactivating or disabling pathogens.
- Improved feed intake and nutrient utilisation, ensuring effective delivery of health-supportive compounds.

When integrated with husbandry measures such as water quality management, stocking density based on carrying capacity of the pond, and strict biosecurity protocols, functional feeds like Nutriva Plus represent a practical approach to mitigating EHP-related losses.

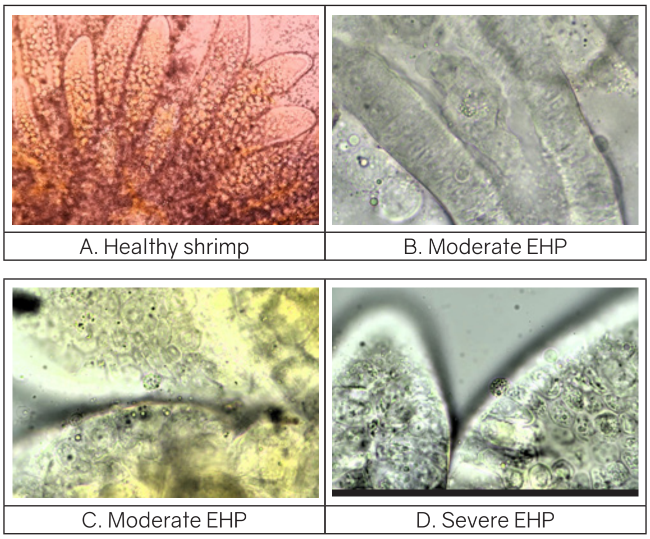


Figure 1. Histology of hepatopancreas (HP) tubules shows evidence of EHP infections, as compared to healthy shrimp. A. Healthy shrimp: Tubules are tightly arranged, full epithelium, intact basement membrane, star-shaped lumen. B&C. Moderate EHP: There is mild to moderate tubule atrophy with vacuoles between tubules. There are exfoliated cells and damaged basement membrane visible. D. Severe EHP: In severe cases, there is severe tubule atrophy, loose structure, severely damaged basement membrane, massive sloughing of epithelial cells, large vacuoles, spore clusters visible.

Water quality management

The shrimp pond with ideal water quality parameters (Table 2) and regular applications of water and soil probiotics, for bioremediation will minimise stress and pathogen proliferation.

Managing EHP outbreaks in Andhra Pradesh

Recent times have seen shrimp farmers across key districts of Andhra Pradesh grappling with escalating challenges from EHP infections, resulting in significant production decline and economic losses.

Mapping the impact

We conducted a comprehensive questionnaire-based survey over the past year across Krishna, East Godavari, and West Godavari districts—major shrimp farming regions of Andhra Pradesh. The survey covered more than 145 shrimp farms, including both healthy and EHP-affected farms, each operating under the region's standard 2–4 crop annual cycle. The study relied on the Growel 360° app to capture and organize all pond-level data.

EHP infection status

Of the 145 farms surveyed, 93 (64%) showed signs of EHP infections during the year. Only 52 farms (36%) remained unaffected, suggesting either successful implementation of preventive measures or just limited exposure to microsporidium. The high infection rate underscores the urgent need for coordinated disease management and biosecurity protocols across the region.

Categorising severity of infection

Based on field observations, EHP-affected ponds were classified into three categories:

Healthy shrimp: No visible signs of infection, optimal growth, and feed conversion.

Moderate EHP: Shrimp showed signs of stunted growth, moderate size variation and reduced feed efficiency.

Severe EHP: Severe growth retardation, high mortality, high size variation and significant economic loss.

Parameter	Recommended range	Relevance to EHP Control
Temperature	28°C–30°C	Ideal for growth and immune function; below 26°C or above 30°C increases susceptibility to WSSV and *Vibrio*
Dissolved oxygen (DO)	≥ 5.0mg/L	Critical for metabolism and stress reduction
Salinity	15-25ppt	Stable salinity supports gut health and microbial balance
pH	7.5-8.5	Maintains enzyme activity and reduces physiological stress
Total alkalinity	120-160mg/L	>80 mg/L is minimum; Buffers pH fluctuations and supports microbial stability
Total ammonia-N	<1.0mg/L	Ammonia above 1ppm increases shrimp metabolic stress and vulnerability to EHP; chronic exposure reduces growth and increases secondary infections
Unionised ammonia	<0.1mg/L	Most toxic form; elevated with high pH/temperature
Nitrite	<0.2mg/L	Elevated nitrite disrupts oxygen transport, aggravating stress, and disease severity

Table 2. Recommendations on water quality parameters for ideal growth and immune function.

Distinct impacts of EHP on production costs

In farms affected by EHP, pond preparation has become more intensive and costly. Activities such as tillage and soil preparation with tractors, bleaching, and liming critical for disinfection, are now performed more rigorously to eliminate residual spores and prevent reinfection.

Our study revealed a 15% to 28% increase in pond preparation costs depending on the severity of EHP in infected ponds compared to healthy ones. This escalation is driven by the need for enhanced cleaning protocols between crop cycles, often requiring additional labour and materials.

More rigorous diagnostic approach for EHP detection

To assess the presence of EHP, a structured diagnostic protocol was followed:

- Preliminary observations: Field technicians examined shrimp for visual signs of EHP, including growth retardation, pale hepatopancreas, white faeces, and poor feed conversion.
- Wet mount microscopy: Suspected samples were screened under a wet mount to detect microsporidian spores in hepatopancreatic tissue.
- Confirmation with RT-PCR: Molecular confirmation was performed using reverse transcriptase polymerase chain reaction (RT-PCR), ensuring high sensitivity and specificity in detecting EHP DNA.

Using a classification of pond health status based on RT-PCR results and cycle threshold (CT), ponds were categorised into three health status groups.

- **Healthy pond:** No detectable EHP infection.
- **Moderately infected ponds:** CT > 25
- **Highly infected ponds:** CT < 25

This classification enabled targeted analysis of production costs and disease impact across varying infection levels.

	Healthy shrimp	Moderate EHP	Severe EHP
Hepatopancreas (HP)	Normal size, firm texture, tan brown to dark orange colour; lumen small and star-shaped	HP begins to be pale, slight atrophy, size reduction; may appear softer	Pale white yellowish, markedly atrophic, soft and friable texture, atrophy in HP.
Clinical signs	No clinical signs; normal behaviour, feed intake, and faecal appearance	Intermittent white faecal strings, reduced feed intake (noticeable drop in feeding trays)	Persistent white faeces (floating strands accumulate at pond edges) with poor feeding, lethargy, anorexia, loose cuticle in dead/ moribund animals, black spots on body.
Body weight & size variation	Uniform size distribution; low coefficient of variation (CV) <15%; normal weight aligned with days of culture (DOC)	Moderate size variation (CV 15–25%); smaller animals begin to appear in population; growth lags DOC benchmarks	High size variation (CV >25%); extreme runts; harvested at 120–140 DOC with counts of 40–60/kg vs. normal 70–90 DOC and 50–70/kg
Average daily growth (ADG)	Normal ADG: 0.20–0.28g/ day (varies by system and feed)	Reduced ADG: 0.10–0.18g/day (~20–50% reduction); growth slowed from ~second month onward	Severely reduced ADG: <0.10g/day or near-zero
Spore detection (wet mount)	None or very rare spores; PCR may be positive at subclinical levels	Moderate spore presence in HP tubule lumen and faeces; plasmodia visible	High density of spores in HP lumen, faeces (white faeces contain abundant spores)
EHP infection Index (EII) % of HP tubule area infected	I0: 0%. I1: 0.004–0.14%	I2: 0.51–5.92%. I3: 6.85–9.26%	I4: 10.15–45.67% (mean ~32% in severe cases)
EHP load (copies/ ng HP DNA by qPCR)	0 - <10^3 copies/ng (low risk, minimal growth impact)	10^3–10^5 copies/ng (moderate risk, visible growth retardation begins)	>10^5–10^7 copies/ng (high risk, severe growth depression and WFS)
CT value	35-40	28-35	0-22

Table 3. Categorising features of EHP infected shrimp against healthy shrimp.

Cost component/crop (INR)	Harvest size 100/kg			Harvest size 60/kg		
	Healthy	Moderate EHP	Severe EHP	Healthy	Moderate EHP	Severe EHP
PL cost (0.35INR/PL)	75,000	75,000	75,000	75,000	75,000	75,000
Pond preparation	40,000	40,000	40,000	40,000	40,000	40,000
Labour cost/crop)	37,333	37,333	37,333	44,710	44,710	44,710
Feed	172,125	187,000	178,500	346,059	345,174	297,381
Chemicals & additives	48,040	57,900	63,340	58,351	70,021	75,000
Electricity & diesel	24,000	27,000	27,000	59,500	70,000	70,000
Harvest expenses	16,500	16,500	16,500	22,000	22,000	22,000
Miscellaneous	16,000	18000	18000	15000	18000	18000
Target Biomass (kg)	2,250	2,000	1,750	3,540	3,124	2,499
Total Expenditure	428,998	458,733	455,673	660,620	684,905	642,091
Target Biomass (kg)	191	230	261	186	219	256
Total feed/kg production	2,025	2,200	2,100	4,071	4,061	3,499
FCR	0.90	1.10	1.20	1.15	1.30	1.40
Survival (%)	90	80	70	85	75	60
Average farmgate price for last 6 months (Jan - Jun 2025)	234			318		
Profit & Loss	43	4	-19	132	89	62

Table 4. Comparing production cost according to harvests and economic losses between three cases of EHP infected crops.

Comparison of economic losses

This was studied with direct costs between the non-EHP-infected farms and EHP-infected ponds, as shown in Table 4. We also analysed the impact on costs, ranking them as in Table 5.

Conclusion

In this article, we demonstrate the cost impact per kg shrimp with EHP infections and its subsequent influence on WFD incidences. In moderately and severely infected ponds, the cycle is not profitable with harvests of size 100/kg. The cycle is profitable when the cycle continues to harvest size of 60/kg, aided by higher selling prices. Effective EHP control benefits farmers reducing cost of production thus increasing the profit margins for farmers.

Shrimp culture practices require the adoption of effective methods for pond preparation and biosecurity, regular health monitoring, early disease diagnosis, nutritional and functional feed interventions as well as water quality management.

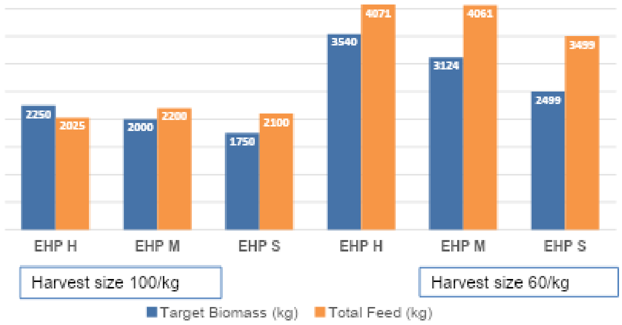
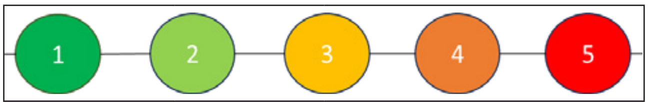


Figure 2. Graphs showing the impact on feed use vs biomass produced in EHP healthy (EHP H), Moderately infected (EHP M) and severely infected ponds (EHP S) for harvests at size 100/kg and size 60/kg.



Category	Average impact rating (1-5)	Description
Feed	4	Increased consumption due to poor growth and feed conversion
Pond Preparation	4.2	More intensive liming, bleaching, and tractor work for biosecurity
Electricity and Maintenance	2.3	Slight rise due to extended aeration and equipment upkeep
Feed supplements to control or prevent EHP	4.1	Frequent use of probiotics, immunostimulants, and additives
Water Treatment costs	3.7	Frequent use of probiotics, and other additives

Table 5. Impact rankings on production cost components.

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Media filtration: An essential aspect of any well-functioning farm

Are you saving money with your filtration choices? The complexity of a well performing media filtration system is explained

By Mike de Maine

As a technology, media filtration, has been around for centuries, but is often so poorly understood that the required performance often misses the mark by a long shot. This article is meant to highlight the main items to be aware of, without using complicated turns and theories. It is not a scientific paper but comes from accumulated experience over many years in the filtration field.

Media filtration can take many forms: Slow gravity filtration, rapid gravity filtration, pressure filtration and multimedia pressure filtration. The main concepts are simple: 1) dirt is trapped between the media grains during the filtration phase and 2) particles adhere to the grains. In both cases the particles should be ejected/released during the backwash phase. Figure 1 explains the concepts involved.

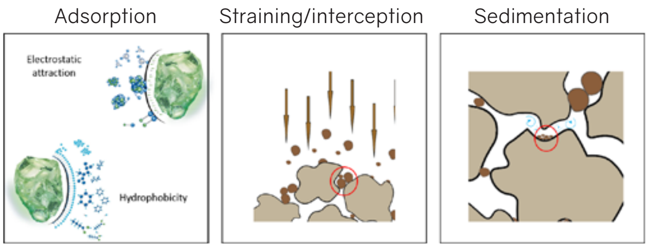


Figure 1. The concepts involved in media filtration

"I believe that it is the perceived simplicity that has resulted in the under appreciation of the complexity of a well performing media filtration system."

Main impacts on media filtration performance

These are as below:

Filtration velocity ($m^3/h/m^2$ (m/h) or gpm/ft^2) which depends on:

- Particle size (microns)
- Particle density (kg/l)
- Loading rate (mg/l TSS)
- Media bed depth (mm)
- Backwash velocity (m/h)
- Bed expansion (mm or %)
- Filter vessel hydraulic design

Filtration velocity

The interesting question to ask is what is the right filtration velocity? This is very dependent on the quality of your water source, what you aim to remove from it, the level of removal efficiency you want to achieve, and the filtration method you are using.

Below are some of the recommendations and often observed filtration velocities.

Filtration Type	Application	Recommended		Often used	
		m/h $m^3/h/m^2$	gpm/ft^2	m/h $m^3/h/m^2$	gpm/ft^2
Gravity filters	Water treatment	5 - 10	2 - 4	5 - 10	2 - 4
	Aquariums	5 - 10	2 - 4	8 - 12	3 - 5
Pressure filters & Multimedia	Water treatment	5 - 15	2 - 6	5 - 30	2 - 12
	Aquariums	15 - 25	6 – 10	15 - 40	6 - 16
	Aquacul-ture	10 - 25	2 – 10	15 - 40	6 - 16

Table 1. Recommendations and often observed filtration velocities

Why is velocity so important?

Water source quality - specifically alkalinity and hardness: Due to the lack of ionic charges in soft water that prevents the coagulation of particles to a size that can be filtered out, the filtration performance is generally compromised.

Ideal alkalinity and hardness values for good filtration performance is 50 to 150 mg/L alkalinity and 80 to 200 mg/L hardness.

Filtering at slower velocities can compensate a little for the hardness, but often hardness buffering or coagulation/flocculation chemicals are required.

Particle size: If your velocities are very high and you are trying to remove mostly fines (below 10µm), filtering more slowly increases the chance that these fine particles will settle within the media bed and/or be adsorbed onto the media surface. At higher velocities, however, the particles tend to travel with the water stream and pass through the media bed.

Particle density: In applications where the particles may be very soft, such as soft organics (note that the aquaculture application is listed separately in Table 1), higher velocities tend to shear these particles into smaller and smaller pieces as they travel through the media bed, resulting in very limited removal.

This same effect is often seen in drum filters too, where the particles are squeezed through the mesh by the differential pressure cause by the water height differences between inside and outside the drum. Our studies have shown that in RAS systems the filtration velocities should not be higher than 15m/h or 6 gpm/ft^2.

Loading rate: In applications where there is a high TSS loading rate (>30mg/L), higher velocities cause a shift from depth filtration to surface filtration and therefore cause a quick increase in the differential pressure across the bed, resulting in particles being sheared into smaller pieces, but also increasing the backwash requirements substantially.

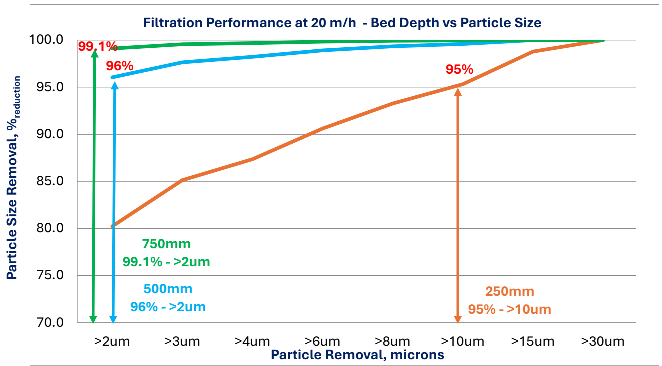


Figure 2. Filtration efficiency improves with greater media bed depth.

Filtration Type	Application	Recommended	
		$m^3/h/m^2$	gpm/ft^2
Gravity filters	Water treatment	30-60	12-25
	Aquariums	30-60	12-25
Pressure filters & Multimedia	Water treatment	50-75	20-30
	Aquariums	35-45	14-18
	Aquaculture	40-50	16-20

Table 2. Some general practices for good backwash velocities used in industries. Note: Any backwash velocities below 30m/h or 12gpm/ft², should always be preceded by an air scouring/ backwash.

Media bed depth

As media filtration is not a barrier filtration method like cartridges, bags, or membranes, it does not rely solely on surface blockage but instead on all the principles illustrated in Figure 1. Therefore, the greater the media depth, the higher the filtration efficiency.

Of course, this is more important when considering a once through flow system, such as seawater intakes, and less impactful on recirculation systems or is it? Unfortunately, although the overall thought is that in a recirculation system, eventually all the particles are removed, it is more common that the particles are sheared into smaller pieces and the bulk of small micron particles increases overtime, i.e. it is never actually being removed. This therefore contributes to an increasing load which can often be seen in the increasing COD and BOD values (chemical and biological oxygen demands) and the resultant increase in oxygen injection requirements.

A minimum bed depth of 750mm of the filtration media grade will ensure the best possible performance for that particular media.

Backwash bed expansion and back wash velocity

Often the most underestimate impact on the overall system performance is the backwash velocity to ensure sufficient media bed expansion to allow for the removal of the dirt. Somewhere along the line a figure of 1.5 to 2 times the filtration velocity has crept into recommendations. In swimming pools where their filtration velocities are 30m/h and they are therefore backwashing at 45m/h or 18gpm/ft², it can work to sufficiently expand the media and to lift the dirt out the filter (depending on the media's density).

However, when you are filtering at 15m/h or 4 gpm/ft², then a backwash velocity of 22.5m/h or even 30m/h (6 or 12gpm/ft²) is not even enough to expand the bed to allow for the dirt to move out the media, never mind lifting that dirt out the filter. Of course, each grain size and media type has a different expansion vs velocity, but Table 2 gives some generalisations for good backwash velocities used in industries.

However, everything is dependent on the media size and shape you are using i.e. large grain sizes need higher velocities to get them to the require expansion, while elongated media, often found in some cheaper glass medias, requires very high velocities to get them to expand due to their shape.

Secondly it also depends on the type of particles you need to get rid of i.e. heavy metal particles (oxidise from intake systems) require >50m/h or 20gpm/ft² due to their weights/densities Without naming products, the graph (Figure 3) shows just how different bed expansions can be for different media and even depending on from which mine the sand may have come from (red and orange lines are sand medias).

The German DIN standard requires a bed expansion of 15% to ensure that the media is separated enough to release the particles from the media, but depending on the specific gravity of the particles, even those that reach the expansion of 15 % at lower velocities does not mean that the particles will be lifted out of the filter and that it is good practice to take 40m/h or 16gpm/ft² as a minimum requirement for backwash velocities.

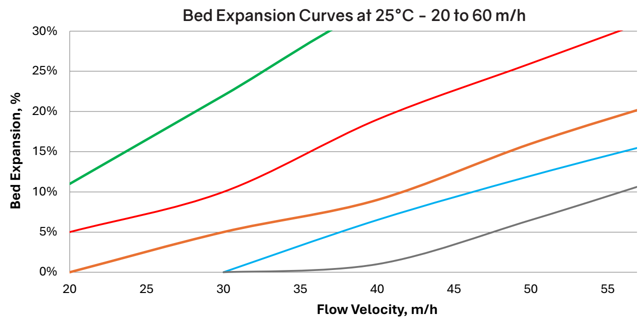


Figure 3. Bed expansion curves at 25°C for filtration velocities ranging from 20 to 60 m/h. The red and orange curves represent sand media, the green curve represents an engineered glass media, and the blue and black curves correspond to traditionally hard crushed glass media.

Grain sizes vs velocity

Table 4 shows how the velocities can be quite different depending on the grain sizes.

Filter material	Grain size combinations (mm)		
Type	I	II	III
EVERZIT®N	0.6–1.6	1.4-2.5	2.0-4.0
Quartz sand	0.4–0.8	0.71–1.25	1.0–2.0
Support layer	2.0-3.15	3.15-5.6	5.6–8.0
of Quartz gravel*	3.15-5.6	5.6–8.0	8.0–12.0
Backwash rate (m/h)	35-40	50-60	80-95

Table 3. Relationship on grain sizes combinations and velocities. Source: Evers GmbH – www.evers.de

Even more important and contrary to most beliefs, higher backwash velocities save water as shown in Figure 4.

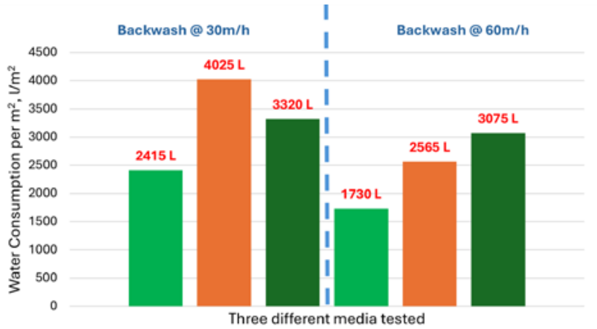


Figure 4. Water saving in litres (L) with higher backwash velocities

Filter vessel hydraulic design

Unfortunately, over the years and with strong competition to supply the cheapest filters, the aquarium and aquaculture industries have been drawn into using filters that just cannot perform for the requirements of the application.

1. A promise of filtration velocities of 50m/h or 20gpm/ft², which as shown above, is not possible to achieve effective filtration performance.

2. Poorly design laterals that are either too short or too large in diameter to properly distribute the flows to create bed expansion instead of boiling the media. This results in only a portion of the filter surface area being used correctly, resulting in preferential flows through a much smaller surface area. Therefore, it is operating at much higher filtration velocities than you have designed for.

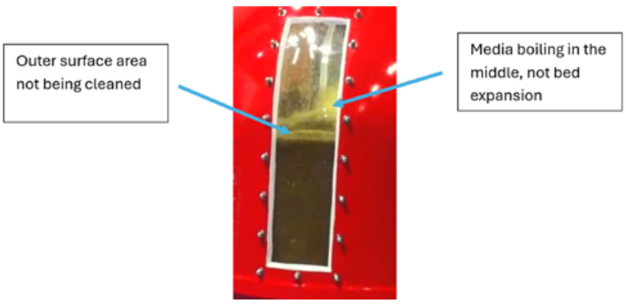
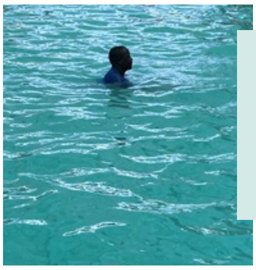


Figure 5. Short laterals show that the filter cleaned a third of the surface area during the backwash

To demonstrate an extreme example that we have encountered before. The client was filtering at the manufacturer's recommendation of 50m/h and backwashing at 50m/h, but as the laterals were very short, the filter was only cleaned a third of the surface area during the backwash (Figure 5). So, when recalculating the filtration velocities of the actual surface area being used, the system was filtering at over 110m/h or



Swimming pool where the client was unknowing filtering at 97m/h due to the poor filter hydraulics. This case would be even worse in an application where the organics are soft, such as aquariums and aquaculture.

45gpm/ft² resulting in no filtration performance, as the particles were just being sheared into smaller pieces increasing the overall COD and BOD while the water became increasingly opaque.

3. Filter laterals that do not have a good enough surface area coverage i.e star shaped laterals with too few laterals section and in large diameter filters (>900mm).

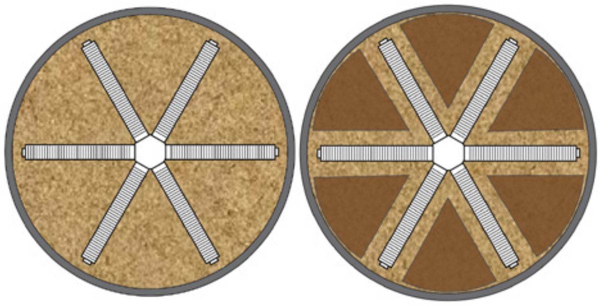


Figure 6. In star shaped laterals with too few laterals section, the brown area on the right shows what is not being cleaned during the backwash process.

The brown areas in Figure 6 on the right shows what is not being cleaned during the backwash process. In the worst case where the laterals are also oversize in diameter, you would be able to see the star shape on the surface of your media.

4. Poorly designed inlet distribution, which causes the media to pile in the middle or around the edges, resulting in preferential flows through a much smaller surface and therefore operating at much higher filtration velocities than you have designed for (Figure 7).

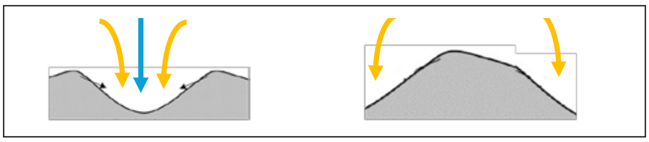


Figure 7. Example of poorly designed inlet distribution with media piled in the middle (right) or around edges.

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https://www.rastechmagazine.com/ras-media-filtration-an-important-aspect-of-any-well-functioning-farm/

Tilapia in Thailand: 60 years on for a brighter future

At the press conference during Tilapia 2025, Dr Pholphisin Suvanachai, DOF, (left) with Warren Andrew Turner, Nam Sai Farms and Prachaya Nawatrilap, Farm Story Company Limited (middle), representing the Tilapia Association of Thailand (TAT).

Tilapia was introduced to Thailand 60 years ago by King Rama IX as a gift from Emperor Hirohito of Japan. Today, it accounts for 27% of the country's aquaculture production. In 2024, Thailand produced 265,000 tonnes of tilapia, valued at USD365 million, with 97% consumed domestically. Production is projected to reach 275,000 tonnes in 2025. Thailand is also the world's largest exporter of tilapia genetics, supplying over 100 million fry annually—primarily from Manit Genetics, Nam Sai Farms, and P. Charoen Farm.

At the International Trade and Technical Conference and Exposition on Tilapia (TILAPIA 2025), held from November 3–5, Dr Pholphisin Suvanachai, Executive Advisor on Fisheries Management at Thailand's Department of Fisheries (DOF), highlighted recent progress and innovations in the sector. Key developments include improvements in feed formulations, integrated farming systems, and sustainable aquaculture practices. The DOF is actively embracing digital transformation to enhance productivity and competitiveness, including the adoption of solar energy and AI technologies.

The DOF is leading this digital transition to support growth in both domestic and export markets. Collaboration between public and private stakeholders is essential. As Pholphisin emphasised, "Technology alone isn't enough. Innovation must be linked to business, farmers, and sustainability."

At a press conference, Dr Pholphisin was joined by Warren Andrew Turner, Managing Director of Nam Sai Farms; Prachaya Nawatrilap, CEO of Farm Story Company Limited; Dr Kevin Fitzsimmons of the University of Arizona, USA; and Lukas Manomaitis, East Asia Aquaculture Lead at the U.S. Soybean Export Council (USSEC) to discuss industry challenges and solutions.

Tilapia is the most important farmed fish in Thailand. According to Prachaya, the Tilapia Association of Thailand (TAT) aims to improve farming practices; enhance biosecurity, certification, and health management; and rebrand tilapia as a premium, sustainable protein source. TAT also supports value-added product development and market access for Thai tilapia. It connects farmers, exporters, and researchers through various activities and meetings. In partnership with the DOF, it is developing a national fish disease reporting program and has signed an MoU on fish disease research to strengthen biosecurity. TAT also supports young entrepreneurs and farmers in adopting good aquaculture practices and standards, promotes the local consumption of tilapia and has showcased Thai tilapia at the Osaka Expo 2025.

In Thailand, tilapia is farmed in cages at high density using extruded pellets in canals, rivers, lakes, and reservoirs. Pond farming is typically polyculture-based and often relies on farm-made feeds. The industry is fragmented and dominated by small- and medium-scale family-run farms. Off-flavour is common in pond-reared fish. According to Turner, poor water quality is a challenge in cage farming environments, whereas it is more manageable in pond ecosystems with lower stocking densities.

Turner also noted that tilapia feed costs in Thailand are approximately 30% higher than in Vietnam, making Thai tilapia less competitive in export markets. There is concern that free trade agreements may favour the import of cheaper tilapia. Dr Pholphisin acknowledged that while the DOF is working to reduce feed costs, high raw material prices remain a significant barrier.

Prachaya emphasised that instead of pursuing high volumes, "Thailand should use its strengths as a producer of value-added products for premium quality fillets." TAT is collaborating closely with the DOF's genetics team on breeding programs aimed at lowering feed conversion ratios (FCR) and increasing survival rates, ultimately reducing production costs.

Turner pointed out that most fish are currently sold through middlemen, resulting in a loss of traceability and lower farmgate prices. He proposed linking farms directly with buyers to improve both pricing and product traceability.

Dr. Pholphisin concluded with three key messages.

- Tilapia is no longer just a domestic fish but a global aquaculture commodity.
- Thailand aspires to be the regional leader in knowledge and investment for responsible tilapia production; and
- Modern, science-based production will continue to support food security and job creation across the region.

TAT is now part of a broader regional initiative—the Southeast Asian Tilapia Association (SEATA)—launched at TILAPIA 2025 to unify and strengthen the tilapia industry across Southeast Asia. In March 2026, TAT will organize events to celebrate 60 years of tilapia in Thailand.

The red-bellied pacu in India

Popular as an affordable fish, but concerns are on the environmental impact of escapees on wild resources and the lack of standard farming practices

By Laxmappa Boini and Ravinder Rao Bakshi

Pacu and striped catfish harvested from polyculture in Telangana.

Among the more affordable fish species with good meat quality that can help increase freshwater fish production and provide consumers with more choices for fish protein is the omnivorous roopchand or red-bellied pacu *Piaractus brachypomus*. Its farming is steadily increasing in Andhra Pradesh, Kerala, and West Bengal. The fish is known for its adaptability to various water conditions and for its rapid growth, which allows for a shorter culture period.

In India, the farming of pacu began in 2005. It is now popular among fish farmers due to its high growth rate and market value. The Department of Fisheries has issued guidelines in 2025 to streamline pacu farming across the country. These guidelines, which cover the grow-out culture practices of commercially important species, including pacu, address various aspects such as pre-stocking pond preparation, seed sourcing, seed transport and stocking, crop management, including pond environment, nutrition and health management, as well as harvesting and measures to prevent fish from escaping into natural water bodies.

Pacu prices have risen more sharply than those of Indian major carps (IMC) and striped catfish, making pacu farming especially profitable and appealing to local farmers.

Breeding strategies

The farming and breeding of the red-bellied pacu began in West Bengal and subsequently gained traction in Andhra Pradesh. The technology for induced breeding of pacu using hormonal methods has been well developed and is now widely practiced.

Numerous hatcheries for the pacu have been established in West Bengal, while farmers in Odisha, Andhra Pradesh, Kerala, the north-eastern states, and Uttar Pradesh have also achieved success in breeding and producing pacu seed on a limited scale across the country. Andhra Pradesh and West Bengal are the pioneers in pacu farming.

Mono- and polyculture systems

Initially introduced into India as an ornamental species, the fish is now farmed in both monoculture and polyculture systems with Indian major carps and striped catfish in Telangana, Maharashtra, Karnataka, Tamil Nadu, Uttar Pradesh, Odisha and the north-eastern states. As there is no recommended culture method, farmers generally

Market-sized pacu collected from polyculture with striped catfish.

Parameters	Telangana	Andhra Pradesh
Stocking density (fish/acre)	Pacu: 2,000-3,000 Pangasius: 10,000-15,000	Pacu: 4,000-5,000 Pangasius: 400-500 IMC: 400-500
Stocking size of juveniles (cm/fish)	Pacu: 8-10 Pangasius: 5-7.5	Pacu: 10-12.5 Pangasius: 7.5-10 IMC: 15-20
Culture duration (months)	8-10	6
Harvest type	Total harvest	Partial harvest
Harvest fish size (kg/fish)	Pacu: 1-1.3 Pangasius: 1-1.2	Pacu: 1-1.2 Pangasius: 1.5-2 IMC: 1-1.5
*Field survey; IMC= Indian major carps		

Table 1. Some common practices of pacu farming in Telangana and Andhra Pradesh from a field survey.

Parameters	Telangana	Polyculture*	
		With striped catfish	With catfish+ IMC
Stocking density (fish/acre)	4,000	2,000	4,000
Stocking size of juveniles (cm/fish)	10-12.5	8-10	10-12.5
Culture duration (months)	4-6	8-10	6-7
Feeding rate	Once daily @ 3-4% of body weight		
Feed type	Pellet feed		
Crude protein %	24-28		
FCR	1:1.5-1:1.8		
Harvest type	Partial harvest		
Harvest fish size (kg/fish)	0.95-1.30		
Total production (kg/acre)	4,000	2,200	4,200
Farm gate price (INR/kg)	82-126 (USD0.97-1.43)		
*Field survey			

Table 2. Common practices of pacu farming in India from a field survey.

adopt practices that best suit their local conditions and convenience, particularly in terms of stocking density, yield and culture duration.

In Telangana, farmers typically follow a single-stocking and single-harvest system. The stocking density is 2,000-3,000 fingerlings/acre (5,000-7,500) in polyculture. Whereas in Andhra Pradesh, pacu is cultured in monoculture systems with a single-stocking density of 4,000-5,000 fingerlings/acre (10,000-12,500/ha) and multiple harvests (Tables 1 and 2).

Pond water management

Good water quality management and maintenance of adequate dissolved oxygen (DO) are of prime importance for ensuring the health and growth of pacu. Regular monitoring of water quality parameters in grow-out ponds at regular intervals is essential.

Intermittent application of zeolite (at 5-10 kg/acre) helps absorb and remove harmful substances such as heavy metals (lead, mercury, cadmium) and other toxins from pond water.

Ponds are stocked with healthy pacu fingerlings of 8-10 cm in size.

In addition, gas adsorbents (at 200-400 g/acre) are applied for the adsorption of obnoxious gases like ammonia, sulphur dioxide, hydrogen sulphide and methane during the culture period in grow-out ponds. However, the timing and dosage of these applications depend on the quality of pond water. Maintaining an optimum water pH (7.5-8.5) and dissolved oxygen (>4 mg/L) is essential throughout the grow-out phase.

Feed and feeding practices

Feed constitutes about 60-70% of total farming costs and accounts for both cost and nutritional issues. The fish are fed once daily in the morning with floating pelleted feed specially formulated for pacu. Feeding rations vary with the age and size of fish. The feed conversion ratio (FCR) ranges from 1:1.5 to 1.6 under optimal culture conditions, but can rise to 1:1.7 to 1.8 when conditions are less optimal.

Pacu requires commercial feeds to achieve expected growth-to-market-size rates. Floating feeds are sold according to crude protein levels, commonly 24%, 26%, and 28%. Many Indian farmers opt for lower-cost feed options or will even prepare their own mixtures to save costs. Prices for floating pelleted feed can vary depending on protein content and fat ratio.

Harvesting

Harvest size and culture duration vary by state and culture practice. Based on the field survey, in Andhra Pradesh, most farmers harvest pacu at sizes 1.0-1.2kg after 6 or 7 months of culture. The average culture duration in West Bengal is about 8 months, during which pacu typically reach 500-800g. In Kerala and Telangana, most farmers culture pacu for a period of 12 months, achieving sizes of 1.0-1.3kg.

Generally, starving the fish for 2-3 days before harvest improves flesh quality. High productivity of 4,000-5,000 kg/acre with survival rates of 90-95% is achievable in Andhra Pradesh. A mid-harvest of larger sized fish during the fourth month, followed by a full harvest in the sixth month, helps regulate the pond biomass and achieve better market prices.

Weight (g)	Farmgate prices in INR/1-1.5kg in 2025									
	January	February	March	April	May	June	July	August	September	October
1000	121	122	124	120	116	113	92	94	82	83
1200	122	123	125	121	117	114	93	95	83	84
1500	123	124	126	122	118	115	94	96	84	85
Source: Growel 360°										

Table 3. Recent farmgate prices for pacu in Andhra Pradesh in India.

Marketing trends and price collapse

The farmgate price of pacu is comparatively higher than that of Indian major carps and striped catfish. However, prices differ regionally depending on the operational costs involved in transport, feed and the average size of the harvest. Therefore, many farmers are struggling due to the lack of compensatory prices. Fluctuations in the sale price of this fish over the last couple of months show significant seasonality in the markets.

In 2025, the pacu industry encountered a sudden price collapse, with average prices in major producing areas dropping to INR 85/kg (USD0.9). Rising pond rental rates, high feed costs and low fish prices then prompted many farmers in Andhra Pradesh to reconsider restocking and farming of pacu.

Pacu and pangasius farmers face hurdles in selling market size fish because demand in many states is a minimum fish size of under 1 kg. While some farmers transport their produce to distant markets for better prices, this increases risks of reduced freshness and higher logistics costs. In the Indian market, pacu and pangasius prices vary according to fish size during the harvesting season. In 2025, farmgate price fluctuated between INR 82 to 126/kg (Table 3).

Weighing of pacu fish for packing and transport.

Escapees and ecological impacts

Red-bellied pacu farming involves several critical aspects such as pond management, seed sourcing, fish transport, and nutrition and health care. However, ecologists are particularly concerned on pacu entering natural water bodies, as the rapid and unregulated growth of pacu farming poses potential ecological risks from accidental releases.

At present, there is no standard farming practice, and farmers tend to use their own methods. Authorities and specialists have therefore emphasised the urgent need for registration and regulation of existing pacu farms and hatcheries to ensure proper management and oversight. There is pressing demand for the immediate registration of pacu farms and hatcheries to facilitate effective species management and avert potential negative ecological impacts.

To promote this culture, a set of guidelines has been developed; however, they need updates to help farmers establish better standards in cultural practices. The absence of adequate supervision and weak adherence to environmental and ethical farming practices have raised concerns over biodiversity conservation, ecosystem health, and potential biosecurity threats with the pacu fish. This underscores the need for a more cautious and sustainable approach, supported by a stronger regulatory framework and improved management systems.

To achieve this, stakeholders and aquaculture ecologists and farmers should be trained in Best Management Practices (BMPs) to ensure sustainable production. These include maintaining optimal culture conditions, minimising pollution, controlling pathogenic bacterial loads, preventing disease outbreaks, monitoring and preventing fish escapes, regularly removing waste from culture areas, and identifying new and responsible market opportunities.

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Tilapia 2025: Expanding footprint, shifting markets

USSEC's Lukas Manomaitis (left) led the panel discussing production volumes and challenges. From second left, M Gulam Hussain, Eon Aquaculture Limited, Bangladesh; Wang Xueguang, CAPPMA, China; Pamudi, USSEC, Indonesia; Mohamed Razali Mohamed, Aquagrow International, Malaysia; Florendo Jon Juico Jr., PHILTILAPIA, Philippines; Malasri Khumsri, DOF, Thailand; and Nguyen Hoai Nam, VASEP, Vietnam. Photo credit: Infofish.

After a decade-long hiatus, the global tilapia community reconvened in Bangkok for TILAPIA 2025, the International Trade and Technical Conference and Exposition on the Tilapia. This event, organised by INFOFISH and co-hosted by the U.S. Soybean Export Council or USSEC, was also the 13th International Symposium on Tilapia Aquaculture (ISTA). Over 30 expert speakers shared insights in a dynamic panel format, spotlighting the latest trends, technologies, and trade developments.

In his keynote, Professor Kevin Fitzsimmons, University of Arizona, USA, did a quick overview on global production. He highlighted tilapia's global reach—now farmed in 140 countries, making it the world's most widely farmed aquaculture species. His key takeaways were that China remains the top producer and exporter, with major markets in West Africa with Côte d'Ivoire, Burkina Faso, and Mali among its top buyers and the European Union (EU). The US market is smaller but still notable, especially for frozen fillets. Brazil is rapidly scaling up, with domestic prices now outpacing beef, pork, and chicken. Indonesia, Egypt and Bangladesh are also expanding production. India is the latecomer, but its industry is now three times the size of the US. Vietnam is gaining ground in the US market, filling gaps left by tariffs on Chinese imports.

Tilapia remains at the forefront of aquaculture innovation, utilising production systems such as recirculating aquaculture systems (RAS), in-pond raceways (IPRS), and saline as well as cage farming. Genetics such as GIFT strains, red tilapia, and YY super males are boosting yields and profitability. Product forms are from live and fresh fish to IQF fillets, ready-to-eat meals, and pre-cooked formats. In the UK, Regal Springs is collaborating with partners on fish-and-chips offerings.

Fitzsimmons predicted that in the future, "China and Brazil are going to be two massive producers that are also exporting a lot of products. China is increasing domestic demand. In Brazil, prices of tilapia now are even better than beef, pork, and chicken on a per kilo basis."

Fitzsimmons noted that tilapia prices have remained stable in real terms, even amid inflation. This resilience is largely due to farm-level innovation—producers are achieving higher survival rates, faster growth cycles, more efficient use of inputs and expanded product formats.

"The production of tilapia still only adds up to about two fish per person per year worldwide. So, if we can get people to eat one more tilapia, we have to double world production".

Tilapia in Asia: Data, challenges and opportunities

Lukas Manomaitis, East Asia Aquaculture Lead at U.S. Soybean Export Council (USSEC), led a panel to delve into production and industry challenges in their countries. He began the discussions with data from the recent Global Seafood Alliance's Responsible Seafood Summit, Colombia, October 2025. Global production in 2025 at 6 million tonnes and Asia produced over 4.7 million tonnes (≈67% of global output, GSA, 2025).

Manomaitis showed production data Table1, a result of several USSEC's contractors collecting and aligning information from various sources. Production has been increasing in Thailand and Bangladesh. Tilapia is the third leg for Vietnam's aquaculture industry. Estimated Asian production for 2025 and 2026 are 4.2 million tonnes and 4.5 million tonnes, respectively.

USSEC AQ Tilaptia Assessments

Production in tonnes					
Country	**2022**	**2023**	**2024**	**2025e**	**2026e**
China	1,738,947	1,816,828	1,899,000	1,985,000	2,075,000
Bangladesh	390,000	420,000	450,000	450,000	450,000
India	150,000	100,000	100,000	100,000	100,000
Indonesia	600,000	600,000	650,000	700,000	750,000
Malaysia	30,250	31,076	35,020	31,990	40,690
Philippines	271,973	264,418	287,687	296,318	302,244
Thailand	269,394	266,480	258,160	281,000	289,000
Vietnam	268,800	270,000	310,500	372,600	447,120
Total	3,719,364	3,768,802	3,990,367	4,216,908	4,454,054

Table 1. Production data presented by Lukas Manomaitis. Source: Regional Sub-Session 1.1: Asia Emerging Tilapia Producers and Exporters in South and Southeast Asia, presented at Tilapia 2025, November 3-5, Bangkok, Thailand. 2025e and 2006e are estimates.

The team from Manit Group, Wasana Suebong, Yosita Harsup, Pannarai Sittiwong (middle), with Sergio Zimmermann, Zimmermann Aqua Solutions, Norway (left) and Roberto Cascione, Virbac, Thailand (right).

Regardless of the data source, USSEC and GSA RSS data, Manomaitis said that tilapia is a key aquaculture species in Asia, with strong growth potential into the premium white fish. Tilapia supports food security, serves diverse markets, and is well-suited for export.

The panel representing industry in Bangladesh, China, Indonesia, Malaysia, Philippines, Thailand and Vietnam outlined some common challenges including disease mitigation, high feed cost affecting costs of production, poor fry quality and limited access to affordable credit for small and medium commercial farmers.

The current production in **Bangladesh** is around 0.4 million tonnes, which is 190 times higher than in 2000. It is a key contributor to national aquaculture output, food security and rural livelihood. The domestic market remains the primary growth driver. Dr M Gulam Hussain, Chief Aquaculture Adviser, Eon Aquaculture Limited, said "For us, the GIFT strain, introduced in 2000, was a game changer. We have more than 500 tilapia hatcheries and 25,000 commercial farms. We produce 5 billion monosex fry and with better hatchery management and feed use, the expectation is a 4-6% annual increase. To expand production, we are looking at RAS and IPRS. The export market is favourable with processing." In 10 years, the target production is one million tonnes. The 2025-2035 vision is to position Bangladesh as a regional leader.

In 2024, **China** exported 479,179 tonnes valued at more than USD1.4 billion. Wang Xueguang, Vice President and Secretary-General, China Aquatic Products Processing and Marketing Alliance (CAPPMA), said, "There is an excessive reliance on exports while the domestic consumer market is untapped. The industry is pursuing multiple strategies such as enhancing by product utilisation to increase overall value of the fish and developing product forms more suited for domestic markets. For exports, it is diversifying to emerging markets in Asia, Africa and the Middle East."

USSEC's Technical Consultant Pamudi, citing feed production of only 400,000 tonnes estimated 600,000–700,000 tonnes of fish production in **Indonesia**. Two large producers, Regal Springs and PT Japfa Comfeed Indonesia exported 12,000 tonnes. Farmers often prioritise low-cost feeds, but Pamudi emphasised the need to build farmer capacity through quality inputs. The Indonesian government is promoting farming salt-tolerant tilapia in abandoned shrimp farms.

In **Malaysia**, Mohamed Razali Mohamed, CEO, Aquagrow International, anticipates that the market will primarily focus on fresh and live fish for domestic consumers. The projection is for steady growth centered on the local market rather than driven by exports. "The key challenge is the rising cost of production. Feed cost MYR2.50-2.70/kg (>USD 0.60), while the farmgate price remains low at MYR10/kg (USD2.40). Farmers need organisation, technology and efficiency."

In the **Philippines**, there was a dip in production during the pandemic, but production is increasing again. The target is 350,000 tonnes, which Florendo Jon Juico Jr., President, The Philippine Tilapia Stakeholders Association (PHILTILAPIA), is confident the country can achieve. Production is for domestic markets and retail prices vary regionally, averaging PHP120-180/kg (USD2.0-3.05). There are 725 hatcheries and 75,851 grow-out farms. Issues include an ageing workforce, poor water quality, high feed costs, unstable fry supply, and weak marketing systems. Innovative systems like IPRS and sustainable practices are being promoted to boost efficiency.

Production in **Thailand** was stable over 2020-2024, said Dr Malasri Khumsri, Aquaculture Technology Expert, Inland Aquaculture Research and Development Division, Department of Fisheries (DOF). Until October 2025, the production is less than 270,000 tonnes. Thailand imports from China and Indonesia, while it exports premium products, mainly to the US. Challenges include rising feed and energy costs, limited access to capital and credit, market fluctuations, climate change, disease outbreaks, inadequate biosecurity, and additional limitations such as varying export market requirements and the lack of strong farmer groups.

Vietnam's current production is 300,000 tonnes. The advantage of tilapia over the leading fish commodity, pangasius, is that it can be farmed across both the northern and southern regions of the country, in ponds as well as reservoirs. Seed self-sufficiency is low at 30%. Nguyen Hoai Nam, General Secretary, Vietnam Association of Seafood Exporters and Producers (VASEP), said, "We are still new in tilapia production, but we see the market opening because of the US tariffs on China (45-54%). We have planned for different areas, each for the farming of pangasius, shrimp and tilapia. The interest is also tilapia in brackish water ponds."

"We strive for tilapia to be the third export commodity from Vietnam. At 10-15% growth/year, by 2027, we can expect USD100 million of exports to the US, EU, Japan and Middle East. We expect cost reduction by 15% by working with feed companies."

Professor Kevin Fitzsimmons and author Dr M Gulam Hussain, at "Meet the Authors and Book Signing" side event at Tilapia 2025. The book "Tilapia Farming Breeding Plans, Mass Seed Production, and Aquaculture Technologies" is available at https://shop.elsevier.com/books/tilapia-farming/hussain/978-0-443-29853-0

AI and innovations in early-stage aquaculture technology for marine fish

At Aquaculture Europe 2025, held on September 22-25 in Valencia, Spain, **INVE Aquaculture** introduced four new product developments in an exclusive session with customers mainly from Spain, Türkiye, Italy, Greece, Portugal and Norway. Mario Hoffmann, Regional Sales Director EMEA emphasised INVE's commitment to supporting marine fish hatcheries—especially for seabass, sea bream, and meagre—by enabling a strong start with quality fingerlings and contributing to sustainable production.

"Our role is working with marine fish hatcheries so that they have a good start with quality fingerlings. At the end of the road, we are glad to be part of the value chain to ensure sustainable production."

These innovations span multiple stages of the hatchery supply chain, enhancing both efficiency and biosecurity, which include advanced tools for egg development analysis in marine fish larvae, optimized solutions for *Artemia* production, a novel algae-based rotifer feed, and compact extrusion equipment for DIY preparation of moist broodstock diets.

AI powered egg and larvae management tool

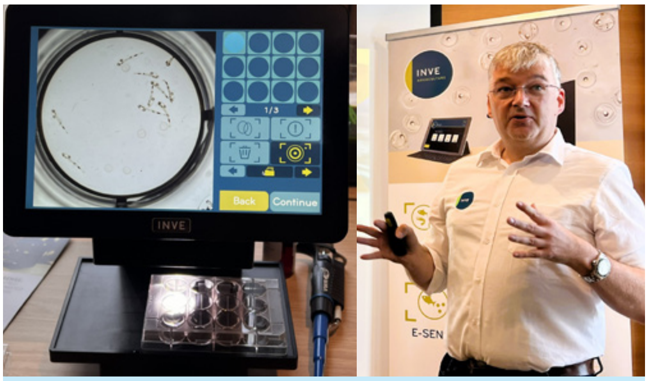
Two years ago, at Aquaculture Europe in Vienna (AE2023), INVE officially launched SnappArt™ 360 L-SENSE, a revolutionary automated live food counting tool. This device provides precision live food quantification as it replaces conventional manual counting with a method that requires far less time and effort while offering unparalleled precision.

This year, INVE and technology partner ARIS unveiled the extension of the SnappArt™ 360 called E-SENSE. This is an AI powered management tool for advanced egg and larvae development analysis. It is a species-specific AI model, which to date, has been completed for the Gilthead seabream *Sparus aurata* and European seabass *Dicentrarchus labrax*, although the team will continue to make adjustments and improvements. Future developments will be for barramundi, sole, turbot and grouper.

Geert Rombaut, Product Manager Artemia and Live Food demonstrated the features of SnappArt™ 360 E-SENSE. "This will help producers to do qualification and quantification of marine fish eggs and just-hatched larvae. It is not only the marine larvae itself but the stages in its development. The device gives a comprehensive classification of egg stages - high precision quantification of fertilisation success, real time data insights, and is user friendly. This is the same device that we have for live food, but we have added a new module to help the hatchery do a precise evaluation of the egg quantity, stage and quality before the start of larval culture."

Today, the process at the hatchery is to collect eggs, weigh, and stock into tanks. In most cases, after some microscopic checks, hatcheries then decide to use the eggs or not, after they determine their viability. Rombaut said, "This practice is very subjective as well as time consuming. It requires expertise. When hatcheries reduce sample sizes, this decision is made on a much smaller sample.

"The precise detection of embryonic stages on this platform, clearly helps with information on the spawning process and allows for an evaluation of hatching rate before stocking. The data are stored on the platform, and the hatchery can do a comparison of the development status with a previous batch. Our aim is to enable hatcheries to have higher efficiencies in fry production and traceability via data and shared images. There is a personalised data base, information for setting key performance indicators (KPIs), with an option to recheck images and not depend on numbers. Furthermore, it allows the user to access fertilisation rates prior to incubation and when providing eggs to customers, it acts as the counting tool," added Rombaut.



The SnappArt™ 360 E-SENSE is for the qualification and quantification of marine fish eggs and just-hatched larvae, said Geert Rombaut.

This development is part of the whole package from INVE with different objectives: L-SENSE is for live food, i.e. the quantification and development of rotifers and *Artemia*; Q-SENSE is specific for quality control of *Artemia* in laboratories; E-SENSE is for eggs and larval development; and S-SENSE is for verification and development of shrimp larvae. Each module can be activated through a subscription.

Novel algae-based rotifer feed

Tania De Wolf, R&D Group Leader Artemia & Live Food, introduced Vitalgae™ Nanno, a premium, 100% algal-based feed designed specifically for rotifer culture, offering high nutritional density, ease of use, and sustainability. This is pure *Nannochloropsis*, a single-species microalgae feed for optimal rotifer nutrition. It is a high algal cell density to deliver more nutrients per dose, improving feed efficiency and reducing waste. De Wolf said, "The production of high-quality live food remains a key success factor in many hatcheries for marine finfish species. The required rotifer quantities, needed to successfully produce fish larvae, have decreased in the last years. Because of this trend, it is of uttermost importance that the provided rotifers are of high nutritional and microbial quality and that the procedures to produce them are easy and limited in time."

High-quality *Artemia* production

Effective microbial management, biosecurity measures, and cleaning protocols are essential for consistent high-quality *Artemia* production. Letizia Chiappi, R&D Engineer joined Rombaut to present another tool for *Artemia* production in hatcheries, EG SEP-Art® D-FENSE. This combines magnetic separation and antimicrobial protection for optimal yield and biosecurity.

The process starts with magnetic separation followed by clean harvesting and enhanced microbial management to ensure a clean start, consistent and predictable and stable finish in *Artemia* production. Hatching with this tool reduces *Vibrio* loads by 5 logs and total bacterial load by 3 logs in the hatching water. The tool promotes stable microbial conditions during hatching, thus providing an optimal starting point to enrichment. This leads to more consistent, reliable, and high-quality enrichment outcomes.

In a presentation during the scientific session, Chiappi and team highlighted the use of EG SEP-Art® D-FENSE cysts and a CIP (clean-in-place) agent to enhance biosecurity and improve microbiological and nutritional quality, and to standardise *Artemia* production in hatchery operations. The cysts achieved a 3-log reduction in total bacterial load and a 4-log reduction in *Vibrio* load in the hatching medium after 24 hours.

DIY broodstock diet

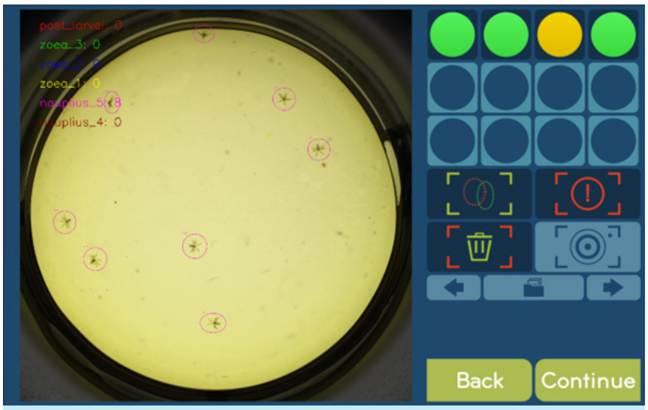
Thomas Raynaud, Product & Business Development Manager for Formulated Diets, and Valentina Carbone, Global Technical Expert Fish demonstrated INVE's third broodstock solution, Fish™ Breed M, a powder mix made from premium ingredients. When mixed with water, it easily transforms into a moist diet containing 30% to 40% moisture. This versatile formulation is suitable for a wide range of species, including European seabass, Asian seabass, seabream, amberjack, and grouper. It allows hatcheries to customise feed size and texture — particularly useful when feeding large broodstock (>3 kg) or introducing new species.

Raynaud also introduced new equipment designed to streamline and automate the preparation of Fish™ Breed M into semi-moist pellets. "We have been working with a partner to develop a small extruder that allows hatcheries to produce up to 10 kg/hour of 20–30 mm moist pellets for broodstock." The system includes a mixer, extruder, and rolling machine, offering a compact and efficient solution for on-site feed production.

Qualification of marine shrimp larvae

This is the S- SENSE for shrimp which Stefano Calloni, R&D Engineer INVE Aquaculture, presented during Hatch India 2025 in Visakhapatnam in October. He explained how the stocking of shrimp nauplii is the first, and crucial step in initiating hatchery culture correctly. Thanks to recent advancements in Visual AI—a form of artificial intelligence capable of interpreting images— and the integration of this technology into SnappArt™ 360 S-SENSE, this process has become both simpler and more efficient. Following the stocking, it is essential to monitor the stages of larval development; to optimise the feeding protocol and provide the correct feed for each shrimp larval stage. In a practical demonstration, Stefano showcased how the SnappArt™ 360 S-SENSE system is used to observe larval progression from zoea to mysis, capturing subtle developmental changes. Calloni highlighted how this platform seamlessly integrates human expertise with machine intelligence, enhancing hatchery operations through real-time insights and hands-on experience.

Fish™ Breed-M extruded moist pellets (20mm) using a small 10/kg per hour unit of mixer, extruder and rolling machine.



An actual example of larval development from zoea to mysis with S-SENSE and view on the platform, as shown by Stefano Calloni, at Hatch India 2025.

INVE Aquaculture's Mario Hoffmann (third left), Veerle Courtens, Key Account Manager EMEA, (centre), Thomas Raynaud (third right) and Nikos Pappas (right) with customers, Faouzi Nouira (left) and Guiseppe Vizini, (second left) from Acqua Azzurra, Italy.

Collaboration to accelerate innovation in shrimp health management

Disease management remains one of the most pressing obstacles to sustainable shrimp production worldwide and is critical for the sector's resilience and future growth. In October, INVE Aquaculture and Dalan Animal Health announced they will collaborate to accelerate innovation in shrimp health, addressing one of the industry's greatest challenges: disease management.

In development at Dalan, is a groundbreaking vaccine technology targeting major pathogens affecting shrimp populations, including white spot syndrome virus (WSSV), one of the most devastating diseases in shrimp farming. Their novel approach focuses on broodstock vaccination, representing a paradigm shift in how the industry approaches disease prevention.

INVE Aquaculture, a global leader in early-stage shrimp nutrition and health, brings more than four decades of expertise in developing practical solutions that reach one in three farmed shrimp worldwide. Through this collaboration, Dalan and INVE aim to explore how their complementary strengths could accelerate the development of innovative, scalable approaches to shrimp disease prevention.

Dr Olivier Decamp, R&D and Business Development Health Director of INVE Aquaculture said, "By combining Dalan's innovation in shrimp vaccines with INVE's reach and expertise, we can accelerate the delivery of practical disease-prevention tools to farmers."

Dr Annette Kleiser, CEO of Dalan Animal Health, added, "Dalan is committed to enhancing the sustainability of global aquaculture and food supply. We are excited to collaborate with INVE to explore synergies between its global reach and our vaccine platform, accelerating healthy innovation in shrimp broodstock management."

The collaboration underscores both companies' commitment to helping shrimp farmers protect their operations, reduce the risks of disease-related losses, and ensure the long-term sustainability of the industry.

Revolutionary breakthrough in vaccinating shrimp against common diseases

The six-year-old startup's journey into shrimp health began with bees. In January 2023, the company received conditional approval from the USDA for the world's first honeybee vaccine against American foulbrood, a bacterial disease that has plagued beekeepers worldwide. The technology behind this this innovation (maternal immune priming) has proven surprisingly adaptable across species boundaries. This biological mechanism allows a mother to pass immunity to her offspring after exposure to disease-causing pathogens, creating a natural vaccination effect that works even in invertebrates, previously thought incapable of such immune responses.

Annette Kleiser, CEO of Dalan Animal Health is pictured with Patrick Waty, CEO INVE Aquaculture at the Global Shrimp Forum 2025, held on September 3-5, Utrecht, The Netherlands.

The company has focused its initial efforts on WSSV and *Vibrio* bacteria - two of the most economically damaging pathogens in shrimp farming. These early successes suggest the platform could eventually address a broader spectrum of diseases that currently limit production efficiency.

At the Innovation session during TCRS Shrimp Summit 2025 in Bali, Indonesia, Kleiser explained how this vaccine technology offers a fundamentally different approach by stimulating the shrimp's own immune system to resist infection, potentially reducing or eliminating the need for antibiotics while providing more consistent protection against multiple pathogens. The audience voted Kleiser with the most promising innovator for aquaculture.

Kleiser explained, "The same fundamental biological principle that works in bees also functions in shrimp. This cross-species application demonstrates the versatility of our platform and opens new possibilities for sustainable disease prevention across aquaculture." Dalan's platform with broad spectrum vaccines can activate innate immunity. It has been demonstrated to work against bacteria, viruses, and fungi. Initial field trials have demonstrated promising results.

Field trial success

Shrimp exposed to the company's vaccine technology showed significantly higher survival rates when challenged with common pathogens compared to unvaccinated control groups. At the summit, Kleiser explained that 10g shrimp from vaccinated broodstock showed significant increase in survival 9 days post-challenge to *Vibrio*. Similarly, 2g shrimp showed increase in survival, 12 days post-challenge to white spot pathogen. There was a slowdown in the spread of disease too.

Kleiser expects completion of expanded field trials and regulatory approvals and to present the first broad spectrum shrimp vaccines against early mortality syndrome (EMS) and white spot by early 2028.

Taiwan Smart Agriweek 2025: Unlocking global agribusiness

An AAP report on leading smart solutions for sustainable aquaculture in Asia

The 2025 edition of Taiwan's agriculture exposition – Taiwan Smart Agriweek 2025, was held in TaiNEX 1, Taipei on September 3-5. Amidst the turmoil caused by the imposition of high tariffs by the US on many of her trading partners, the Agriweek called for the unlocking of global agribusiness and urged for transformation and cooperation to work towards shared prosperity in the global family. It was Asia's leading 6-in-1 smart solutions expo for agriculture, aquaculture, livestock and feed, cold chain, agri-food, and sustainable farming.

The show gathered agricultural industry experts, business leaders, and decision-makers from Taiwan, Asia, and around the world. It attracted more than 400 exhibitors of which 20 were from overseas. "The showcasing of all these cutting-edge technologies is to provide a platform for industry leaders to connect, collaborate, and drive sustainable growth in agriculture and aquaculture across Asia," said Irene Liew, General Manager of My Exhibition, organiser of the Smart Agriweek event. These technologies can not only reduce energy and labour costs but in some cases make the culture operations more consistent, and easy.

This report covers **AQUATECH TAIWAN**, which showcased smart aquaculture, premium seafood, algae applications and value-chain innovations aimed at sustainable, high-value aquaculture, drawing on Taiwan's expertise to enhance global seafood development.

Interviewing Secretary-General, Tu Chen- Tung (left), Fish Breeding Association, Taiwan. Lan Hsiang Pin, USSEC, Taiwan helped to translate the conversation.

The Taiwanese situation

In an interview, the Secretary General of the **Fish Breeding Association Taiwan**, Tu Chen-Tung recounted that fish, prawn, and shrimp production in Taiwan has been declining over the years. Comparing the total fish production in 2023, where production was 130,000 tonnes, the 2024 production had declined by 5%. In the 1980s, Taiwan's production of the black tiger shrimp (*Penaeus monodon*) was around 95,000 tonnes but dropped to around 10,000 tonnes annually in recent years. Taiwan is no longer the leader in aquaculture production as it was in the 1980s.

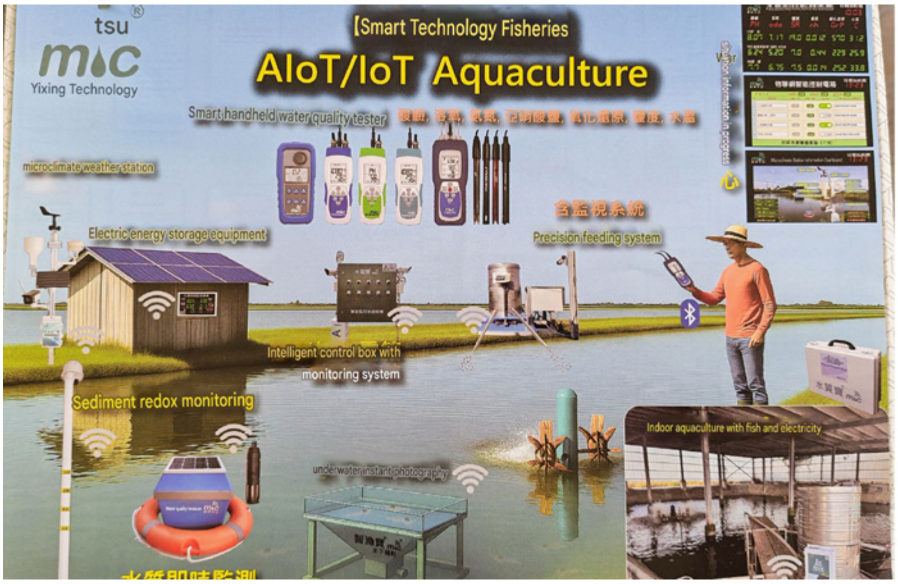
To reclaim its status as the world's leading aquaculture producer, Taiwan is advancing towards smart farming through the integration of Internet of Things (IoT) sensors and artificial intelligence (AI)-based technologies. The adoption of facility-based systems, such as recirculating aquaculture systems (RAS), addresses challenges associated with global warming and water pollution. In addition, Taiwan is promoting innovation by encouraging younger generations—particularly second and third-generation successors of established farmers—to engage actively in modernising traditional practices, emphasising labour saving and environmentally sustainable technologies.

Hor Yuen-Long, Chief Executive Officer, Aquaculture Development Association (ADA).

Youths as the engine of growth

Yuen-Long Hor, Chief Executive Officer, **Aquaculture Development Association (ADA)** disclosed that Taiwan is mobilising its youths through youth associations to take an interest in aquaculture. ADA wants youths to be the engine of growth and bring back the glory days of the 1980s. These young members who are below 45 years in age are given training in pond grow-out of fish, milkfish, sea bass, and tilapia, as well as in processing technology. Emphasis is given to smart aquaculture applications involving carbon reduction and environmentally-friendly concepts with the aim to attain product certification.

ADA, founded in 1996, is tasked by the Taiwanese government to establish the Aquaculture Specific Zoning Plan. ADA also acts as a bridge between the youths and the government and establishes opportunities for them to link up with various research institutions. These young entrepreneurs, with their better use of technology than the older generation farmers are able to brand their products and create better market opportunities.



Translated with Google Lens

Meter Industrial Company (MIC) pond culture model integrating image recognition, real-time data transmission, and environmental monitoring to improve aquaculture production and sustainability.

IoT and AI displays

There were many innovations on display featuring the use of IoT and AI to drive the Taiwanese aquaculture industry forward. Companies such as **MIC Meter Industrial Company (MIC)** provide AI-driven hardware like underwater cameras with illumination and software for analysing shrimp health and growth, triggering alerts, and predicting harvesting time. Their solutions integrate image recognition, real-time data transmission, and environmental monitoring to improve aquaculture and sustainability.

MIC also markets a MultiLine & InoLab model which can perform reagent-free optical measurements for parameters for COD and NO_3 and is equipped with test programs for various water analysis applications. The **iFish** systems provide automated and intelligent monitoring and control for fish farming, including intelligent feeding systems, water quality monitoring, waterwheel remote control, and fish counting devices to manage feed quality and reduce feed wastage.

Innovative technology to ease aquaculture bottlenecks

Very often the conventional culture of live feed such as algae in a series of flasks or other containers as the first feed for larval feeding of fish and crustaceans, remains a difficult step in the whole aquaculture cycle and in a lot of cases constitutes a bottleneck to successful aquatic production. Dr Joe McDonald, Managing Director of **Varicon Aqua** said that his company has developed a system which makes culturing algae easy. This company is the manufacturer of the Phyco™ range of photo bioreactors and the Cell-Hi line of algal nutrients.

Joe McDonald, Managing Director of Varicon Aqua. The company has developed a system which makes culturing algae easy. This is the Phyco™ range of photo bioreactors and the Cell-Hi line of algal nutrients.

iFish provides automated and intelligent monitoring and control for fish farming system.

The Varicon Aqua team has more than 30 years of experience in designing, constructing, and deploying algal photobioreactors, high-rate algal ponds and aquaculture production systems worldwide. To date, the team has deployed over 350 photobioreactor systems all over the world, ranging in scale from 5L to 40,000L. All systems are built to high specifications using precision manufacturing processes. Prominent products include the serpentine Phyco-Flow™ and Phyco-Pond systems, which are often deployed in pilot or commercial production environments.

Phyco-Flow™ has a proprietary cleaning system which effectively manages and removes biofilms that can develop during continuous use. The other models include the Phyco-Lift and Phyco-Bubble, as well as an ever-expanding array of systems, which encapsulate both high-rate algal ponds and other alternative designs.

One other bottleneck frequently encountered in aquaculture is the difficulty faced in the production of same sex animals. The traditional way is either microinjection or surgery of post larvae. These methods are often expensive and often stresses the animal, thus causing considerable mortality. In the technology developed by **GenderAqua Biotech Co. Ltd (GAB)**, sex differentiation is made simple by mixing a proprietary oral additive known as GAB into the feed.

This additive contains lipoplex and liposomes and is currently used for the Malaysian freshwater prawn (*Macrobrachium rosenbergii*) to increase the proportion of males in the population, but its use is applicable for other species like mullet, ayu and grouper as well. Under normal conditions the proportion of females: male in this prawn is 70:30; after applying the GAB technology, the ratio of females: male transforms to 30:70. Males are favoured in this culture because they grow faster than females. The GAB product with its tagline - "Gender is not about fate BUT a choice" also enhances feed efficiency and shortens farming cycle.

Unlocking global business: Achieving a win-win for all stakeholders from farm to fork through trust and mutual support

Hanaqua Tech Inc. was founded by Peter Chiang in 1984 and his first focus was on animal feed production before he expanded to other sectors of aquaculture development. His business has now grown to include food processing and marketing, He now aspires for a bigger involvement in the aquaculture business.

Since 2022-2024, he has been working hard with the **Taiwan Aquaculture Consortium (TAC)** to realise his greeNaqua fish farming model utilising green technology to reduce the carbon footprint where all stakeholders in the seafood culture and supply chain will be vertically integrated working towards a common goal to achieve environmental, social and governance (ESG) targets with a win-win format to achieve social justice and shared prosperity for all. greeNaqua was registered in over 40 countries worldwide in 2022, including the US and India. It provides technical consulting including environmental engineering, aquaculture, and fish processing.

The fish of choice for greeNaqua is barramundi *Lates calcarifer*, and considerable success has been achieved in the domestic front. The company produces 8,000 tonnes of seabass annually of which about 10% are Aquaculture Stewardship Council (ASC)-certified. The barramundi was then processed into various value-added products such as skin and fillet, cubes, slices for hot pot, seasoned fillet with Shaoxing wine or with some herbs, and congee.

Currently, 85% of the products are sold locally while 15% are exported to Australia and the US. With his greeNaqua model for barramundi farming already well in place in Taiwan, Chiang now aspires to dream even bigger - to unlock the global business and bring greeNaqua to the global stage.

Shaoxing steam barramundi (220g steaks) from Hanaqua.

Hanaqua's Peter Chiang (middle) said that his greeNaqua fish farming model for barramundi farming is already well in place in Taiwan with 8,000 tonnes of annual production.

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AE 2025: The largest gathering in show history

Aquaculture Europe 2025 took place in Valencia, Spain, from September 22-25. Its focus was on "Aquaculture for everyone," highlighting aquaculture's global role in healthy, sustainable seafood. This annual meeting of the European Aquaculture Society (EAS) had a record attendance which reached 3,115 from 97 countries, including 381 students. The scientific program featured 57 sessions, 597 oral presentations, and 571 e-posters from over 1,254 abstracts. The trade show included 155 booths across two locations.

Following the style of EAS, there was a plenary speaker for each day of the scientific conference. Dr Carlos Duarte from King Abdullah University of Science and Technology (KAUST), in Saudi Arabia discussed "Regenerative Aquaculture to Reconcile Human and Planetary Health." Day 2 had Dr Elisabetta Giuffra from INRAE, France, leveraging the value of functional genome annotations and refined phenotypes.

Duarte said that regenerative aquaculture must create economic value, and social capital, i.e. quality jobs, and healthy consumers. It should also rebuild natural capital, mitigate pressure, and promote biodiversity increase on oceans and land, as well as create cultural capital, infusing elements of traditional knowledge and cultural practices.

From left, Ronnie Tan, US Grains & Bioproducts Council; David Bassett, EATIP; Mieke Eggermont Laboratory of Aquaculture, Ghent University, Belgium and Pedro Encarnacão, Director Aquaculture at Jeronimo Martins Agro, Portugal.

Sacchi Kaushik, Retired Director of Research at INRA, France , with shrimp farmer, Ning Widjaja (right), now at Kasetsart University, Bangkok, Thailand.

Mid-day on day 3, Joan Riera from Kantar Worldpanel gave a captivating update on "What's happening with seafood consumption in Spain". While the latest Eurobarometer report from the European Commission reveals a decline in seafood consumption across the European Union (EU), Spain remains an exception to this trend, leading the EU in seafood consumption. Kantar Worldpanel tracked consumers' buying patterns and showed that 76.5% are buying for health and 64.7% seek better health. The trend is a general decline in seafood consumption due to price.

In Spain, per capita seafood consumption at home is less than 20kg, while overall fish demand in EU dropped 11% in 2024 compared to 2019, largely due to high food inflation post Covid, leading to consumers being more price sensitive. Supermarket private labels increased to 45.9% in 2025. In Spain, fresh seafood which averages EUR11/kg, dropped 6% in volume. The next reason is that seafood is not perceived as convenient as other foods.

However, salmon is an exception due to four factors: it can be an ingredient, ready to eat, convenient and readily available, leading to a 4% increase in demand (2024 vs 2019). In terms of demographics, seafood consumption is higher among retirees. The proposal is to adapt to consumer needs as seafood demand is expected to grow because a significant portion of the population is reaching retirement age.

EATIP hosted an Innovation Forum, focusing on knowledge transfer and financial support for aquaculture innovation. EATIP is the European Aquaculture Technology and Innovation Platform, based in Belgium. It develops, supports, and promotes technology and innovation in European aquaculture, ensuring sustainability, competitiveness, and societal relevance. It brings together companies, institutions, universities, and associations with a professional interest in aquaculture.

Ghent University, Belgium announced that it is participating in the Masters of Science in Health Management in Aquaculture (AquaH). The program is part of the prestigious Erasmus Mundus Joint Master scheme. The study program enables candidates to experience studying at Ghent University (Belgium), Norwegian University of Science and Technology (NTNU, Norway), Wageningen University (The Netherlands), Universitat Autonoma de Barcelona (Spain) and Universitat de Barcelona (Spain).

During the scientific program, Ning Shinny, discussed her PhD research on "Enhancing shrimp colour and yield: evaluating the impact of natural astaxanthin in plankton systems for competitive farming in the EU market." She discussed optimal management practices aimed at enhancing shrimp colouration, meat quality, health, and yield performance. The findings provide valuable insights into the effects of various feed additives on shrimp health and overall performance, and practical guidance for local farmers to optimise operations.

CROs at AE2025

Europe's aquaculture CRO (contract research organisation) landscape is highly specialised, with most activity centered around feed and additive trials (palatability, digestibility, growth performance), diagnostics (vaccine efficacy and safety), genetic and genomic services (SNP genotyping, selective breeding support, welfare and behaviour assessments (stress biomarkers, tank design, stocking density) and innovation, regulatory compliance, and sustainability across marine and freshwater systems.

Present at this AE2025, was **AquaBioTech** Group, based in Malta which conducts trials on marine systems as well as recirculating aquaculture systems (RAS), feed and vaccine testing. It is ISO-certified, with a global reach and is strong in EU-funded projects.

UK based **Pontus Research** Group operates out of Wales and Singapore. It offers bespoke, in vivo R&D studies for aquaculture in both the marine, and freshwater sectors. The Singapore research centre is based in the Marine Aquaculture Centre on St John's Island, providing R&D services for the Southeast Asian market. Pontus was also at AE2024. New at Pontus is precision and haematology services tailored for aquaculture research. See report on interview at AE 2024 (https://issues.aquaasiapac.com/link/859126/60/)

The US based **Center for Aquaculture Technologies,** with its Canadian branch rebranded in June 2024 to Onda, provides innovative, tailor-made genetic solutions for aquaculture. It specialises in genotyping, genomics, breeding and genome editing. A presentation by the team explored key factors influencing marker density requirements, including the number of traits, genome size etc. It highlighted that by optimising marker selection, aquaculture breeding programs can enhance genetic improvement efficiency, maximise selection accuracy, and sustain progress over generations.

IMAQUA is a specialised CRO which focussed on shrimp health within the aquaculture industry. It operates internationally and is based in Belgium as a spin-off from Ghent University. It offers shrimp health trials whereby it designs and conducts controlled studies to evaluate the impact of feed additives, vaccines, and health products on shrimp immunity and disease resistance. It also specialises in assessing immune responses and resistance to pathogens, including viral and bacterial challenges. There is also tailored R&D for product validation, regulatory support, and performance benchmarking.

ShrimpVet's Loc Tran (right) and Thanh Chau (left).

ShrimpVet is a leading CRO in Asia. Based in Vietnam and headed by Dr Loc Tran, ShrimpVet conducts R&D trials to validate innovative products, from feed additives to challenge test for functional ingredients and feeds. R&D facilities include diagnostic laboratories and bioassay facilities in Ho Chi Minh City. It has a demonstration farm of 7ha comprising of RAS tanks of 550L, 60m^3 tanks and 1,000m^3 tanks. There are 2,000m^3 ponds for feeding trials. These allow for commercial field trials to support laboratory-based findings. ShrimpVet is particularly well known for its *in vivo* disease challenges test facilities, having worked on shrimp diseases (WSSV, IMNV, EMS/AHPND), WFD, muscle necrosis, TPD and EHP. In fish, it has covered ISKNV and *Vibrio harveyii* in seabass, TILV in tilapia, and *Edwardsiella ictaluri*, and *Aeromonas hydrophila* in pangasius.

At their booth, the team also displayed their latest project, a greenfield 200ha vannamei shrimp farm, already in production with its first shrimp crop.

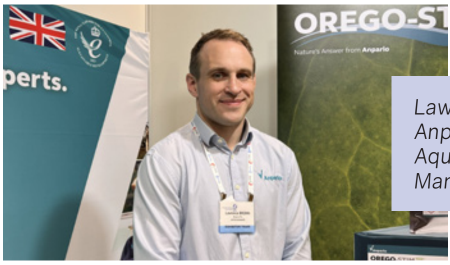
Feeds, feed ingredients, and processing equipment

Ruud van den Berg, New Business Development Manager, ORFFA, Belgium (right) with Marc Verkuijl, Aquaculture Production Director at Yalelo Uganda, one of East Africa's largest and most advanced aquaculture companies, specialising in sustainable tilapia farming in Lake Victoria.

Dr Sacchi Kaushik, with former student Saravanan Subramanian, Aqua Business Manager - Europe and Central Asia at Trouw Nutrition (left).

Premium larvae liquid feed VivoHatch is now manufactured by **GrupoNutec** and is marketed by **PTAqua** at this tradeshow. VivoHatch multilayered encapsulation technology preserves the essential amino acids, vitamins, and antioxidants to ensure performance of larvae. The moist feed stays stable in suspension in the tank - thanks to the squishy protein technology, and high levels of marine PUFAs is achieved via LipoCaps TECH. All these were developed by Huddlecorp and patented as SupFEED technology.

Leiber GmbH, specialising in brewers' yeast applications for animal nutrition has CeFi® Pro, a yeast hydrolysate derived from *Saccharomyces cerevisiae* (brewer's yeast), produced via a gentle autolysis process that preserves both cell wall and intracellular components. The company said that CeFi® Pro is an all-round talent among brewer's yeast as it contains the positive effects of the immunomodulating ß-glucans and prebiotic mannan oligosaccharides with natural components of the cell wall interior. A study showed how the autolysed brewer's yeast enhanced growth and intestinal health in early life stages for the Nile tilapia. The product improved weight gain and feed conversion ratio of tilapia fry after 35 days. Weight gain was 35% higher and FCR 22% better. The product was evaluated on resistance of post larvae (PL10) *Litopenaeus vannamei* against AHPND and EHP. There was a reducing effect of EHP loads in PL34 and 2g shrimp fed the autolysed yeast product over 21 and 70 days, respectively.



Lawrence Brown, Anpario PLC, Aquaculture Manager.

Anpario PLC is well known for its Orego- Stim Forte®, a high quality eubiotic developed to manage intestinal health and performance of aqua species. It is an emulsion powder containing 100% natural oregano oil, saponin extract and natural antioxidants. Another product is Mastercube, a low inclusion binder, free from urea formaldehyde which helps to improve pellet quality, feed intake, and performance. It releases nutritional space in the feed. The product is marketed for poultry, swine, ruminant, and aquafeed applications.

Virtual visit at the Kunststoff-Spranger GmbH booth.

European companies lead in equipment for water treatment and RAS. **Hydrotech by Veolia** produces top quality market leading water treatment drum and disc filters with a delivery of 12,000 filters worldwide.

Germany-based **Kunststoff-Spranger GmbH** is a specialised engineering and manufacturing company focussed on aquaculture system design, construction, and component production. Spranger collaborated with Adisseo to design and install a RAS experimental setup on St John's Island, Singapore. This system supports tropical marine aquaculture research, particularly for Asian seabass. It has developed various degrees of RAS - research facilities such as at the Institute of Fisheries Ecology in Bremerhaven and for feed company Aller Aqua and a commercial two storey RAS for local production of shrimp and fish.

The MixScience team, from left, Eloise Galmiche, Product Manager Aquaculture; Stephane Frouel, Aquaculture Specialist; Marta Arredondo Luque, Aquaculture Business Development and Elise Begos, Sales Manager for Aquaculture.

Silver sponsor **MixScience**, showed its Aqua Welfare range, designed in partnership with different companies from Avril, to promote animal welfare, and long-term performance in aquaculture. Stephane Frouel, Innovation leader BU Feed Additives and Aquaculture Project Manager presented on digestive modulator Valopro Fit –a sustainable solution containing plant-based products, developed to help fish better cope with nutritional challenges. The team introduced Provea, a high-quality protein concentrates of plant origin, packed with essential nutrients to support efficient and sustainable feeding.

The Corbion team of Lenaig Richard, Business Development and Aisha Villegas, Marketing Communications Coordinator (left).

Corbion has AlgaPrime™ DHA, designed for aquafeed and pet food applications. It is produced by the fermentation of microalgae *Schizochytrium* species and is a concentrated source of DHA (docosahexaenoic acid) available in powder and liquid forms for dry and wet applications. The powder form contains ≥35% DHA, with excellent thermostability during extrusion. The controlled fermentation and manufacturing process ensures high quality, consistency at scale and product purity. Low carbon emissions are confirmed by ISO compliant life cycle assessments (LCAs) and is verified deforestation free. AlgaPrime™ DHA is widely adopted by leading feed producers like BioMar and is increasingly used to meet sustainability targets in aquaculture and pet nutrition.

2026

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AQUAINDIA 2026
Mamallapuram, Tamil Nadu
aquaprofessional.org

February 16-19
Aquaculture America 2026
Las Vegas
was.org

February 2-6
35th Annual Practical Short Course on Feeds, Petfood and Aqua Extrusion
Texas A&M University, USA
teesedge@tamu.edu

March 10-12
VIV Health & Nutrition Asia/ Victam Asia 2026
Bangkok
vivhealthandnutrition.nl/

March 18-20
VietShrimp Asia 2026
Ho Chi Minh City
vietshrimp.vn

May 18-21
The International Symposium on Fish Nutrition and Feeding (ISFNF 2026)
Darwin, Australia
agentur.eventsair.com/isfnf2026/

June 2-5
World Aquaculture Singapore 2026
was.org

August 19-20
TARS 2026, Aquafeeds
tarsaquaculture.com

TARS 2026
The Aquaculture Roundtable Series

AQUA CULTURE Asia Pacific EDITORIAL CALENDAR 2026

Look out for AAP's annual report on trends in Asia's production of marine shrimp and aquafeeds

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	January/February	**March/April**	**May/June**	**July/August**	**September/ October**	**November/ December**
Deadlines - ***Technical Articles***	*November 15, 2025*	*February 10*	*March 13*	*May 15*	*July 17*	*September 18*
Deadlines - ***Advert Bookings***	*November 25, 2025*	*February 17*	*March 20*	*May 22*	*July 24*	*September 25*
Innovations	Experiences and opinions covering role models; clear and present needs of industry; innovations and digitalisation in aquaculture					
Interviews	Leaders driving change, innovations and sustainable aquaculture					
Issue focus	Nursery & Hatchery	Health & Disease Management	Sustainable & Responsible Aquaculture	Demand & Supply Equilibrium	Aquaculture Innovations	Health & Disease Management
Industry Review	Shrimp	Marine Fish	Aquafeed Production	Tilapia	Shrimp	Catfish & Freshwater Fish
Feed Technology & Management	Functional Feeds/ Additives	Fishmeal/oil	Sustainable Ingredients	Alternative Ingredients	Larval & Nursery Feeds/ Feed management	Feed Enzymes
Production Technology	RAS/Biofloc	Intensive culture	Hatchery Technology/ Waste management systems	Auto feeding/ Post harvest	Shrimp/Fish Nursery systems	Cage culture
Marketing and Certifications	Market and product developments, post-harvest processing, generic marketing, certifications, branding, food safety etc					
Company/Product News	News on activities at international, regional and local conferences and trade shows					
	VIV H&N/Victam Asia 2026 Bangkok, Thailand March 10-12 **VietShrimp International** Ho Chi Minh City March 18-20	**Seafood Expo Global** Barcelona, Spain, April 21-23	**World Aquaculture 2026** Singapore June 2-5	**TARS 2026, Aquafeeds,** August 19-20 **Global Shrimp Forum 2026** Utrecht, The Netherlands, September 1-3		Contact Us

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