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Is Aquafeed a Weak Link?

Zuridah Merican

In the run up to TARS 2026 on Aquafeeds in August, this editorial will discuss the weak links in aquafeed. The theme Fit for Future 2.0 represents a strategic shift in aquafeed development to address current and future aquaculture needs, for today's production systems and for the future aquaculture landscape. How do we meet the nutritional requirements of the species with the available ingredients to produce a kg of fish/shrimp at the optimal feed cost? Where are the weak links?

1. In terms of nutrient requirements for major species, we still do not have a complete picture of the essential amino acids and fatty acid requirements. The last Nutrient Requirements of Fish and Shrimp was published by the National Research Council in 2011. Since then, there have been an abundance of research and fortunately many have been captured in the International Aquaculture Feed Formulation Database (IAFFD).

2. With ingredients, do we have the DP:DE ratios to reduce crude protein levels in feed and consequently reduce waste and the sludge build-up that deteriorates water quality. This is perhaps more critical in shrimp feeds for high density intensive culture systems, where carrying capacity could be easily breached.

3. With regards to environmental sustainability, we know that waste due to poor digestibility pollutes. Tilapia is increasingly farmed in cages in lakes where eutrophication is a challenge. Could enzymes improve feed efficiency? Uneaten feed is also an issue and attractability and palatability are critical for feed efficiency. Smart feeding systems have been proven to improve FCRs and reducing variability but some question if the cost-benefits are worthwhile.

4. The future of feed is moving into Life Cycle Assessments (LCAs), its carbon footprint and traceability. Could this differentiate feed companies? Will we see LCAs as an additional constraint in the least cost formulation program? Sustainability comes with a cost and someone in the value chain must pay for it.

5. Fishmeal is regarded as a strategic ingredient, but can we reduce inclusion rates further? Rabobank alerts us that fishmeal could be short as soon as 2028 sending prices skyrocketing. How do we balance this, or does something have to give?

6. Nursery feeds and early-stage nutrition are wanting. At PL12 shrimp are sometimes 'weaned' from USD15/kg micro diets to USD 1.50/kg starter feeds. If price is an indicator of feed quality, then this is a startling drop. Compounding the situation is the stress the animal must encounter moving from a climate-controlled hatchery to an open pond. This is when functional feeds are required before and during the transfer to build immunity and gut health. If there was a need to avoid risk and over-formulate, this is the critical stage to do so.

7. For both shrimp and tilapia, genetic selection has significantly improved growth and robustness and yet the industry does not have bespoke feeds to help upregulate the phenotypic expression. In vannamei shrimp, average daily growth has improved from around 1g to more than 4g. Surely a high growth potential strain will require a denser feed. The question is whether research on amino acid requirements done 40 years ago can be relevant today?

8. Asia has always compared its pelleted shrimp feed to Ecuador's extruded feed. Apart from feed formulation, processing is a major difference. What are the pros and cons? The pelleting process is more cost effective, but could extrusion be better for nursery feeds and for automated feeding systems of the future. Which processing system will be better at handling alternative ingredients?

9. Unlike the salmon or Mediterranean seabass/seabream sectors, Asia produces numerous species of marine fish. Admittedly there are more species-specific feeds for marine fish recently but feed companies complain about the poor economies of scale.

10. It is unfortunate that the low price for the pangasius fish limits the drive to improve feed quality. However, the fish converts the feed into usable output and in this case – fillets. How can we improve on this feed efficiency?

Preparing for the future is not only the responsibility of the feed producer but also the other segments in the value chain. The wish is for the feed segment to play a leading role in pushing Asia's aquaculture ahead.

If you have any comments, please email:
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India crosses a million tonnes of shrimp

Lighting the lamp by guests with Saji Chacko (middle) and some members of the Society of Aquaculture Professionals (SAP) Executive Council. Photo Credit: SAP

Ecuador and India lead global shrimp production. At the opening of AQUAINDIA 2026, President of the Society of Aquaculture Professionals (SAP), **Saji Chacko** praised farmers' resilience and shared that SAP's annual shrimp crop review showed a total output of 1,050,946 tonnes, comprising vannamei shrimp at 990,386 tonnes and monodon shrimp at 66,560 tonnes. This biennial marquee event of Indian aquaculture, organised by SAP, was held on 30-31 January 2026 in Mamallapuram, Chennai.

In 2025, Andhra Pradesh produced 78% of vannamei shrimp output. The revival of monodon shrimp was driven by specific pathogen free (SPF) post larvae from Moana (USA), UniBio (Madagascar) and locally bred Andaman stocks.

Growth reached 13%, prompting Saji to ask, "Did profitability increase at the same rate?" The answer is no, as farmgate prices have remained low. In 2025, farmgate prices were unpredictable, staying just above the levels seen in 2024. Disease outbreaks occurred sporadically.

Speakers and panellists in the session on Global Trade & Market Shifts, from left, Ravikumar Yellanki, Vaisakhi Marine India (moderator); Santhana Krishnan, Marine Technologies, India; Willem van der Pijl, Shrimp Insights, The Netherlands; D.V. Swamy, MPEDA, India; Nitin Awasthi, InCred Capital, India, and Joash Mathew. Kontali. Photo Credit: SAP

Shrimp Crop Review 2025

Region / State	*L. vannamei* (tonnes)	*P. monodon* (tonnes)	Total production 2025 (tonnes)	Total production 2024 (tonnes)	Feed sold (tonnes)	Post Larvae stocked (millions)
North Andhra Pradesh	468,000		468,000	170,000	655,000	29,325
South Andhra Pradesh	146,500	30,000	176,500	155,000	259,000	12,100
Krishna District, Andhra Pradesh	163,423		163,423	380,000	229,000	16,000
Odisha	87,500		87,500	70,300	136,000	4,000
West Bengal	59,000	6000	65,000	63,000	90,000	3,980
Tamil Nadu	36,750	560	37,310	29,000	53,000	2,639
Gujarat	5,000	29,500	34,500	30,000	67,000	1,260
North India	9,000		9,000	7,200	12,000	345
Karnataka	5,713		5,713		8,000	211
Kerala	1,500	1,800	3,300		2,020	65
Goa & Maharashtra	2,000	500	2,500		3,900	140
Rest of India				25,000		
Crop Loss/Polyculture					60,000	
Grand Total	**990,386**	**66,560**	**1,050,946**	**929,500**	**1,574,920**	**70,065**

Tariffs and marketing Indian shrimp

India, the world's second-largest shrimp exporter, mainly supplies peeled deveined shrimp to the US. In August 2025, a 58.26% US tariff caused Indian shrimp exports to fall by 43%. By 2 February 2026, tariffs were reduced from 25% to 18% after a new trade deal, with the extra 25% tariff linked to India's Russian oil purchases eliminated.

D.V. Swamy, IAS, Chairman of MPEDA (Marine Products Export Development Authority), the Government of India body which regulates and promotes the export of marine products stated that while Indian shrimp exports to the US rose until April 2025 due to frontloading before the tariff deadline, they fell between August and November as exporters shifted to other markets, namely Europe and Russia. "This is a great victory for Indian shrimp to other markets, but it was not just diversification of markets, but meeting the preconditions imposed - such as audits at farm to the processing plant by Russian importers. He highlighted that meeting market-specific requirements was crucial for diversification. Challenges include stricter inspections. Japan checks 100% of consignments, while the EU checks 50%, with additional port delays of up to 10 days, despite a free trade agreement (FTA). Finally, he commented that "farmers want better prices, but how can we expect better prices if quality is not there."

India surpassed 810,000 tonnes in shrimp exports in 2025, driven by a shift from peeled to headless shell-on (HLSO) products and market diversification. Growth in H1 was due to a strong first crop; H2 benefitted from expanding into new markets. While vannamei shrimp exports to the US declined, exports to China, EU and Vietnam increased. From January to October 2025, exports grew 12% to Russia and 47% to the EU, according to **Willem van der Pijl** of Shrimp Insights.

"Moving forward, I think India's focus on the US market is a big risk as today Ecuador is expanding from head-on, shell-on (HOSO) to peeled and value-added. Soon they will start pushing cooked products to this market as well. Diversification of markets of value-added products is important." Willem added that monodon export markets tilt strongly to China and EU-27. Therefore, the question is who can absorb the next crop of more than 120,000 tonnes, especially when in Europe, the preference remains for the right size of vannamei shrimp.

Robins McIntosh, Charoen Pokphand Foods Public Company Limited, Thailand (second right) with from right, Chelsea Andrews and G Srinidhi, I&V Bio, India; Varsha Easwaran, Optimal Nutrition, India and Anagha Mehta, Aker QRILL Company.

Willem provided an overview of the continental European market, including Russia, noting that together

Kavitha Reddy Yarabolu, Director at Geekay Group (left) who moderated the session on turning the tide towards the domestic market with Vijay Anand, Director, Business Development at Salem Microbes, India (middle) and Saji Chacko.

they could constitute the second largest market after China. In 2025, the EU alone imported 600,000 tonnes, reflecting an 18% growth in imports. Regarding opportunities for Indian shrimp, he recommended that Indian companies invest in market promotion for the EU and work to enhance the perception of India as a quality supplier. India benefits from scale and price competitiveness, positioning it to potentially capture market share from Vietnam and Indonesia, particularly in cooked, marinated, and breaded shrimp segments in northwestern Europe. Additionally, Indian suppliers may expand their presence in southern Europe by refining product offerings, focusing on high-quality HLSO and HOSO vannamei and monodon shrimp, and broadening the market for peeled products.

Regroup, Rethink and Refocus

The organisers selected these for the event. In its 13th edition, everyone was encouraged to unite: regroup as a community, reconsider established assumptions and refocus on building resilience for the future and diversifying technology. Across the two days, sessions went beyond marketing to explore key issues such as disease mitigation, rethinking feed strategies, product diversification, innovations and new technologies.

Robins McIntosh, Charoen Pokphand Foods Public Company, Thailand addressed the theme. There has been a steady increase in global shrimp production from 2008 to 2026, with a high correlation (R^2 = 0.9581) indicating consistent growth. Production volumes from India and Ecuador represent 78% of the world's shrimp exports, with Ecuador showing higher annual growth (+120,000 tonnes/year) compared to India (+10,000 tonnes/year). Ecuador expects to produce 1.9 million tonnes in 2026. Robins noted that, "The global market needs competitiveness. Indian shrimp production is not in a crisis but is flatlining with challenges such as multiple pathogens, environmental changes and public image issues. However, to survive, it must become stronger and grow at a very consistent rate."

In shrimp production, issues continue to be more biological - multiple pathogens are weakening the shrimp and diseases are harder to combat. Comparing seawater conditions off Guayaquil (Ecuador) and off Chennai (India), the water quality is deteriorating more off India. Over-intensification and monoculture practices lead to stress, which increases susceptibility to diseases and reduces productivity. Other issues are rising costs and value going down with the increased world production.

Sandip Ahirrao, VP-International Business (centre left) and Dr B. Ravikumar, VP-Sales (centre right) and the Growel Feeds team.

The I&V Bio team of Lokesh Kumar, Regional Sales, Operations Manager (centre right) and G. Srinidhi, Operations Manager (centre left).

Since India exports its shrimp, exported shrimp is the most competitive while domestically sold shrimp, always has a slight premium. Therefore, many countries seek domestic markets.

Robins cited Thailand's reduced production costs from 2002 to 2008 due to technological advances, and Brazil's shift after infectious myonecrosis virus (IMNV) to a lower output of 40,000 tonnes. Brazil then developed a strong domestic market, raising production to 150,000 tonnes as consumption quadrupled in eight years. Robins stressed that India should embrace new technology, enhance biosecurity and boost domestic demand to stay competitive in the shrimp industry.

Turning the tide towards domestic sales

At this AquaIndia as well as at SAP's past events, expanding India's domestic market has been a top priority. This year's panel brought together experts from policy, e-commerce, seafood exports, shrimp nutrition and chefs, emphasising the urgent need as both India and Ecuador ramp up production, with Ecuador holding a competitive edge in the US market. Moderator **Kavitha Reddy Yarabalu** (Geekay Group) stressed, "India must look inward if this industry is to grow stronger. It is about reducing dependency on volatile global markets and strengthening farmer resilience." Speakers repeatedly highlighted the significance of boosting domestic consumption and Kavitha questioned why progress remains slow despite ongoing discussions about opportunities and challenges.

FreshToHome (FTH), launched in 2015, is a major Indian online platform for fresh fish, chicken, mutton and seafood. Promising "100% Fresh, 0% Chemicals," it delivers across major cities and aims to make prawns a household staple. CEO **Shan Kadavil** described the prawn market as a "sleeping giant," with sales growing from 1.7% in 2017 to 14.3% in 2025. FTH uses the 4P (Product, Price, Place, Promotion) framework to boost domestic prawn consumption, targeting both Gen Z online shoppers (ages 30-35, consuming 20,000 tonnes annually) and wet market buyers (about 600 million people, consuming 80,000-100,000 tonnes). The FTH app will show shrimp prices at wet markets and address consumer preferences. Prawns in India cost four times more than boneless chicken, while in Western countries the cost difference is is just 1.5 times.

At Gadre Marine Export Pvt Ltd, Managing Director **Arjun Gadre** has been actively expanding the company's reach in overseas Indian markets. He noted that traditional perceptions continue to influence local consumption trends. The common understanding is that 81% of India's population are vegetarians; it is less widely known that 72% of this group consume fish, either purchased weekly at wet markets or enjoyed at restaurants. This highlights the significance of horeca and retail channels; however, restaurants face issues such as glazing and inconsistent product sizes, while consumers contend with high menu prices, allergy concerns and deveining.

Arjun noted a strong rise in per capita seafood consumption and more domestic consumers. Trust in brands and frozen seafood is growing. He expects demand to keep rising, especially through online sales to millennials and Gen Z. Major challenges include correcting misconceptions about frozen seafood's freshness, explaining price gaps with wet markets and boosting confidence in cold chain logistics and branding.

Varsha Easwaran, Founder of Optimal Nutrition, dispelled myths about shrimp, such as concerns over cholesterol and saturated fat. Chef **K Thiru**, Founding Dean at Hahindar University, discussed how chefs can innovate with domestic prawns, reimagine regional prawn dishes, introduce global prawn dishes to Indian Gen Z consumers and create visually instagrammable experiences to encourage more frequent prawn consumption. "Chefs can be market makers and turn occasional eating to weekly prawn consumption."

Gaétan Gutter, Aqua Commercial Manager APAC, at ADM (second left) and team.

The Techna France Nutrition team, from left, Pierre Fortin, Aquaculture Manager; Ganesh Kumar Reddy, Technical Sales Manager - Aqua (pan-India) and Jean-Noël Gracie, Managing Director, Techna India with Jonathan Bester, Co Founder, Peptobiotics, Singapore.

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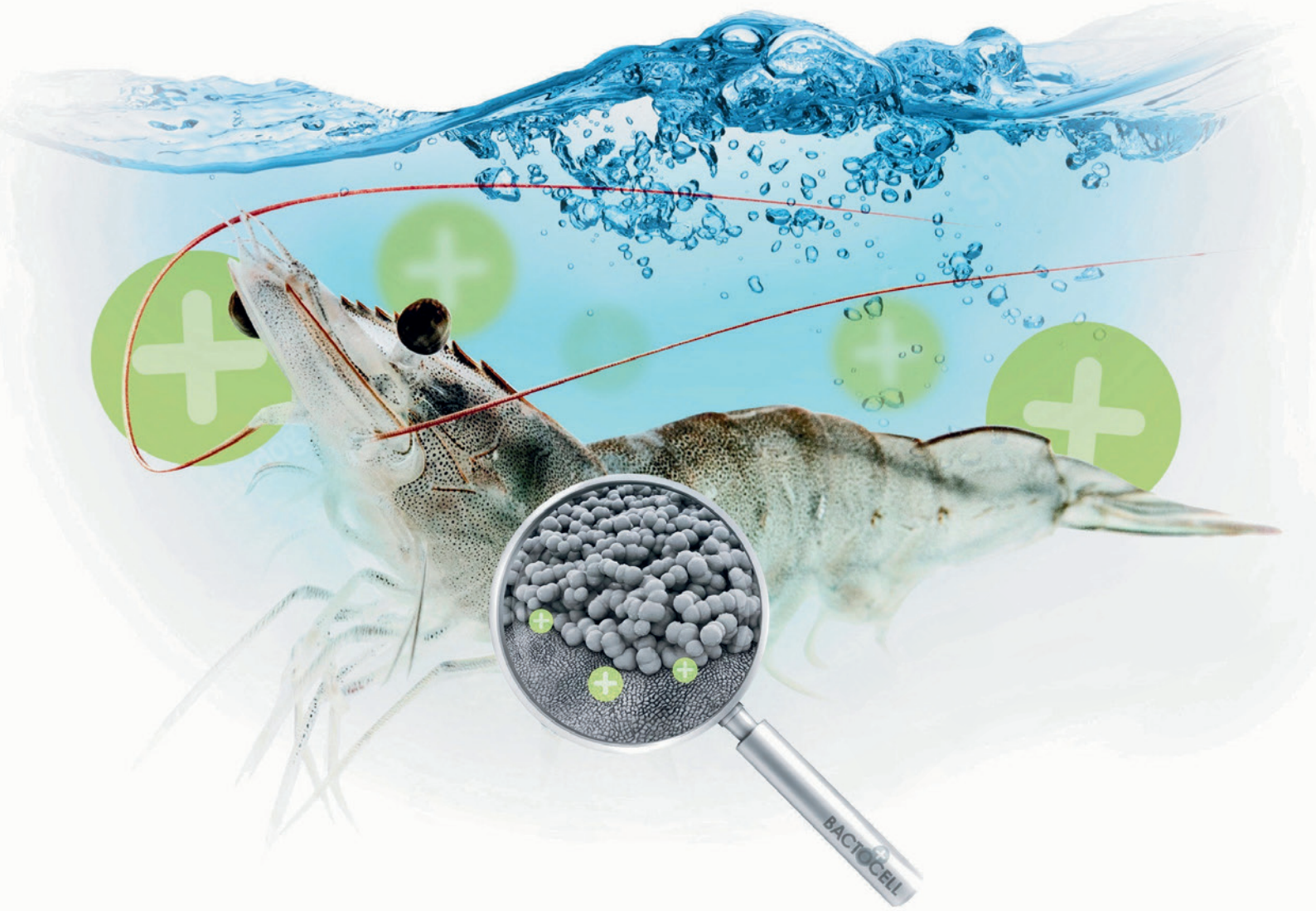

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Reshaping Indonesia's shrimp aquaculture

After a turbulent 2025 for Indonesia, JALA Shrimp Outlook is proposing to thrive through change for 2026

At Shrimp Outlook 2026, Liris Maduningtyas with the winners of JALA's Baruni, the all-in-one device to measure pH, salinity, dissolved oxygen, oxidation-reduction potential (ORP) and temperature, and to sync data to the cloud. Photo credit: JALA.

JALA's Shrimp Outlook 2026 conference took place on 12 February in Jogjakarta, attracting a record 450 participants, predominantly shrimp farmers from across Indonesia. It was the occasion for Founder and CEO **Liris Maduningtyas** to launch its annual industry review for 2025 - Shrimp Outlook 2026, and present the prognosis for the coming year.

JALA is not just a tech startup—it's a platform transforming shrimp farming into a more transparent, traceable and sustainable industry. With over 16,000 users, 9,500 farms and 27,000 ponds producing 22,500 tonnes of shrimp, JALA collects data which represent industry trends across the archipelago over the past year.

"Here in Indonesia, 2025 was full of challenges, which include global market uncertainties, price fluctuations, disease pressures and weather calamities. What is clear is the resilience of the industry stakeholders," began Liris. "Exports were rather stagnant in 2025 at 201,113 tonnes. Production in 2025 was estimated at 311,385 tonnes.

Farm productivity vs stocking intensity

Liris noted, "While overall, the average farm productivity rose 4.61% to 19 tonnes/ha in 2025, only low (<80 PL/m^2) and median stocking density farms (80-150 PL/m^2) showed productivity gains supported by better survival and growth rates and harvest sizes." A significant decline in survival (3.86%) was observed at farms with high stocking density (>150 PL/m^2). The trend was towards harvest of larger shrimp of size 58/kg.

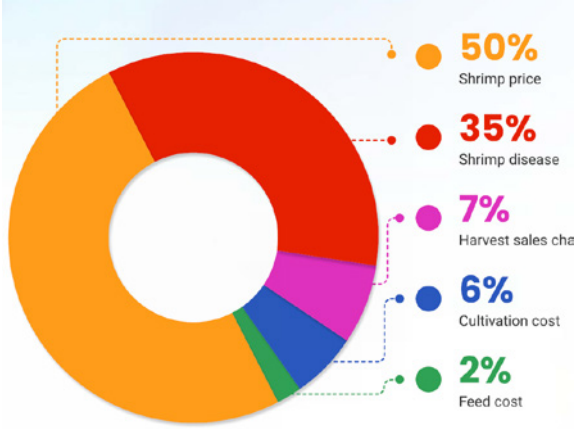
CeKolam's national data revealed infectious myonecrosis virus (IMNV) had the highest positive rates among shrimp pathogens. In Q3, *Enterocytozoon hepatopenaei* (EHP) and acute hepatopancreatic necrosis (AHPND) rates increased, suggesting rising disease pressure in H2. Field reports

Shrimp Outlook 2026 presents a comprehensive overview of the state of Indonesian shrimp farming through 2025, focusing on the industry's resilience in the face of disease pressures, climate change and market dynamics. This report is based on an analysis of primary aquaculture performance data collected from JALA App users covering 5,000 crop cycles. It included interviews with 100 farmers across 33 districts in Sumatra, Java, Nusa Tenggara and Sulawesi. jala.tech/outlook/report/2026

noted more cases of white muscle syndrome (WMS) after 50 days of culture throughout Indonesia, with WMS appearing earlier and often co-infection with EHP and IMNV.

Marketing Indonesian shrimp in 2025

The dependence on the US market—accounting for almost 70% of shrimp exports —led to unwanted vulnerability to the US reciprocal tariffs. Exports were under further pressure in the latter half of 2025 because of Cesium-137 (Cs-137) contamination. Consequently, exports to the US dropped by 86% in October. Recovery came in November but overall volumes to the US declined 8% as compared to 2024.



Liris said that for the first time, industry identified prices as the main issue, followed by diseases. In contrast in 2024, disease was listed as the most significant issue.

Liris added, "Fortunately, data indicated a strategic shift away from the US market. Notably, the Chinese market expanded by 27%, reflecting an increased focus on Asian markets. The European market, albeit small in value, grew 41%." The report noted that the domestic market with a 280 million population, when realised could serve as a buffer against global trade disruptions.

Since 2023, Indonesia's shrimp prices, notwithstanding size, were on the downward trend. In 2025, prices moved downwards with issues related to antibiotics and Cs-137 contamination after a short rise over the February-June 2025 period. Prices were volatile for size 100/kg, indicative of sensitivity to market pressures. Compared with other countries, Indonesian shrimp recorded the lowest prices at USD3.33/kg for size 50/kg.

Indonesian shrimp in global markets

According to **Willem van der Pijl**, Shrimp Insights, two major shocks disrupted global supply and demand in 2025. They were tariffs (affecting most producing countries) and radioactive shrimp (affecting Indonesian exports). Despite the exposure to tariffs, most countries increased export volumes through frontloading. Indonesia saw a 13% drop in Q4, y-o-y. Attributed to radioactive shrimp, volumes dropped 10% y-o-y in H2 2025. In 2025, Indonesia maintained its position in the peeled and breaded segment but lost market share in HLSO and cooked segments.

Willem's message was that Indonesia is currently over-dependent on the US market. It should focus on market diversification, such as to China, for HLSO and HOSO products and the EU for raw and value-added vannamei and monodon shrimp. It also needs to continue to focus on its expertise in processing highly value-added products and aim to gain market shares from Vietnam, Thailand and China.

It is essential to build a positive image among shrimp buyers for Indonesian shrimp through certification and other sustainability initiatives to maintain market access to the world's largest shrimp markets.

Thriving through changing shrimp farming conditions

Several presentations collectively mapped out the four biggest forces shaping the future of shrimp farming: *Vibrio* control, genetics, nursery systems and post larvae and feed management. Each speaker focussed on different aspects of the production chain, but together, they presented a coherent picture of what farms must upgrade to remain competitive.

Abung Maruli Simanjuntak, dsm-firmenich, said that Vibrios are becoming more aggressive and control is becoming increasingly difficult. Controlling *Vibrio* cannot be achieved with partial solutions; it requires advanced approaches to its virulence and quorum. **Melony Sellars**, Genics, Australia, advocated for evidence-based solutions, biosecurity and genetic selection to enhance shrimp growth, survival and disease resistance. **Bas Wolkenfelt**, Hendrix Genetics stated that while genetic selection has improved shrimp disease tolerance and growth, survival largely depends on environmental and management factors. Breeding strategies use disease studies and sentinel populations, but aligning genetics with farm conditions is crucial for optimal performance.

Mihai Sun, Inve Aquaculture compared nursery systems in Indonesia and Latin America, emphasising that shrimp nurseries significantly improve production efficiency, profitability and disease control. **Albert Tacon,** USA, outlined standard procedures for post larvae, highlighting the importance of quality feed, nursery care and sound farm management.

Changing shrimp farming practices

A question posed by Ronnie Tan, Aquaculture Consultant at US Grains and Bioproducts Council, to a panel discussing the above topic was, 'Do we need to change our farming practices?' Indonesia's disease pressure varies sharply by region, and stocking density must follow suit. **Robins McIntosh,** Executive Vice President, Charoen Pokphand Foods (CPF), warned that pond failure is the industry's biggest cost, and high densities in high-pathogen zones only increase risk. **Gerry Gilang Kamahara,** Chairman, Farmers Learning Club, agreed with the statement, stating that he has been farming in red areas (areas with poor conditions), while using a 'weakest-point' rule to set carrying capacity. In West Indonesia, he finds that <100 PL/m² delivers the most consistent profit.

Daranee Seguin, Product Director Shrimp, Aker QRILL Company, commented on whether low-protein feeds are a cost-saver or a growth limiter. Indonesia's shift to 30–32% crude protein feed is driven by cost pressure and algae-bloom concerns. However, low protein only works at low densities. At higher densities, shrimp need 35–36% protein to reach their growth potential. Gerry prioritises profitability over FCR, noting that mortality—not feed—spikes FCR.

A post-harvest issue is water absorption and texture degradation during long-distance transport to processing plants in slurry ice for up to 48 hours. With the vast archipelago, Gerry argues that building processing plants near farms is economically unrealistic. The real solution is a stronger cold chain, though costly. Robins recommended lower core temperatures and higher ice to shrimp ratios.

The panel on 'Do we need to change our farming practices' had Ronnie Tan, USGBC, as moderator (left), with Gerry Gilang Kamahara, Farmers Learning Club (from second left), Daranee Seguin, Aker Qrill Company and Robins McIntosh, Charoen Pokphand Foods (CPF). Photo credit: JALA.

Association leaders, from left, Anna Maria, Executive Secretary, Indonesia Fishery Product Processing & Marketing Association or AP5I; Denny Mulyono, Chairman, Indonesian Feedmills Association or GPMT; Rizky Darmawan, Chairman, Young Shrimp Farmers Association Indonesia or PMI; Andy Tamsil, President, Shrimp Club Indonesia; and moderator, Andy Solomon. Photo credit: JALA.

On the use of acoustic autofeeders, Gerry noted that small ponds, heavy paddlewheel aeration and high CapEx make adoption difficult. On which stocking density, Gerry advocated smarter, region-specific stocking and reducing mortality risk, Robins quoted India and Ecuador's success with 30–60 PL/m² and modest aeration—yielding consistent 8–11 tonnes/ha at low cost.

The future of the Indonesian shrimp industry

Andy Solomon led a group of association members to discuss how they could collaborate to shape the shrimp industry's direction over the next 5–10 years. The panel was clear that Indonesian shrimp should not be labelled as 'radioactive' or 'with antibiotics'. It is important that feeds should be antibiotic-free, said **Denny Mulyono,** GPMT, while **Rizky Darmawan,** PMI insisted that farmers should use registered-only products or fully understand any adulterated products being used.

After the Cs-137 incident, Indonesia invested in detection equipment for shrimp exports. **Aryo Wiryawan,** Chairman of JALA and moderator for the panel on redefining competitiveness and consumer expectations, asked how the industry can leverage this for the future and help secure clean products for the US markets. The panel noted that it is crucial to show proactive food safety measures and identify the source of contamination to demonstrate progress beyond simply remedying the situation. Aryo concluded that trust and transparency are critical moving forward.

From left, Liris Maduningtyas, and Aryo Wiryawan, Chairman of JALA, with panellists, Erwin Dwiyana, Aquaculture Division (KPP), Ministry of Fisheries and Marine Affairs; Kevin Sidharta, Representative, Haven Foods and Dan Gibson, Deputy Editor for the EMEA, Undercurrent News. The panel discussed 'Market Landscape: Beyond US, Redefining Competitiveness and Consumer'. Photo credit: JALA

Next gen meet in Cebu

Filipino shrimp and tilapia farmers exchanged ideas with their Indonesian and Thai peers during the second meeting in this series aimed at the next generation

Caleb Wurth, U.S. Grains & BioProducts Council (middle right) with shrimp and tilapia farmers from the Philippines. Photo credit:USGBC.

A fascinating story lies behind this initiative to unite the next generation in collaborative problem-solving. Indonesia's Young Shrimp Farmers Association, known as PMI (Petambak Muda Indonesia), founded in 2015, serves as the model.

Caleb Wurth, Regional Director for Southeast Asia and Oceania at the U.S. Grains & BioProducts Council (USGBC), is leading a program to empower young shrimp and fish farmers across Southeast Asia's aquaculture sector. "We want to expand this model to other Asian countries to foster the development of the next generation by facilitating opportunities for exchanging experiences and technology."

The meeting on 27 January brought together some of the next generation of shrimp and tilapia farmers from the Philippines to connect with their peers from Indonesia and Thailand. There were 46 participants.

In describing the PMI model, Co-Founder **Rizky Darmawan,** explained that it was set up to help a group of young farmers address operational issues and develop business strategies. "Among our goals is to ensure better practices and support regeneration within the industry. We provide one another with practical guidance through peer exchanges and strong community building." Rizky observed that the younger generation is more open to change, and is more collaborative, scientific, data-driven and results-oriented.

This report covers the shrimp session. A follow up article on the tilapia session will be featured in a future issue.

Rizky Darmawan, Delta Marine Group, Indonesia (left) led a panel on common themes and collaboration. From second left, Khemika and Yanisa Klomsuwan, Krabi Kieang Seng, Kitcharoen Farm, Thailand; Christopher Tan, Mida Trade Ventures, Singapore; Bernard Lim, HPL Group, Philippines; Patrick Wijaya, PT Trisula Amerta Mandiri and Reynard Suharja, PT Sinar Putra Samudra, Indonesia. Photo credit: USGBC.

Know your markets

There is now an oversupply situation in the global shrimp market and understanding domestic and global marketing is essential. **Christopher Tan,** Director at Mida Trade Ventures, Singapore, provided an overview on shrimp demand and supply trends. The forecast on global supply in 2025 was 6 million tonnes, led by Ecuador (1,538,000 tonnes), India (1,106,000 tonnes), China (992,000 tonnes) and Vietnam (704,000 tonnes). Christopher noted that shrimp farming in the top four countries are concentrated in one area such as in the Guayas (Ecuador) and Andhra Pradesh (India). In Indonesia and the Philippines where production is spread across the coastlines, there is potential for expansion.

In H2 2025, importers were China at 469,600 tonnes (26.3%), USA at 414,500 tonnes (23.2%), Japan at 98,990 tonnes (5.5%) and Spain at 86,900 tonnes (4.8%). "China is an exception; it is probably the only country in the world which can farm shrimp and consume all of their production." Ecuador exports most of its shrimp to China and lesser volumes to the EU, US, Russia and Japan.

Christopher said, "In the US, the retail market accounts for 40% of total shrimp consumption. A significant portion of the shrimp is semi-processed and ready for cooking or consumption. The leading suppliers are India and Indonesia." He added that the bulk of Ecuador's production is geared towards producing one or two items. Ecuador is now increasing value added products as it pivots to the US market.

He concluded that the global shrimp market is growing but increasingly saturated. At current price levels, farmers earn ~30–50% margins, supporting continued and aggressive capacity expansion. Strategic diversification and risk management are critical for long-term sustainability in the shrimp industry. If supply outpaces demand, it will bring prices down. Disease trends lead to a volatile market.

SWOT on vannamei shrimp aquaculture in the Philippines, Indonesia and Thailand

Bernard Lim, Vice President of HGL Group, Philippines, stated that 90% of production is consumed by the domestic market, where prices remain high. However, unregulated imports of cheap frozen shrimp from other Asian countries are flooding the local market, resulting in a 20–30% drop in farm gate prices and squeezing farmers' profit margins.

Bernard noted that even with biosecurity protocols in place, the industry continues to face disease outbreaks—including AHPND (acute hepatopancreatic necrosis disease), WSSV (white spot syndrome virus), *Enterocytozoon hepatopenaei* (EHP) and emerging pathogens—that threaten both survival rates and profitability. He added, "Avoiding antibiotics helps meet EU standards, increasing access to that market. There is growing demand in the EU for eco-friendly, antibiotic-free shrimp, giving the Philippines an opportunity to promote its product as safe and traceable."

Patrick Wijaya, PT Trisula Amerta Mandiri, a third-generation farmer managing two farms in Java, and **Reynard Suharja,** PT Sinar Putra Samudra, a PMI Co-Founder with farms in both Java and Lombok, said that Indonesia's shrimp farming faces major challenges. "Despite a promising, tech-savvy generation of farmers, outdated infrastructure, disease threats and policy issues slow progress. Many farms lack modern aquaculture design, limiting sustainable production." Skilled labour is also in short supply despite Indonesia's large population.

They presented examples of farms spanning from the east to the west of the country, each with distinct traits and facing different challenges. Since every area encounters unique shrimp diseases, farmers must develop systems tailored to their specific needs. Rizky, Reynard and Patrick employ semi-biofloc technology at their farms in Sumbawa, Lombok and West Java as they address endemic EHP. Farms in Sumatra are affected by both AHPND and EHP. This new wave of farmers is characterised by their technical skills, willingness to collaborate and enthusiasm for modernisation. Reynard expressed pride in the growing PMI young farmers' community, describing it as "strong, expanding and receptive to new technology."

SVM-CSM's Ian Rhald S. Magallona (centre) with brother Herald and business partner, Nolan Bretana (right). Farming vannamei shrimp at 100-120 PL/m², Ian took over his father's 72-80ha farm in General Santos, Mindanao in 2018. He said, "Not every teenager has the chance to start a farm".

In Krabi province, Thailand, sisters **Yanisa** and **Khemika Klomsuwan** are now running their family's Krabi Kieang Seng, Kitcharoen Farm. Thailand's production has been limited by disease risks like EHP and WSSV, with mortality and slow growth, as well as environmental challenges. Today, the industry has shifted from disease recovery to prioritising sustainability and biosecurity.

Biosecurity and controlling costs are essential for the industry's future. Khemika explained, "Our production expenses are higher than in other countries because feed, labour and energy prices are all elevated." They outlined the steps taken to transform production at the farm. By Q1 2025, average daily growth (ADG) rose from 0.25g to 0.41g, yield increased to 6–8 tonnes/rai in 90–100 days (up from 2.5 tonnes/rai in 120 days), and shrimp size grew from 20–22g to 30–55g. "With an 80% success rate per cycle and alignment with global sustainability standards, these efforts produce steady growth and consistent output," said Yanisa. (One rai=1,600m²)

	PHILIPPINES	INDONESIA	THAILAND
STRENGTHS	• Good climatic conditions • Established culture technology/large production bases • Consensus on antibiotic-free farming • Good local market -90% of production • Government policy & roadmaps • Strong private sector & associations e.g. PHILSHRIMP	• Climate & long coastline (54,716 km) • Culture technology tailored to environment and specific farm • Willingness to collaborate	• High density culture (60-200 PL/m²) • Culture with probiotics and biofloc • RAS adaptability • SPF and fast growth genetics (>3g/ week) • Low FCR (1.5) • Antibiotic-free farming • Good local market -73% of production
WEAKNESSES	• Biosecurity and recurring diseases • Limited accessibility to labs • Rising costs (feed, energy and labour) • Poor financial capacity • Weak government support for R&D • Lack of young generation to continue industry	• Poor standardisation for Best Aquaculture Practices • Lack skilled human resources • Weak regulations • Reliance on a single market	• High feed, labour, energy costs • Environmental pollution • Export dependence
OPPORTUNITIES	• Potential to brand shrimp as safe and traceable • Increase exports competitiveness with value-added products • Government certification	• New generation farmers & PMI • Large population - potential for a large domestic market • Access to Southeast Asia and Asian markets	• Fast growth in domestic demand • Strong premium market positioning in EU • ~50 farms with ASC/~70% with GAP • Automated feeding and sensors
THREATS	• Diseases - Vibriosis, WSSV, AHPND and EHP • Poor regulation on cheap shrimp imports, impacting local prices • Several cyclones/year	• Disease outbreaks • Geopolitical and economic policies • Extreme weather conditions and global warming	• Climate driven diseases & WSSV, AHPND, EHP • Price competition • ESG & traceability barriers

Table 1. Tabulated summary of strengths, weaknesses, opportunities and threats (SWOT) for vannamei shrimp farming as presented by Bernard Lim (Philippines); Reynard Suharja and Patrick Wijaya (Indonesia) and Yanisa and Khemika Klomsuwan (Thailand).

Together, cousins - James Benedict de Galicia and Sharsee Vegerano started SVJD Aquafarm in Calatagan, Batangas. They have two farms, 2ha and 5ha. Their first harvest was in 2023, with final sizes of 24g shrimp.

Nursery, feed and collaboration

Rizky led this panel discussion. On nursery practices, opinions varied. Khemika explained that many Thai farmers avoid nurseries and opt to use "Super" post larvae (PL 15–20 or PL 25). In the farm in West Java, Reynard uses a small nursery for 5–7 days to check on post larvae quality. In Lombok, he does not use a nursery due to cost. While nurseries in Ecuador can produce up to 4-5 cycles/year, Asian farms face challenges, from increased costs, high stocking densities, disease risks to requirements for water treatment and for a different set of technical skills.

The panel shared industry standards and their feed preferences. Thai farms typically use feeds containing 35–40% crude protein (CP), with a regulated minimum of 32% CP. Indonesian farms prefer feeds with 28–32% CP. Yanisa prioritises digestibility (92%) over crude protein at her farm. Feed prices are USD0.80–1.00/kg in Indonesia, USD1.23–1.30/kg in Thailand for feeds with more than 35% CP, and USD0.90–0.95/kg in the Philippines.

Regarding ADG, Khemika reported 0.4g. Patrick noted his maximum ADG is 0.3g over 90 days, influenced by weather, stocking density, and water capacity. Reynard, despite varying stocking densities, considered 0.25g as a minimum benchmark.

Rizky asked for a 2026 wish list.

- Khemika and Yanisa: Increase production while keeping quality high and boosting efficiency without raising stocking density or cycle numbers.
- Patrick: Survive another year, embrace new ideas and manage risk.
- Bernard: Enhance data integration and learning loops.
- Christopher: Wish to see the initial steps of collaboration.
- Reynard: Encourage collaboration, integrate AI for decisions and promote work–life balance ("happy life, happy farm").

Caleb Wurth, USGBC (right) with Rizky Darmawan, Delta Marine Group, Indonesia (middle) and from the Philippines, Ryan Alegre, Dobe Hatchery; Constatine Ong, Santeh Feeds Corporation and King Umali, Forum Aquafarm.

Building resilient shrimp: How genetics and hatchery systems drive post larvae quality

Given the growing challenges in farming environments, achieving sustainable and profitable shrimp production in Asia requires resilient post larvae

By Natthinee Munkongwongsiri and Craig L. Browdy

Global shrimp production continues to grow, with major producers such as Ecuador, India, China, Vietnam and Indonesia expanding output to meet rising demand. At the same time, shrimp farming is becoming increasingly complex. Disease pressure, environmental variability, tightening biosecurity requirements and rising feed costs are placing greater emphasis on consistency and risk management rather than maximum growth alone.

Shrimp seed quality matters

Particularly in Asia, shrimp are farmed across highly diverse salinity ranges, pond systems and management styles. Recent data from across Asia showed a significant percentage of ponds are being flushed or crops harvested early due to slow growth, high mortality rates and disease outbreaks. The financial toll from lost crops is substantial, compromising farm viability. Under these conditions, the quality of shrimp post larvae (PL) —especially their robustness and resilience—has become a critical factor in farm performance. Consistency in survival, adaptability and feed efficiency now rank alongside growth as core performance indicators.

As a result, shrimp breeding programs and hatchery systems are evolving toward integrated, science-based approaches that link genetics, hatchery technology and performance data across the production chain.

Genetics and building resilient shrimp post larvae

In modern shrimp farming, genetics defines more than growth rate. As farming environments become more variable and challenging, and production risks increase, breeding objectives must focus on producing shrimp post larvae that perform consistently under commercial conditions despite these challenges.

Earlier breeding approaches often prioritised rapid growth, assuming this alone would drive farm success. Experience has shown that such single-trait selection for growth frequently leads to trade-offs, particularly reduced robustness and lower tolerance to stress or disease. Shrimp that perform well under ideal conditions may struggle when exposed to fluctuating salinity, water-quality challenges or pathogenic pressure.

To overcome this, advanced breeding programs now apply balanced genetic strategies that improve multiple traits simultaneously. High genetic diversity provides the foundation for long-term improvement, while quantitative genetics and genomic selection increase accuracy and rate of genetic improvement for combinations of complex traits. Index-based selection allows growth, survival, robustness, and disease tolerance to be improved together rather than in isolation.

Balanced breeding programs, such as those implemented within SyAqua's genetic development framework, apply index-based and genomic selection to simultaneously improve growth, robustness and disease tolerance, reflecting the shift towards resilience-driven breeding objectives.

From genetic design to commercial farm performance

Balanced breeding strategies must ultimately prove their value under commercial farming conditions. Genetic programs designed for resilience must therefore deliver consistent performance not only when farming conditions are optimal but also under farm-level stress conditions.

"These trends are supported by multi-country commercial production records generated through structured benchmarking programs, including datasets developed within SyAqua's commercial farming network."

Breeding programs that deliberately select and test shrimp across different salinity environments have demonstrated that strong performance can be maintained across low-, medium- and high-salinity systems. Rather than producing environment-specific lines, balanced genetic strategies allow a single genetic line to perform reliably across diverse farming conditions.

Disease pressure represents an additional and often disruptive source of production risk. While different genetic stocks may show similar growth and feed conversion under non-challenged conditions, clear differences emerge when shrimp are challenged by the presence of disease pathogens. Controlled challenge testing shows that genetically tolerant stocks maintain significantly higher survival, better growth and improved feed efficiency under disease pressure. This tolerance has been demonstrated for viruses as well as bacterial and fungal pathogens such as acute hepatopancreatic necrosis disease (AHPND) and *Enterocytozoon hepatopenaei* (EHP).

Commercial farm data confirms the practical value of these traits. Across ponds facing variable environmental and health challenges, balanced genetic lines show more stable growth, efficient feed conversion and consistent yields. Performance trends remain similar across environments rather than diverging sharply, reducing uncertainty for farmers and feed producers.

These trends are supported by multi-country commercial production records generated through structured benchmarking programs, including datasets developed within SyAqua's commercial farming network.

Genetic integrity and traceability

As breeding programs become more sophisticated, maintaining genetic integrity and traceability throughout the production chain is increasingly important. Unintentional hybridisation, genetic drift or misidentification of stocks can compromise performance outcomes and reduce confidence in production results.

This issue is particularly relevant for farmers sourcing post larvae from hatcheries that manage multiple genetic stocks. Without reliable verification, it can be difficult to link on-farm performance—such as survival, growth or feed conversion—to a specific genetic line. This uncertainty complicates management decisions, feed evaluation and comparisons between production cycles.

Genomic tools now allow reliable verification of genetic identity using small sample sizes collected at the farm level. Proper sampling protocols and secure data handling ensure confidentiality while providing statistically robust differentiation between genetic lines. This enables farmers to confirm that the post larvae stocked in ponds match the intended genetic source (Figure 1).

Hatchery systems to unlock genetic potential

Genetic improvement alone does not guarantee performance. The expression of genetic potential depends heavily on hatchery systems and management practices. Poor hatchery execution can mask genetic advantages, resulting in variable post larvae quality and inconsistent farm performance.

Key hatchery elements that support high-quality post larvae production include:

- Strong biosecurity and water treatment systems
- Effective bioremediation and water quality management
- High-quality fresh and formulated feeds
- Feeding strategies aligned with larval developmental needs

Larval feeds are critically important, from healthy algae to clean, enriched *Artemia* with little to no *Vibrio* contamination and high-quality manufactured larval feeds. Hatcheries have many choices in larval feeds from low-cost flakes to the most advanced, highly digestible and nutritionally balanced microencapsulated particles.

In a well-managed hatchery, high-quality feed improves profitability by increasing survival rates and enhancing post larvae quality. Feed management is particularly critical. Overfeeding does not improve larval performance and often leads to deteriorating water quality and compromised health. Successful hatcheries rely on frequent observation of survival, gut fullness and larval condition, adjusting feeding rates accordingly rather than following fixed feeding plans.

Measuring and assuring post larvae quality

Post larvae quality cannot be assumed—it must be measured. Comprehensive post larvae quality assessment programs typically include:

- Morphological assessments for size consistency, deformities, fouling and tissue damage
- Evaluation of physiological indicators such as lipid reserves
- Stress tests and stocking accuracy checks
- Pathogen screening using molecular and microbiological tools
- Continuous monitoring of key water quality parameters

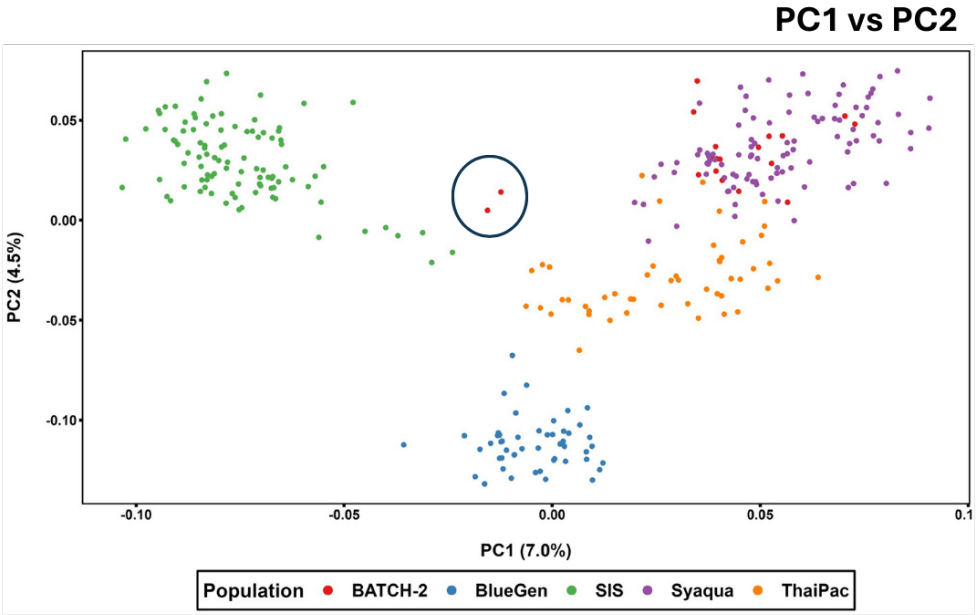


Figure 1. Genomic analysis enables reliable statistically powerful differentiation of SyAqua from non-SyAqua or hybrid stocks.

Coupled with new AI-based tools for measuring and quantifying post larvae, these assessments provide hatcheries and farmers with greater confidence in the quantity and quality of seed entering grow-out systems. Ensuring that the pond is stocked with the correct number of post larvae is critical for proper pond management. Even small improvements in post larvae quality can translate into significant gains in survival, growth, and feed conversion efficiency at the farm level.

"Investing in high-quality shrimp post larvae delivers returns that far outweigh the initial cost."

Conclusion: Investing in post larvae quality pays dividends

Shrimp farming success increasingly depends on integrating genetics, hatchery technology, and data-driven decision-making. Advances in genomic selection, combined with balanced breeding strategies and modern hatchery systems, enable the production of post larvae that are not only fast-growing but also robust, disease-tolerant and efficient feed users.

For the industry, the message is clear: investing in high-quality shrimp post larvae yields returns that far outweigh the initial cost. As farming environments become increasingly challenging, resilient post larvae will form the foundation of sustainable and profitable shrimp production worldwide.

Note: The article was first published in the December 2025 issue of International Aquafeed.

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Can the Philippines aquaculture rise again?

A conversation with Christopher G. Co on integration, innovation and industry reform

Christopher G. Co is Chief Operating Officer at Cebu-based Oversea Feeds Corporation, integrated company spanning feed milling, hatchery and grow-out operations in Cebu and beyond.

As Chief Operating Officer at Cebu-based Oversea Feeds Corporation, **Christopher G. Co** has spent nearly four decades in the Philippine aquaculture industry, long enough to have seen cycles of boom, disease and reform. Oversea Feeds Corporation is an integrated company spanning feed milling, hatchery and grow-out operations in Cebu and beyond. He sits on industry boards, advises the government and runs a business that began with fishponds in 1987 that now stretches across several islands. If the Philippines is to rise again as an aquaculture powerhouse, it will do so by importing substitutes, preserving margins, innovating technology and improving policy.

During a conversation at the company's hatchery business in Cebu, Christopher discussed integration, innovation, and reform in the Philippine aquaculture industry. The discussion concluded with whether the Philippines could reclaim its status as a leading producer of shrimp and farmed fish in Asia, a position it once held with the black tiger shrimp in the 1990s.

Balancing an integrated supply chain in the Philippines

What was the sequencing for Oversea Feeds Corp towards integration?

We began with grow-out, then set up our own feed mill and later our own hatchery. It was not so much a grand design, but a gradual completion of the value chain. Each step complemented the other. Some companies start with a feed mill or a farm and then move upstream or downstream depending on priorities.

Integration, however, does not mean equality among divisions. In many fully integrated companies, one division exists primarily to support another, upstream and downstream. It may not be treated as a profit centre.

In our case, the feed mill remains the main business. The farm is both a profit centre and a support unit. The farm sources feeds and post larvae internally for our own farms, but the feed mill and hatchery also sell substantially to the open market. In fact, most of our hatchery output goes to other companies.

Others operate differently. Some hatcheries supply mainly their own farms, while other processors rely almost entirely on their own farms for their raw materials. Models vary; priorities dictate structure.

> **"Regardless of setup, in aquaculture, everything centres on the farm. If post larvae arrive late or feed quality slips, performance suffers. The farm must go on."**

When problems arise in one part of the chain, how do you manage them?

If everything is seamless, the schedule runs smoothly. But when one link falters, disruption quickly spreads. I have told our farm managers that if the feed mill or hatchery cannot deliver at the point of need, do not sacrifice farm operations. Inform us and source externally if necessary.

It may look odd when other players notice that an integrated company is buying from outside, but to me, this is preferable to delaying stocking or compromising the feed supply. Regardless of the setup, in aquaculture, everything centres on the farm. If post larvae arrive late or feed quality slips, performance suffers. The farm must go on.

Will you integrate further into processing?

I have always believed that processing can be a standalone. One does not need farms to build a plant. However, in the Philippines, processors without their own raw material base have struggled. They have downsized or stop operations because they cannot secure enough raw material.

We are interested in processing, though it will likely fall to the next generation. At present, our largest revenue and cost centre is the feed mill, followed by the farm. The hatchery is the smallest in both revenue and expense.

How does the feed mill operate within this model?

Feed milling in the Philippines is a low-margin, high-risk business. Feed producers often finance farmers who, in turn, deal with weather calamities, disease, farmgate price volatility and fluctuating input costs. Feed ingredients themselves are exposed to global events.

Our mill focuses exclusively on aquaculture. We produce shrimp, tilapia and bangus (milkfish) feeds, along with broodstock feeds, and we even have lines for aquarium fish feeds. Some broodstock feeds are now used by government and private hatcheries. The feed mill follows the fortunes of the farm. When farmers prosper, so do we.

A processor's intelligent business model

What is your take on growing the processing business in the Philippines?

In the past, integrated models treated farms merely as a captive supplier. It is common for processing plants to impose transfer prices on the farms, aligned with export markets. These prices are controlled, often to the detriment of farm profitability. Here in the Philippines, farms absorbed opportunity losses because wet market prices are higher, but they did not sell to them.

There is one processor that has reversed the accepted logic. He first calculated how much volume the local market could absorb profitably and has prioritised that margin. Only after expanding grow-out beyond local demand did he justify building a processing plant. The surplus harvests feed his processing plant, and then, only with more surplus production will he consider exporting.

His initial goal is 'import substitution' for his processed shrimp. This is supplying domestic buyers who have been importing shrimp from Vietnam or Indonesia. Furthermore, automation plays a central role in his operations when our labour costs are high. Manpower requirements are reportedly reduced to about 10% of conventional levels. This is an operator that seems to be doing it right.

In this scenario, where is the profit?

Each stage is treated as a profit centre. Local sales maintain traditional margins. Surplus production earns processing margins, albeit lower than domestic wet market returns.

This differs from exporters such as Ecuador, where production far exceeds local demand and margins depend almost entirely on export markets. Lower production costs underpin their model, though rising density brings culture complexity. In that scenerio, my view is that survival rates and feed conversion ratios eventually suffer due to intensification.

Do you believe that expansion is always about density?

Not necessarily. Nursery systems within farms allow overlapping cycles, increasing annual output without proportionally expanding land or density. Modular approaches can raise productivity while managing risks.

Packing P. vannamei post larvae for transport at the Cebu hatchery.

Automation to improve productivity

What steps have you recently taken to innovate your operations?

In the hatchery, filtration systems are automated. Larval tanks are fitted with temperature sensors calibrated to different developmental stages. We use ozonation instead of chlorine or formalin for disinfection, thereby avoiding chemicals. Indoor algae culture employs hydroponic-style lighting, similar to systems used in China, which I recently discovered.

At the feed mill, we are upgrading equipment and automating bag packaging. We are in the midst of installing sealing systems from Europe and robotic palletising equipment from China. Labour costs are rising and these are some steps to reduce labour intensity. Our new waterproof packaging eliminates inner plastic liners, reduces odour and rodent damage and improves warehouse conditions.

In shrimp grow-out, we are adopting nanobubble aeration and fine diffusers. Paddlewheels no longer serve as primary aerators but now circulate waste. Stocking densities reach 150–170PL/m^2 at our farms. We harvest shrimp at preferred sizes for domestic markets (20–30g or 50-35/kg) with partial harvesting. We do avoid extreme super-intensive circular tank systems. I believe that the application of technology must match the context.

Major challenges in the Philippines

In your opinion, what are the main challenges today?

For shrimp, the familiar diseases persist. Farmgate prices are relatively strong compared to global levels. That is

precisely why the Philippines exports small volumes of shrimp. Domestic prices are attractive, but imports exert pressure on local suppliers. The country imports between 300,000 and 380,000 tonnes of seafood annually. When imports exceed roughly 350,000 tonnes, I see that farmgate prices for milkfish and tilapia can fall to breakeven levels or even below.

Are weather events worsening?

Typhoons remain a risk, but flooding has become the more frequent problem. Nowadays, destruction from typhoons is rarer than from recurrent inundations.

What about energy and logistics?

Electricity prices have stabilised but remain high relative to our neighbours. Transportation, especially inter-island logistics, is costly. This is a reality that we have accepted. Imports face the same structural expense, but they do not generate sufficient domestic livelihood. There is concern that government policy leans too heavily on importation as a shortcut to ensure a stable food supply and prices.

How does land reform factor in aquaculture development?

Agricultural land continues to shrink. The Department of Agriculture has recently issued a freeze on further land conversion from agriculture to commercial or residential use. This reclassification stops new areas from being developed. The Comprehensive Agrarian Reform Program (CARP) limits ownership to five hectares per individual or company. In practice, agriculture often requires scale. This tension remains unresolved.

You sit on the NFARMC board. What is its role?

The National Fisheries and Aquatic Resources Management Council (NFARMC) is a 15-member advisory body to the Department of Agriculture and Bureau of Fisheries and Aquatic Resources (DA-BFAR). Representation spans capture fisheries, commercial fishing, NGOs, academia, government and there is only one seat for aquaculture, which I currently hold.

Aquaculture production surpassed capture fisheries in 2018 and has remained ahead. Yet representation does not reflect that shift. We are working to address the imbalance.

Recent regulatory work includes draft rules for the Australian red claw lobster and giant freshwater prawn as well as the national good aquaculture practice (GAqP) standards. The council also reviews requests for the importation of seafood - from salmon and pangasius to species that could potentially be cultured locally.

Return to be a leading aquaculture country

Can the Philippines return to being a top aquaculture producer?

We used to be somewhere around number 11 globally. It is possible, but not anytime soon. It requires sustained commitment from both the government and the private sector.

Rank	2022	Total (million tonnes)	Capture (million tonnes)	Aquaculture (million tonnes)
1	China	88.6	13.2	75.4
2	Indonesia	22	7.4	14.6
3	India	15.7	5.5	10.2
4	Vietnam	8.8	3.6	5.2
11	Philippines	4.1	1.8	2.3
SOURCE: https://worldpoputationreview.com/country-rankings/fishing industry by country				

The Department of Agriculture, in coordination with other agencies — and for the aquaculture industry, with BFAR — has been conducting a series of conferences and forums to identify priority agricultural and aquatic products. These discussions identify which products are imported and whether these can be produced locally as part of the import substitution strategy.

Christopher G. Co is flanked by Ramir Dacullo, National Feed Sales Manager (left) and Gina Melendres, Hatchery Manager (right) with hatchery staff at the Oversea vannamei shrimp and milkfish hatchery in Cebu. From the left, Vicente Asok III, Priscillano Melendres, Airen Mae Gepilano, Lou Angeli Lumacad and Reymon Sabayton.

This reflects the current direction of the present government agencies, promoting the development of a more sustainable local agriculture and aquaculture industry. With the coordination and cooperation of the private sector, the initiative also covers products with strong potential for local production. Together with the NFARMC, the government aims to establish the necessary rules and regulations, to better organise and develop specific products/species and industries.

There is also renewed interest coming from facilities such as the Southeast Asian Fisheries Development Center-Aquaculture Department (SEAFDEC-AQD) in developing aquaculture species that were not given much priority. This is positive news on the government's desire to expand production, not just with the existing mainstream species such as shrimp, milkfish, tilapia and seaweed, but also those with promising potential.

All this we have not seen in the past decades. This renewed interest in developing the local industry is very encouraging.

What led to the decline in farming of marine species like the pompano and grouper?

We no longer produce grouper and pompano. Many farms were displaced by imports from China. For milkfish, a critical issue is the supply of fry. Over 60% of fry is imported from Indonesia. Government breeding programmes are under development, but questions remain about scale and economic viability. The government's strategy is for hatcheries to have their own broodstock and they need to wait years before fish reach the spawning stage. In Indonesia, the government implemented small broodstock facilities across the country and supplies day-old eggs to hatcheries. I believe that the government should not be involved in detailed operations.

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Beyond 2030 - where is the future of marine ingredients heading?

By Brett Glencross

The following article is a summary of the OECD-FAO Agricultural Outlook 2025-2034 section on marine ingredients. The original paper is available from: https://doi.org/10.1787/601276cd-en.

Consumption of global seafood is expected to increase, with most of that growth occurring in Asia and Africa. This includes only a slight increase in per capita consumption from 21.1 to 21.8kg. Aquaculture will continue to be the main driver of global seafood production, increasing to 56% of the global supply of more than 200 million tonnes by 2034. Despite this growth and maintenance in demand, the global prices of seafood are expected to decline in real terms.

Exports of seafood are expected to grow, albeit at a slower pace than previous decades. Furthermore, increasing uncertainties face the sector, including changing environmental conditions which impact global production and geopolitical tensions impacting trade policies. Improvement in global fisheries management offers some respite, while a growing focus on sustainable practices will continue to dominate further development of aquaculture.

Fishmeal and fish oil

Marine ingredients have long been considered strategic feed ingredients to global aquaculture production. Of the 21 million tonnes (live weight) of fish products utilised for non-food uses in 2034, 83% are projected to be used for fishmeal and fish oil production. The remaining 17% is likely to be made up of other non-food uses such as for ornamental fish, fingerlings, bait, pharmaceutical goods or as trash-fish use in parts of the world (Figure 1).

Fishmeal will continue to be used primarily as a strategic ingredient in aquaculture feeds, and by 2034, 84% of global fishmeal production will be used by this sector as feed, compared to 78% in the base period of the OECD-FAO study (2022-2024). China will continue to be the largest aquaculture producer, and with this also the largest consumer of fishmeal. OECD-FAO estimates that China will account for 42% of world fishmeal consumption by 2034.

Although fishmeal is mainly used as a feed ingredient by the aquaculture sector, fishmeal is not the main feed ingredient used by that sector. Other feed ingredients, mostly agricultural products such as soybean meal, wheat, rapeseed and corn will continue to make the largest contribution to nutrient supply in feeds for the sector in the foreseeable future. Fundamental differences in scale (3,775 million tonnes grain production versus 6 million tonnes of fishmeal and oil production in 2022 – Figure 2) explain the rationale for this, along with there being limited capacity for any major fishmeal and fish oil production increase. The OECD-FAO study forecasts that by 2034, the use of ingredients such as soybean meal in aquaculture will reach 11 million tonnes, whereas fishmeal inclusion in aquaculture feeds will increase to 4.9 million tonnes.

Consumption of global fish oils shows a different story of growing competition between aquaculture and dietary supplements for human consumption. Forecasts suggest that by 2034, nearly 60% of fish oil (0.9 million tonnes) will be utilised by aquaculture. Farmed salmonids will be the largest aquaculture consumer, with salmonid producing nations like Norway, Chile, Turkiye, and UK continuing to be the main consumers. The remaining 40%+ will be consumed mostly by direct human consumption (pharmaceutical) and pet food applications.

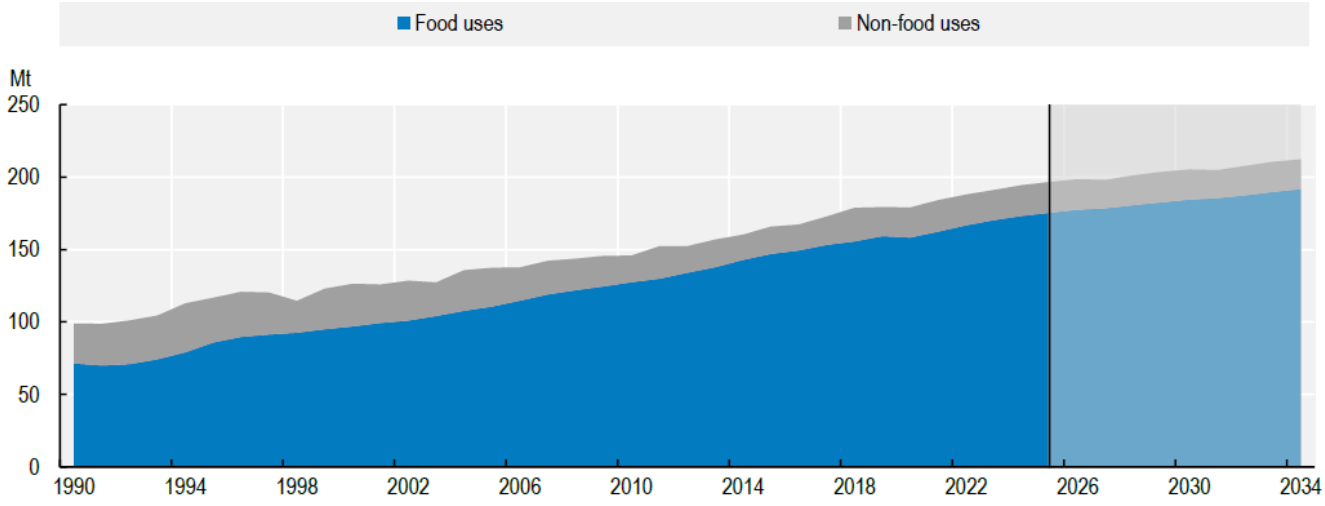


Figure 1. Global usage of fish (fishery and aquaculture) resources, showing food and non-food uses. Notable is not only the diminishing proportion but also the diminishing total volume of non-food use of fishery resources.

Note: Data are expressed in live-weight equivalent.

Source: OECD/FAO (2025), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), http://data-explorer.oecd.org/s/1hc.

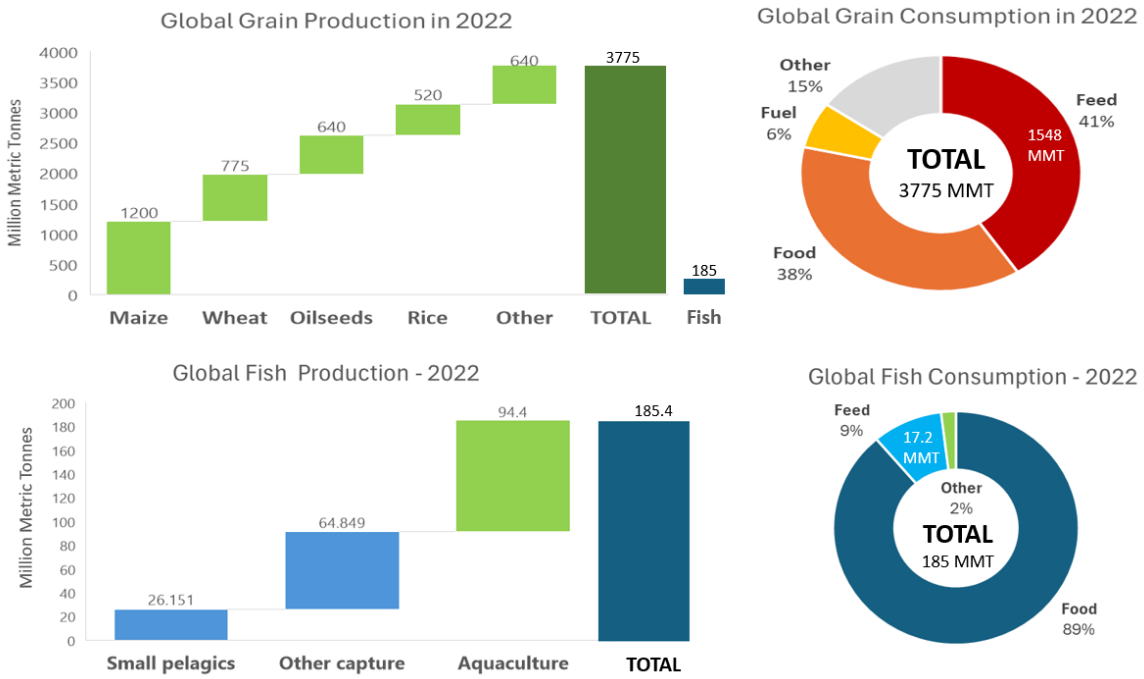


Figure 2. Global grain and fish (fishery and aquaculture) production and consumption, showing food, feed, fuel and other uses of both resource groups. Data source: OECD/FAO (2023), "OECD-FAO Agricultural Outlook", OECD Agriculture statistics (database), https://rb.gy/gngjvf

Figure derived from Glencross et al 2025: Reviews in Fisheries Science and Aquaculture, https://doi.org/10.1080/23308249.2025.2552166. Under a Creative Commons Attribution-NonCommercial-NoDerivatives License.

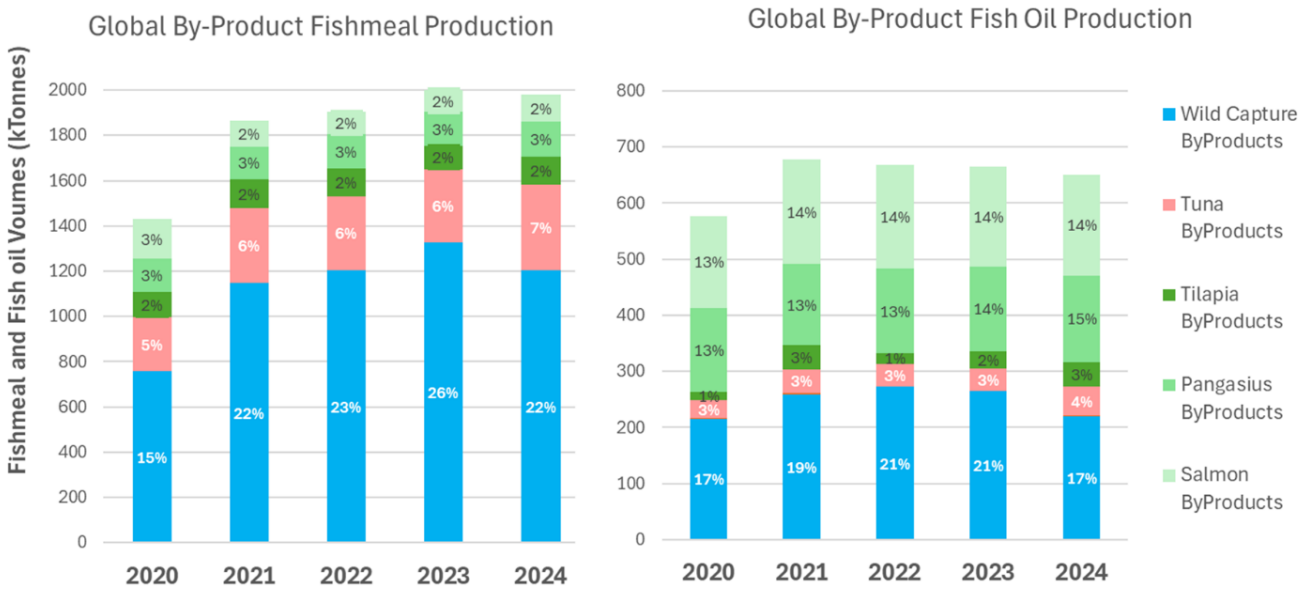
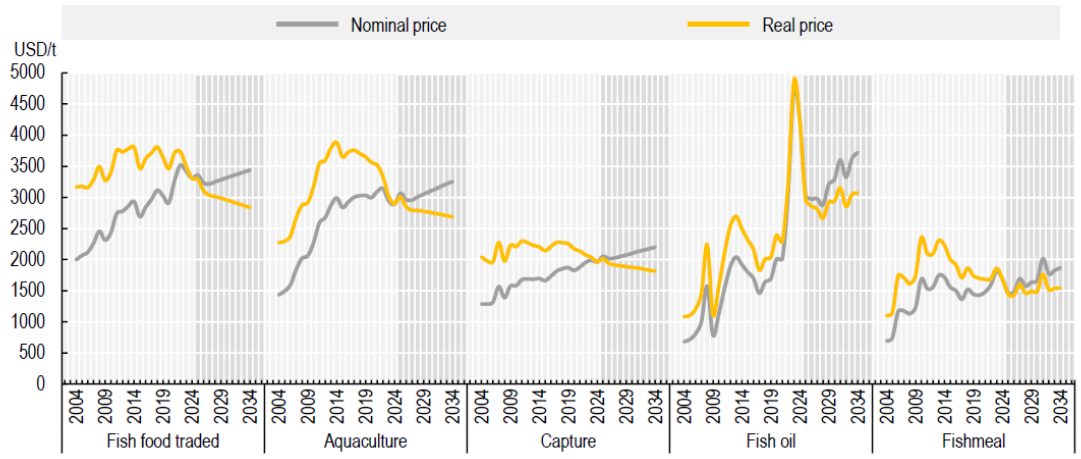


Figure 3. Global production of fishmeal and fish oil from various by-product resource groups over the period 2020-2024. Shown overlaid on the data are the percentage of total (by-product + forage) production in each year. Source: IFFO (The Marine Ingredients Organisation) data 2025.

The OECD-FAO study predicts that the quantity of capture fisheries production that is made into fishmeal and fish oil will show an upward trend in the next decade, compared to the previous decade. While the total volume will vary between 15 million tonnes in *El Niño* years and 17 million tonnes during peak fishing years, the total fishery resource used for direct rendering (forage use) remains well below the 26 million tonnes of fish which were used in the 1990s.

Global production of fishmeal and fish oil is projected to reach 5.9 million tonnes and 1.5 million tonnes by 2034, respectively, representing a 12% increase for both ingredients compared to the base period. Much of this increase is likely to come from fish by-products, with their use in fishmeal production steadily rising over the past decade reaching almost 40% (2 million tonnes) of total production in 2023 (Figure 3). This is likely to continue, driven by the growing demand for fish fillets by consumers, which generates more by-product resource for marine ingredient production. For fish oil, the proportion sourced from by-products exceeds that of fishmeal due to the high oil levels in the waste streams from some aquaculture production sectors (e.g. salmon and pangasius). More than 54% (0.66 million tonnes) of all fish oils came from by-products in 2023. This growth is expected to continue albeit at a slower pace in the next decade.

The OECD-FAO study projects that global exports of fishmeal will rise by 8% relative to the base period, reaching 3.8 million tonnes by 2034. The world's largest fishmeal exporting country, Peru, is expected to record one of the highest growth rates over the next decade, driven largely by a rebound from the unusually low export volumes recorded during base period of the OECD-FAO study, when it experienced a very strong *El Niño* event.



Note: Fish food traded: world unit value of trade (sum of exports and imports) of fish for human consumption. Aquaculture: FAO world unit value of aquaculture fisheries production (live weight basis). Capture: FAO estimated value of world ex-vessel value of capture fisheries production excluding for reduction. Fishmeal: 64-65% protein, Hamburg, Germany. Fish oil: N.W. Europe. Real price: US GDP deflator and base year = 2024.

Figure 3. World fish and other aquatic product prices from 2004 to 2034. Source: OECD/FAO (2025), ''OECD-FAO Agricultural Outlook'', OECD Agriculture statistics (database), http://data-explorer.oecd.org/s/1hc.

China will continue as the dominant global fishmeal importer, accounting for more than half of all imports by 2034. This reflects the growing demand from its aquaculture sector. In contrast, fishmeal imports from other traditional importing countries, such as Norway and the European Union (EU), are projected to decrease as China takes a growing share of production.

Exports of fish oil are forecast to increase by 9% by 2034. Peru, Viet Nam, and Europe will lead global exports of fish oil. In Viet Nam, exports of fish oil will primarily consist of used cooking fish (pangasius) oil exported to the US, where it competes in price with used vegetable cooking oil. The EU, Norway and the United States will remain the primary importing markets over the next decade.

Prices of fish oils are expected to decline in both nominal (-7.5%) and real (-26%) terms over the next decade, reflecting the unusually high prices in the base period (Figure 4). These high fish oil prices during the base period (2022-2024) were caused by combination of unusually low harvests of anchoveta in Peru associated with the 2023 *El Niño* event and high global vegetable oil prices.

The OECD-FAO study predicts the price of fish oil to decline until 2028 in real terms before returning to its historic trend of slow growth due to continuing demand from aquaculture feed and human consumption demands. Prices of fishmeal over the next decade are projected to increase in nominal terms (10%) but decline in real terms (-12%). The real term decline is projected to be significantly lower than in the previous decade, when prices declined 24% from their historic peak in 2013-14. A continued decline in fishmeal prices is forecast in the short-term before settling into their historic pattern of remaining relatively stable on average but with potential price movement due to any *El Niño* event impacts that may occur over the coming decade.

Overall, the future for marine ingredients looks to be steady and transitioning. Growth over the next decade will be limited (~12%), and likely to continue to be affected by global climatic weather like *El Niño* events. Increasingly the sector will transition from relying on whole wild fish to more use of fish by-product streams, serving an important role in the circular food economy as it seeks to retain important nutrients within our food-system.

Consistent with trends over the past decade, aquaculture feeds will become increasingly reliant on grain products to supply most of their nutrients, while marine ingredients will continue to play a strategic role.

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Egg-derived ingredients: Superior nutrition for sustainable vannamei shrimp farming

By Vincent Fournier, Yi-Chi Cheng and Ingmar Middelbos

Circular economy approaches are gaining increasing attention in animal nutrition, where the valorisation of nutrient-rich by-products can reduce waste, improve resource efficiency and decrease reliance on scarce or unsustainable raw materials. Egg co-products from the food industry illustrate this concept. Naturally rich in highly digestible proteins, phospholipids, cholesterol and essential micronutrients, eggs provide both nutritional density and functional benefits that make them attractive for feed applications.

In aquaculture, and particularly in shrimp farming, these attributes are of crucial importance. Unlike many vertebrates, shrimp are unable to synthesise cholesterol *de novo* and therefore depend entirely on dietary sources to meet their requirements (Teshima & Kanazawa, 1983; Teshima, 1997). Dietary cholesterol levels of 0.3–0.5% are generally required to sustain normal growth, moulting and survival in penaeid shrimp (Liu et al., 2014; Gong et al., 2000). In addition, phospholipids — particularly phosphatidylcholine and phosphatidylinositol — are essential for membrane formation, lipid transport and stress tolerance, with recommended levels typically ranging from 1–2% of the diet, depending on developmental stage (Coutteau et al., 1997; Xu et al., 1994). Combination of cholesterol and phospholipids can help to decrease cholesterol requirement in shrimp (Gong et al., 2000).

Traditionally, these key nutrients have been sourced from marine-derived raw materials such as fishmeal, krill meal, squid liver powder or squid paste. While effective, these ingredients face significant sustainability challenges, including overfishing pressure, limited availability and environmental concerns. Moreover, some of these products, notably squid-based meals and pastes, may contain undesirable contaminants such as cadmium, raising additional safety and regulatory issues (Storelli, 2008).

A circular approach to feed formulation using egg-derived ingredients

Egg-derived ingredients offer a promising alternative. They provide a concentrated and consistent source of cholesterol and phospholipids in highly bioavailable forms, while at the same time valorising food industry by-products that would otherwise go to waste.

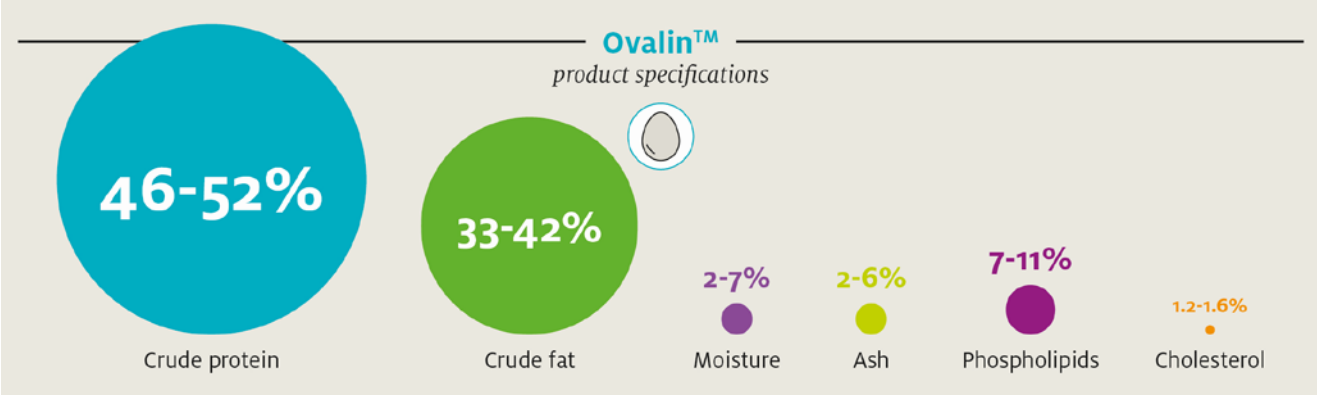


Figure 1. Ovalin product specifications.

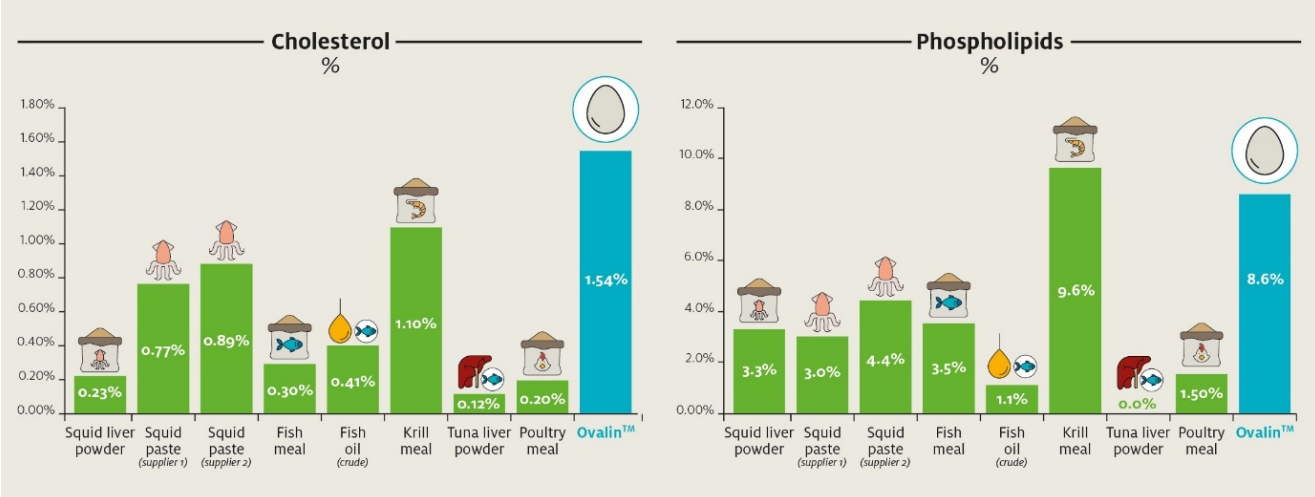


Figure 2. Cholesterol and phospholipid contents in different raw materials commonly used to formulate shrimp feeds.

	Ovalin egg powder replacing	Feed specifications	IBW (g)	Duration (days)	Tank volumes (l)	Shrimp number/tank (n)	Replicates/ diet
Trial #1 Jeju University	Fish meal Squid liver powder	CP 35.7% CF 8.1% Ash 9.0% Energy	0.36	57	215	30	5
Trial #2 Jeju University	Krill meal	CP 37.3% CF 9.0% Ash 10.0% Energy	0.66	71	215	32	5
Trial #3 Jeju University	Squid liver powder	CP 38% CF 9.7% Ash 9.2% Energy 4.4 Kcal/g	0.41	71	215	32	5
Trial #4 Aqualis Thailand	Squid liver powder Krill meal Fish meal	CP 42.2% CF 11.1% Ash 7.6% Energy 4.3 Kcal/g	5.75	28	500	50	4
Trial #5 Aqualis Thailand	Fish meal	CP 39.3% CF 10.1% Ash 7.1% Energy 4.0 Kcal/g	4.5	28	500	50	4

Table 1. Testing conditions applied in the five shrimp trials.

Their inclusion in shrimp diets therefore supports two complementary objectives - improved animal performance and a more sustainable, circular approach to feed formulation.

Symrise, among all its activities, has developed a unique plant network for manufacturing egg meal and egg-derived ingredients across the world with a presence in North America, Europe, and Asia. The Ovalin product range today, whose proximate composition is shown in Figure 1, is the most universal ingredient available and shows an unrivalled composition in terms of cholesterol and phospholipid contents (Figure 2).

This article summarises several performance results obtained with Ovalin egg powder in shrimp nutrition and highlights the potential of such ingredients as a functional, sustainable, and circular alternative to marine-based raw materials in present-day aquafeeds.

Feeding trials

Over a five-year period, five feeding trials were conducted in white shrimp (*Penaeus vannamei*) at two locations – Jeju National University (South Korea) and Aqualis Thailand testing facilities (located near Bangkok). These trials evaluated the performance of egg-based products under various formulation conditions which were then compared to different benchmark diets. Table 1 summarises all experimental conditions.

For these trials, cold-pelletised feeds were formulated and manufactured to fully meet shrimp nutritional requirements and were iso-nutrient across all dietary treatments. Key performance indicators measured included classical zootechnical parameters – survival, feed intake, weekly growth rate and feed conversion ratio – in all trials, as well as protein and fat digestibility in those conducted at Jeju University.

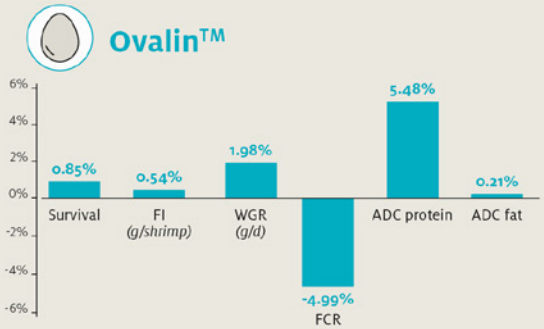
Partial replacement of fishmeal

Ovalin egg powder proved to be a highly effective ingredient for partially replacing fishmeal, even at low inclusion levels (1–2%). Inclusion of egg powder maintained or improved key zootechnical parameters, such as weekly growth rate, feed conversion ratio and protein digestibility (as observed in Trial 1, Figure 3). A slightly reduced performance at the lowest fishmeal inclusion levels (trial 5) appeared to be the result of decreased feed palatability in this dietary treatment.

Replacing squid liver powder

The second set of trial results showed that Ovalin egg powder was a performing, safe and sustainable solution to replace squid liver powder (Figure 4). It did more than just replaced this marine ingredient; it surpassed it in terms of performance for all parameters measured in the three trials conducted in shrimp. While a slight improvement in feed intake was observed with the inclusion of egg powder, the most pronounced benefits were related to feed utilisation efficiency and nutrient digestibility. These improvements resulted in a significant increase in growth performance, giving evidence that Ovalin can be considered as a valuable source of essential macro- and micronutrients for shrimp.

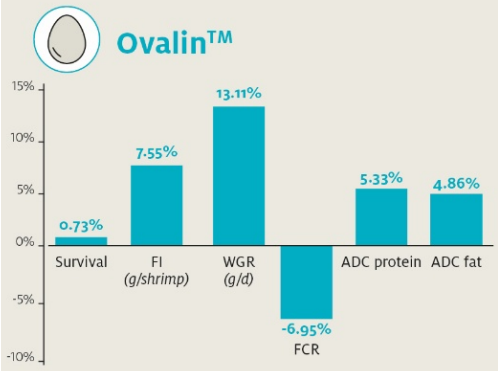
Summary of the performance of Ovalin egg powder in shrimp compared to fish meal
(average of 3 trials)



	Ovalin™	Fish meal	Survival	FI (g/shrimp)	WGR (g/d)	FCR	ADC protein	ADC fat
Trial #1	-	20%	90.0%	11.6	0.94b	1.41a	85.8%b	93.7%
Trial #1	2%	10%	85.3%	12.6	1.08a	1.28b	90.5%a	93.9%
Trial #4	-	15%	86.0%	12.6	1.78	1.73	-	-
Trial #4	1%	8%	89.4%	12.6	1.88	1.62	-	-
Trial #5	-	15%	82.5%	13.0a	1.83a	1.67	-	-
Trial #5	2%	5%	86%	12.2b	1.68b	1.67	-	-
Mean High fish meal diet			86.2%	12.4	1.52	1.60	85.8%	93.7%
Mean Ovalin™ diet			86.9%	12.5	1.55	1.52	90.5%	93.9%
Difference Ovalin/control diet			0.85%	0.54%	1.98%	-4.99%	5.48%	0.21%

Figure 3. Summary of the performance of Ovalin egg powder in shrimp compared to fishmeal (average of three trials). FI: feed Intake; WGR: weekly growth rate; ADC: apparent digestibility coefficient; FCR: feed conversion ratio. Mean values with different letters within the same trial differ significantly (P<0.05).

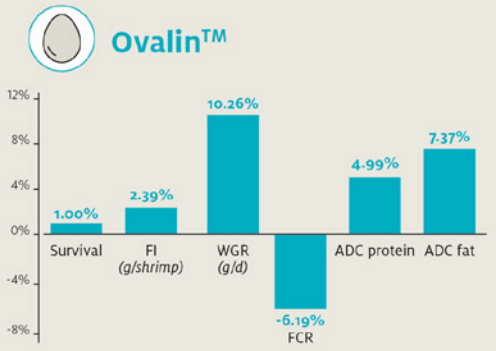
Shrimp and feed performance when Squid Liver powder was replaced by Ovalin egg powder



	Ovalin™	Fish meal	Squid liver powder	Survival	FI (g/shrimp)	WGR (g/d)	FCR	ADC protein	ADC fat
Trial #1	-	10%	5%	84.0%	11.2b	0.86b	1.50a	82.6%b	89.6%b
Trial #1	2%	10%	-	85.3%	12.6a	1.08a	1.28b	90.5%a	93.9%a
Trial #3	-	10%	5%	91.9%	14.7b	1.02b	1.34b	85.1%	92.9%b
Trial #3	2%	10%	-	93.1%	15.7a	1.18a	1.25a	86.2%	97.4%a
Trial #4	-	8%	3%	90.0%	12.1	1.78	1.62	-	-
Trial #4	1%	8%	-	89.4%	12.6	1.88	1.62	-	-
Mean SLP diet				88.6%	12.7	1.22	1.49	83.9%	91.2%
Mean Ovalin™ diet				89.5%	13.6	1.38	1.38	88.3%	95.7%
Difference Ovalin/control diet				0.73%	7.55%	13.11%	-6.95%	5.33%	4.86%

Figure 4. Summary of the performance of Ovalin egg powder in shrimp compared to squid liver powder (average of three trials). FI: feed intake; WGR: weekly growth rate; ADC: apparent digestibility coefficient; FCR: feed conversion ratio. Mean values with different letters within the same trial differ significantly (P<0.05).

Summary of the performance of Ovalin egg powder in shrimp compared to krill meal
(average of 2 trials)



	Ovalin™	Fish meal	Krill meal	Survival	FI (g/shrimp)	WGR (g/d)	FCR	ADC protein	ADC fat
Trial #2	-	9%	1%	96.1%	12.7	0.99b	1.20	88.2%b	85.5%b
Trial #2	2%	9%	-	93.0%	13.1	1.13a	1.11	92.6%a	91.8%a
Trial #4	-	8%	1%	84.5%	12.4	1.74b	1.71	-	-
Trial #4	1%	8%	-	89.4%	12.6	1.88a	1.62	-	-
Mean Krill meal diet				90.3%	12.6	1.37	1.46	88.2%	85.5%
Mean Ovalin™ diet				91.2%	12.9	1.51	1.37	92.16%	91.8%
Difference Ovalin/control diet				1.00%	2.39%	10.26%	-6.19%	4.99%	7.37%

Figure 5. Summary of the performance of Ovalin egg powder in shrimp compared to krill meal (average of two trials). FI: feed intake; WGR: weekly growth rate; ADC: apparent digestibility coefficient; FCR: feed conversion ratio. Mean values with different letters within the same trial differ significantly (P<0.05).

Direct replacement of krill meal

A similar trend was observed when Ovalin egg powder was used as a direct 1:1 replacement for krill meal in shrimp diets (Figure 5). All zootechnical parameters showed improvement and feed palatability remained unaffected. The significant enhancement in protein and lipid digestibility further demonstrated that Ovalin is a nutrient-dense ingredient, providing essential compounds which enhance shrimp metabolism.

Health parameters

As part of the two trials conducted at Jeju University, several health parameters were also analysed at the end of the nutritional trials. Immunity markers (crustin gene expression and lysozyme activity) and antioxidant parameters (SOD, GPx, CAT) responded positively to dietary Ovalin inclusion, Data are not shown and are available upon request.

Conclusions

Like eggs, which are nature's original superfood - a perfectly balanced source of high-quality protein, Ovalin egg powder delivers essential amino acids in optimal proportions for shrimp growth. Rich in healthy lipids, including phospholipids and cholesterol, and packed with micronutrients like choline, pigments (lutein) and vitamins A, D, and B12 (Figure 6), it also supports high shrimp performance, as shown in several trials conducted at different times and under trial conditions. Being available in the main shrimp farming areas, Ovalin egg powder provides animal feed manufacturers with a unique opportunity to enhance feed quality, reduce environmental impact, and boost animal growth and feed performance, while offering shrimp farmers a cost-effective way to improve water and pond conditions, support shrimp health and increase farm productivity.

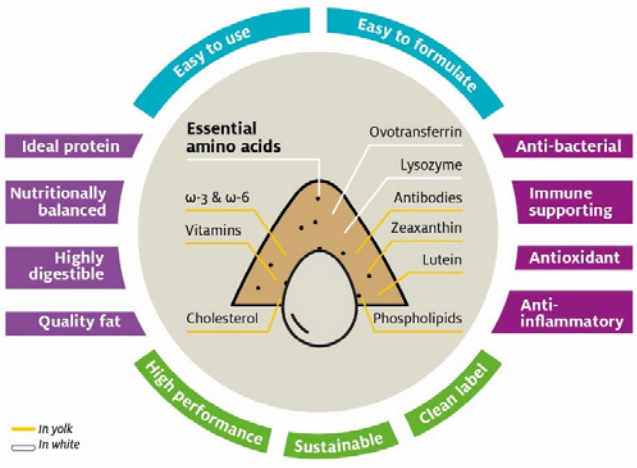


Figure 6. Ovalin product features at a glance.

Acknowledgements
We gratefully acknowledge Professor Kyeong-Jun Lee, from Jeju National University and his students for their support during the shrimp trials. We also acknowledge the former R&D team of Symrise Aqua Feed (Mikael Herault, Clément Martineau and Magaly Hervy) for their significant contributions to data analysis and database management.

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Organic acids can reduce antibiotic use in commercial tilapia farming

Dietary organic acids enhanced immune response and beneficial gut bacteria leading to improved fish survival and production biomass in a commercial tilapia farm in Malaysia

By Wing-Keong Ng, Chik-Boon Koh and Chaiw-Yee Teoh

Fast-growing Nile tilapia strains originating from the GIFT (Genetically Improved Farmed Tilapia) selective breeding program.

The rapid increase in global tilapia production is largely due to the farming of improved fast-growing strains of Nile tilapia. Intensification of culture systems often leads to increased incidences of disease. The spread of diseases in the aquaculture industry had led to the misuse and overuse of antibiotics both as a prophylactic as well as a therapeutic agent. The development of antibiotic-resistant bacteria strains is a potential public health concern other than being harmful to the host animal and the environment. With the current global trend in banning and/or restricting the use of antibiotics, suitable alternatives to antibiotics need to be investigated.

Organic acids in aquafeeds

Organic acids are compounds with one or more carboxyl groups in their structure and include short-chain fatty acids, volatile fatty acids or weak carboxylic acids. Organic acids are categorised as "Generally Regarded as Safe" and have been extensively used in terrestrial livestock feeds. According to a recent bibliometric analysis by de Melo et al. (2025), research on the use of organic acids in aquaculture has greatly accelerated over the period from 1995 to 2024. Our research group at the Universiti Sains Malaysia was identified as having the most cited publications and the highest impact among the 426 authors in organic acids research. We also published a highly cited review paper on the utilisation and mode of action of organic acids in aquaculture which highlighted the beneficial effects of this group of compounds (Ng and Koh, 2017).

Our laboratory research into the use of organic acids as a functional feed additive in tilapia feeds have shown very promising results. It is the aim of this present study to validate whether dietary organic acids can impart beneficial impact when used in a commercial farm setting.

Commercial tilapia farm trial

Four floating cages (two replicates per treatment) in a commercial tilapia farm in Malaysia were used in the study. All male Nile tilapia, *Oreochromis niloticus*, fingerlings (average initial weight 29g) were stocked at an average density of about 56,500 fish per cage (16 fish per m^3). Each fingerling was vaccinated with 0.1mL of a commercial oil-based vaccine against *Streptococcus agalactiae* through intraperitoneal injection.

The extruded commercial tilapia feeds, containing no added organic acids (control) or 2% of a prototype organic acids blend (OAB) were produced by Cargill Feed Ltd. (Malaysia). The prototype OAB were manufactured in collaboration with Sunzen Feedtech Ltd. (Malaysia) and consisted of four organic acids (formic, lactic, malic and citric acids), microencapsulated in a specialised lipid matrix using centrifugal spray cooling technology. With the exception of the added organic acids, both feeds were similarly formulated. Dietary crude protein levels for the starter (Aqua Focus® #6113) and grower feeds (Aqua Focus® #6123) were 37-38% and 34-35%, respectively.

Feeds underwent a comprehensive risk assessment by Cargill International to ensure compliance with GlobalGap and Aquaculture Stewardship Council (ASC) certification for this new functional feed additive. Feeds were transported daily to the tilapia cages and mechanically dispersed twice a day for 203 days of culture. The starter feed was fed for 14 days before switching to the grower feed.

Four semi-rigid circular floating cages were used within a large-scale tilapia farm. The duplicate cages were placed diagonal to each other in the same area to avoid any large variations in water quality and movement between the four cages.

Growth assessments

These were conducted by weekly sub-sampling of the fish population (about 200 fish) in each cage until fish reach 400g and then once every fortnightly up to harvest by using a scoop net. Dead fish from the cages were removed daily and the number recorded.

When fish reached a harvest size of about 900g, they were starved for 24 hours prior to harvesting. At the slaughter factory, the fish were killed and the total harvest weights and average body weights recorded. The fish were then graded by weight, filleted, deboned, vacuum packed and frozen before being marketed.

Sample collection and analysis

Two to four weeks before the final harvest, 10 fish were randomly sampled from each cage using a dip net. For haematocrit value, 5mL blood sample was individually collected from the caudal vein of five anaesthetised fish and transferred immediately into 10mL lithium heparin tubes for later analysis in the laboratory.

For lysozyme assays, 5mL of blood sample from the remaining five fish were individually collected and transferred into 5mL Eppendorf tubes without anticoagulant. A turbidimetric assay with lyophilised *Micrococcus lysodeikticus* was used to determine lysozyme activity in fish serum.

Four fish were sterilised with 70% ethanol to avoid cross contamination. The digestive contents in the hepatic loop (HL) and terminal segment (TS) of the gut were then aseptically extracted, pooled, weighed and made into 10% (w/v) homogenate using sterile phosphate buffer saline (PBS; pH7.4). The homogenates were then serially diluted, spread onto triplicates of nutrient agar plates and deMan, Rogosa, and Sharpe (MRS) agar plates for total viable bacterial (TVB) and lactic acid bacterial counts, respectively, using direct plate counting method. Agar plates containing 30-300 colony forming units (CFU) were enumerated after incubation at 28°C for 24 to 48 hours.

After blood sample collection and digesta removal, the abdominal cavity of all remaining fish was cut open and the liver, viscera and intraperitoneal fat excised and weighed for determination of body-organ indices. The fish carcasses were then filleted for evaluation of fillet yield and the fillets analysed for their nutrient composition.

All data were subjected to one-way analysis of variance (ANOVA) using the SPSS statistical software. Differences between means were determined by independent sample t-test and results with a probability of $P<0.05$ were considered statistically significant.

Tilapia production performance

Under commercial cage farming conditions, fish fed organic acids (2% OAB) consumed, on average, less feed (-930 kg) but produced a higher harvested biomass (+ 528 kg) compared to control (Table 1). Over the 203 days of culture, total average fish mortality was slightly lower (-2.8%) in cages fed the OAB-added feed compared to the control, which likely accounted for the higher harvest biomass.

The economic feed conversion ratio (eFCR) and biological FCR (bFCR) were slightly lower (better) for fish fed the OAB-added feed. The eFCR is of greater importance to farmers as it considers the monetary cost of feeds used but the bFCR is a more accurate estimate of the true feed conversion efficiency of the farmed fish. The better FCR was likely contributed by improvements in the nutrient digestibility of the OAB-added feed (data will be published later). The high growth rates and good FCR are characteristic of this fast-growing tilapia strain.

Farm trials are subjected to great logistical and financial constraints. Dealing with cages stocked with about 56,500 fish per cage was very challenging. As such, a lower number of replicates (n=2) were used which can often lead to variability in results within the replicates. This can be further compounded by various uncontrollable factors under commercial farming conditions. It was therefore not surprising that we did not detect statistically significant differences between the two feeds at a P level of 0.05 (Table 1).

Under controlled laboratory conditions, we previously reported that OAB-fed tilapia showed significant growth improvement in a dose-dependent manner. Nevertheless, in the present farm trial, quantitatively, feeds with added organic acids provided the farmer with a higher harvest biomass using less feed input - likely contributed by the higher fish survival and better FCR.

Biological indices and fillet composition

Organ-body indices, haematocrit and fillet yield were not negatively affected by the added organic acids (Table 2). High fillet yields (42% scaleless skin-on) were obtained. The use of dietary organic acids did not negatively affect the fillet nutrient composition. Tilapia fillets provided a good source of protein (20%) combined with healthy levels of lipids (2.6%) for consumers.

Parameters	Control	2% OAB
Stocking number (individual)	56,570 ± 6055	56,537 ± 628
Culture days from stocking to last sampling	203 ± 1	203 ± 4
Total fish mortality (number)	18,496 ± 6101	17,129 ± 4469
Mortality (%)	33.19 ± 4.63	30.39 ± 8.24
Total feed consumption from stocking (kg)	48,560 ± 3240	47,630 ± 2590
Total fish biomass at last sampling (kg)	35,098 ± 4661	35,625 ± 1628
Total mortality biomass (kg)	5,073 ± 495	4,754 ± 392
Economic FCR	1.46 ± 0.10	1.41 ± 0.14
Biological FCR	1.27 ± 0.08	1.24 ± 0.10
Average final body weight (kg)	876.0 ± 31.6	860.7 ± 51.5
Daily weight gain (g/d)	4.18 ± 0.14	4.10 ± 0.32
Specific growth rate (%/day)	1.69 ± 0.01	1.65 ± 0.03
[1] Values are the mean ± SE of duplicate cages of fish. The differences between the two treatment groups were not significantly different (P>0.05).		

Table 1. Performance of tilapia in cages when fed a commercial feed with or without added organic acids[1].

Immune response and gut bacteria

A decreased TVB count in the HL and TS of the gut of tilapa fed the 2% OAB feed was observed (Table 2). This indicated that organic acids might have a beneficial effect in inhibiting the colonisation of harmful bacteria in the gut. It was also noteworthy that beneficial lactic acid bacteria populations increased in the TS of the gut in OAB-fed fish. Dietary organic acids may have beneficial effects on gut health over that offered by antibiotics which indiscriminately kill gut bacteria.

Tilapia fed organic acids-added feeds had significantly (P<0.05) enhanced serum lysozyme activity (Table 2), almost doubled that of the control. Lysozyme is part of the non-specific humoral defence mechanism against invading microbes in fish. Gram-positive bacteria such as *Streptococcus* spp. are known to be very sensitive to this enzyme. Increased immune response and modulation of gut bacteria may partly explain the reduction in fish mortality in culture cages with tilapia fed the organic acids-supplemented feeds.

Parameters	Control	2% OAB
Condition factor	2.22 ± 0.00	2.37 ± 0.06
Hepato-somatic index	1.17 ± 0.34	1.22 ± 0.32
Viscero-somatic index	1.38 ± 0.22	1.40 ± 0.12
Intraperitoneal fat index	3.39 ± 0.04	3.26 ± 0.40
Haematocrit (%)	37.92 ± 2.25	37.00 ± 1.00
Serum lysozyme (units/mL)	103.75 ± 1.87	196.56 ± 18.44*
Bacteria count ($CFUg^{-1}$)		
Total viable bacteria		
Hepatic loop	$3.01 \pm 2.46 \times 10^5$	$1.27 \pm 0.93 \times 10^5$
Terminal segment	$6.59 \pm 2.45 \times 10^5$	$5.41 \pm 0.20 \times 10^5$
Lactic acid bacteria		
Terminal segment	$2.53 \pm 1.84 \times 10^2$	$4.62 \pm 1.85 \times 10^2$
Fillet yield, skin-on (%)	41.87 ± 0.12	41.84 ± 0.58
Fillet profile (% wet weight)		
Moisture	76.3 ± 0.2	75.9 ± 0.2
Crude protein	19.4 ± 0.2	20.1 ± 0.2
Crude lipid	2.4 ± 0.1	2.8 ± 0.3
[1]Values are the mean ± SE of duplicate cages of fish. Asterisk indicates statistical difference between two treatment groups (P<0.05).		

Table 2. Biological indices, fillet composition, immune response and bacterial counts of tilapia fed a commercial feed with or without added organic acids[1].

Some fish in one of the control cages had skin haemorrhages and infected pectoral and caudal fins. These chronic Streptococcus infection manifestations will decrease the market value of freshly chilled or live fish.

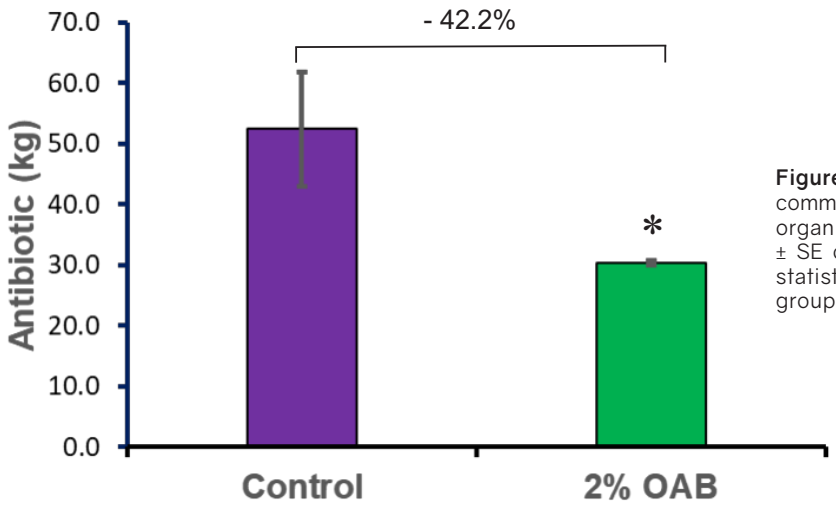

Figure 1. Antibiotic (kg) use in cages of tilapia fed commercial feeds with (2% OAB) or without (Control) organic acids supplementation. Values are mean ± SE of duplicate groups of fish. Asterisk indicates statistical significance between the two treatment groups (P<0.1).

Antibiotic use

The antibiotic, oxytetracycline (OTC) was mixed in-house by top-coating the feeds. Administration of OTC was initiated and supervised by a qualified fish veterinarian only when there is a disease outbreak and considered necessary.

The relatively high fish mortalities encountered were mostly due to *S. agalactiae* infections that sometimes occur during the hot season. It was observed that fish in cages fed the control feed had more incidences of haemorrhages on the skin and fins compared to fish fed the organic acid-added feed.

An average of 42.2% reduction in antibiotic use was observed when tilapia feeds were supplemented with organic acids compared with control (Figure 1). Antibiotic use in cages with OAB-fed tilapia was significantly reduced. Functional feed additives such as organic acids can be used as an immuno-stimulant to offer a more environmentally friendly strategy for intensive tilapia farming.

Conclusions and recommendations

With higher fish harvest biomass, higher survival, lower feed input, better FCR and reduced usage of antibiotics in cages with tilapia fed with OAB-added feed, higher overall cost benefits are expected to be generated compared to the control feed. Indeed, any reduction in the use of antibiotics is good for a more sustainable and eco-friendly farm management practice in tilapia farming.

Even though the therapeutic use of approved antibiotics is permitted under veterinary supervision by various certification schemes such as ASC and GlobalGap, the guidelines of these schemes also advocate for reducing antibiotic use and prioritising disease prevention. Dietary organic acids can have a positive impact on disease resistance of farmed aquatic animals by improving gut health and enhancing immune response to disease thereby reducing antibiotic use.

The tilapia farm where this trial was conducted sometimes experiences high post-vaccination fish mortality. This is likely contributed by handling stress when fish are individually vaccinated by injection and then transferred from nursery to grow-out cages. The stress predisposes tilapia fingerlings to *Streptococcus* infections causing subsequent mortality.

We would recommend the use of dietary organic acids in the nursery phase prior to vaccination as it may help boost fish robustness due to improvements in their immune system and gut health.

As global values on social and environmental responsibility changes, it is important to be committed to reducing antibiotics use in aquaculture. The present study showed that this is possible with organic acids under commercial farming conditions.

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Learnings from managing TPD in Vietnam

Dragoș Mircea discussed his battle with TPD at his two farms in Vietnam and the lessons learnt

In early 2025, translucent post larvae disease (TPD) became a major issue in Vietnam. At TARS 2025, held in August, Dragoș Mircea, CEO of Good Tôm (a shrimp farming startup), discussed his experience tackling TPD at his two shrimp farms and shared relevant field data and insights gained from managing this disease.

Good Tôm (Good Shrimp) operates a 2ha research farm and a 10ha production farm in Bac Lieu, Mekong Delta. The farms use intensive, circular, HDPE-lined ponds (350–1000m³), with biosecurity fencing, automated feeding and waste removal, together with data-based, precise protocols. He runs 3–4 annual cycles targeting size 30-40/50 per kg. Stocking density is typically 200 PL/m² during grow-out. The aim is an antibiotic-free, profitable and sustainable farming, adjusting stocking density as needed to ensure that carrying capacity is not exceeded.

Left: Infected post larvae showed transparent hepatopancreas and intestinal tract. Right: Post larvae in a recovery stage. Photo credit: Good Tôm

"We had some great, very profitable crops, with shrimp sizes 27-40/kg and 70-83% survival rates. We also had EHP outbreaks, producing size 80-100/kg, and some crops with 50-60% survival rates. TPD was a different experience." , said Dragoș Mircea.

***Dragoș Mircea** is a modern, professional shrimp farmer in Vietnam who is focused on adopting science-based principles and a data-driven approach, to produce shrimp with zero antibiotics.*

Three TPD outbreaks

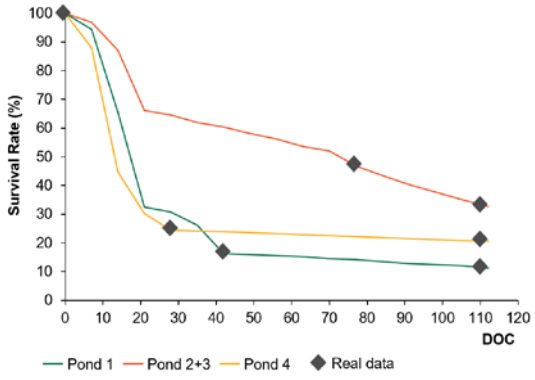
Both farms encountered TPD outbreaks. The first occurred in December 2024, the second in February 2025, and both were in Farm 1. The third case was in May 2025 in Farm 2. In two outbreaks, he linked the source to hatcheries and for one of them, a water borne source. Mortality was high, usually well over 50%, but not precisely measured until harvest. TPD diagnosis was confirmed by PCR.

Case one

"In the beginning, my technicians reported unusual observations. The shrimp exhibited pallor, mortality began at DOC6, transparency increased, and the gut was no longer visible. Despite interventions, mortalities could not be contained," stated Dragoș. Mortality rates rose sharply, with estimated losses exceeding 50% within several days (Figure 1). In ponds 2 and 3, mortality persisted through DOC75 and remained unmitigated. By DOC110, survival was recorded at 33%, with FCR of 1.75. In pond 1, significant mortality continued for an additional 20 days before stabilising. Although these ponds showed improved survival, managing them remained highly challenging, said Dragoș.

An outlier

This is pond 4 where shrimp showed sharp mortality (~75%) until DOC 25-30 at the nursery phase, but as they were transferred to grow-out ponds, it was an easy cycle with survival at 85-90%, resulting in strong economic outcomes. "In the prolonged nursery phase which began with PL12, the shrimp recovered somewhat, and mortality stabilised. Shrimp grew to size 27/kg. How did we do this? To reduce *Vibrio parahaemolyticus* in the gut and water, we used water disinfectants, feed probiotics, organic acids and phytogenics, along with extended probiotic and carbon use in the grow-out pond before transfer from the nursery. I was hoping that *V. parahaemolyticus* TPD will reduce below its lethal threshold and/or evolve into a non or less deadly strain."



Pond	1	2+3	4
SR	12%	33%	21%
Density @ harvest	65	60	88
Size (CAL)	31	34	27
FCR	1.5	1.75	1.3

Figure 1. Case 1: Unpredictable impact of TPD across ponds. All shrimp came from the same batch of post larvae). SR=Survival rate; CAL = number of shrimp per kg. FCR=Feed conversion ratio.

Source: Dragoș Mircea on Managing TPD: The Practical Experience of a Shrimp Farmer in Vietnam. Presented at TARS 2025, Shrimp Aquaculture, 20-21 August 2025, Chiang Mai, Thailand.

"Relief as a decent % of shrimp made it," said Dragoș Mircea.

Dragoș explained, "This gave us the confidence to keep the crop. We continued as usual, distributing the shrimp among the available grow-out ponds. As a result, the density was lower than our typical practice—60–80/m^3 at harvest, instead of the usual 150+ PL/m^3. We had three ponds with TPD shrimp, which we harvested at around DOC 110–115. The shrimp sold for a premium of USD 6-7/kg, partly because it was Chinese New Year (Tet in Vietnam) when prices were high, and because supply was low due to many farms facing TPD."

Case two

A hatchery-linked outbreak with high TPD levels (confirmed by plating and PCR) caused ongoing mortality for 45 days. The post-larvae came from a different hatchery. The crop was terminated, as the same intervention from case 1 was ineffective. Mortality decreased after 15 days but persisted until the crop was abandoned at DOC 45 with shrimp size ~300/kg.

Case three

This was likely a waterborne outbreak in a single pond. The same batch of post-larvae was stocked in several ponds but only one pond had a TPD outbreak. "We believe that shrimp contracted TPD from poorly disinfected pond water. Economic performance was acceptable, as the shrimp recovered relatively fast in this instance." Early intervention, strong disinfection and biosecurity containment prevented the spread. Survival was 50-60% post challenge. The cycle finished with a survival rate of 35%, size 40 CAL, in 95 days.

Lessons to manage TPD

TPD is among the most severe diseases affecting shrimp farming. Drawing from his experience with TPD, Dragoș categorised key lessons into methods for prevention and containment:

- Preventing TPD requires sourcing post-larvae from reputable hatcheries and verifying their quality. This is the most important step.
- It is prudent to always assume water sources may be contaminated with TPD and to implement effective water treatment protocols. For instance, high pH levels can reduce chlorine's efficacy. In Vietnam, it is advisable to presume TPD is present in nearby canals and to apply the required dose of disinfectant before stocking.
- The use of nursery ponds will limit the spread of TPD within the farm. This will also minimise economic losses as smaller volumes of water will be compromised.
- Implementing biosecurity measures has proven effective in limiting the spread of TPD, as demonstrated in case 3.

The dramatic effect of TPD, causing mass mortality - often exceeding 50% - over a few days. Picture shows mortality of PL20+, proving that TPD can affect hatcheries and farms alike. Photo credit: Good Tôm

Dragoș added, "While this may not be the ideal solution, farmers who choose to retain TPD-infected shrimp may consider approaches aimed at strengthening shrimp health, reducing horizontal transmission, and optimising gut health." These are outlined in the table below.

Some approaches to manage TPD infected shrimp	
Stronger shrimp	• Premium nutrition (e.g., *Artemia*, micro-extruded high-quality nursery feed) • Immuno-modulators (e.g., yeast cell wall ß-glucan-based additives)
Reduce horizonal transmission	• Lower density • Water disinfection + re-application of probiotics
Gut health & TPD control	• Reduce TPD load: organic acid blends (e.g., SCFA, MCFAs), innovative phytogenics • Recolonise gut: feed probiotics – QS, QQ, lower inflammation • Phages
Notes: SCFA = short-chain fatty acids; MCFA = medium-chain fatty acids; QS = quorum sensing; QQ = quorum quenching	

Table 1. Some approaches if farmers wish to keep the TPD infected shrimp. Source: Dragoș Mircea on Managing TPD: the Practical Experience of a Shrimp Farmer in Vietnam. Presented at TARS 2025, Shrimp Aquaculture, August 20-21, Chiang Mai, Thailand.

The message was "We noticed that the outcome was mixed, despite using the same protocols. It was an unpredictable disease and we suspected we were dealing with different strains of TPD."

Post note by Dragoș. As an update on TPD since TARS 2025 - outbreaks have decreased significantly, I have not heard of it much in the South of Vietnam this season. Probably hatcheries figured out a way to prevent it, and the consensus has always been that it came from them.

The diagnostics gap: Early detection of pathogens

Kit Yong believes that diagnostics remain a weak link. Farmers often rely on visual symptoms, by which time it is too late to intervene effectively.

"There is the financial toll of disease across board," said Kit Yong, Founder of Forte Biotech, as he highlighted the harsh economic realities faced by aquaculture farmers across Southeast Asia in a presentation at TARS 2025 on shrimp aquaculture, in August 2025. "When disease strikes, farmers lose their harvest and income while feed mills and dealers risk losing receivables tied up in ponds for one to three months. Furthermore, credit chains are disrupted, straining cash flow across the value chain."

"Time is the most critical factor in disease management. Early detection, that is within the first 24 hours of infection, can significantly reduce financial losses. With timely diagnostics, farmers can conduct emergency harvesting, remove infected stocks early, save feed, labour and medication costs and prevent wider spread to neighbouring farms."

The startup, Forte Biotech has been piloting on-site diagnostic tools with farmers across Southeast Asia and reports detecting white spot outbreaks up to seven days before visible symptoms appear. This early warning window allows farmers and their partners to take preventive action rather than reacting to catastrophic losses.

The company offers customisable, on-site diagnostic tools, white label partnerships, subscription models and AI driven advisory support to help farmers interpret results and optimise treatment timing. Its TPD assay was ready for use recently. It runs on the RAPID devices with the same simple workflow: extract, load and get quantitative results in one hour on site. "We have since then, tested this with TPD isolates in Vietnam," added Kit.

Managing *Vibrio*, TPD, WSSV and EHP with functional feeds

John Williamson addressed the challenges in maintaining animal health and productivity through functional nutrition

Central to these strategies is gut health, which is the foundation of shrimp performance. The assertion is that a healthy gut supports better digestion, stronger immunity and resilience to stress. Increasing concerns on antimicrobial resistance and consumer demand for residue free seafood are limiting the use of antibiotics. This has accelerated the development of non-antimicrobial and sustainable health solutions.

On the use of functional feeds, John Williamson said, "I think what we should focus on is value and cost per kg shrimp produced as opposed to cost per kg of feed or of the functional additive itself."

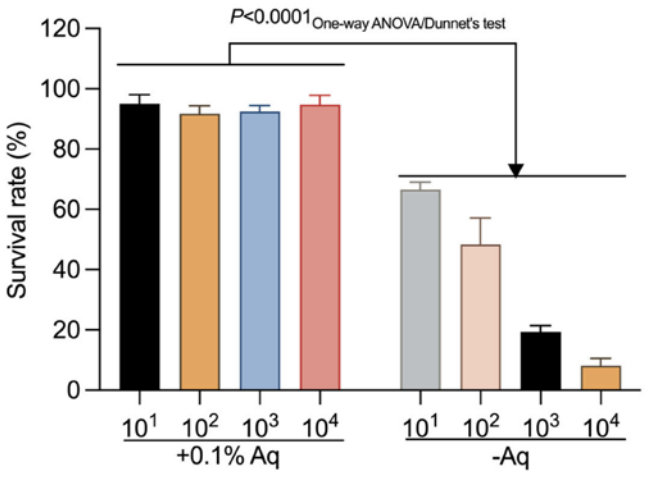


Figure 1. The survival rate of *Penaeus vannamei* challenged with VpTPD at 10^1, 10^2, 10^3, and 10^4CFU/mL when fed with the natural antimicrobial blend- AuraAqua (0.1% Aq). Source: Williamson, 2025.

During TARS 2025, on shrimp aquaculture, John Williamson, Business Development Director, Auranta, Ireland, discussed functional nutrition strategies to mitigate major diseases and outlined results from laboratory and field trials. Auranta is an Irish biotech startup focused on natural, science-backed solutions for animal health, especially gut health, immunity and antimicrobial reduction. It originated as a spin-off from NovaUCD, the University College Dublin innovation hub. "It is important to understand the enemy and then develop solutions," said John. "Understanding the value proposition is critical. Targeted use is important such as during a WSSV outbreak."

Various pathogens such as *Vibrio*, white spot syndrome virus (WSSV) and *Enterocytozoon hepatopenaei* (EHP) are disrupting production cycles and constraining profitability. At Auranta, shrimp primary gut and hepatopancreas cells have been isolated to study infection mechanisms and cellular responses. Combined with *in vivo* infection studies, this work has been documented in seven peer reviewed papers covering *Vibrio*, translucent post larvae disease (TPD), EHP, WSSV and gregarines (Nematopsis), the latter prevalent in Ecuador.

Managing *Vibrio* and TPD

TPD is caused by *Vibrio parahaemolyticus* strains carrying multiple plasmid-borne toxin genes. Key among these are VHVP-1 and VHVP-2, a two-component toxin system where VHVP-1 supports attachment to the shrimp epithelial cell whilst VHVP-2 executes toxic effects inside shrimp cells (Williamson, 2025).

TPD can cause more than 90% mortality within 24–48 hours in PL 2–4 shrimp if left unchecked. Research using shrimp cell models showed that a natural antimicrobial blend based on an organic acid/phytogenic blend can silence key virulence genes, including VHVP toxins and PirA. Downregulation of HCP1 and HCP2 reduces bacterial adhesion and cytotoxicity across different salinities and strains (Asian and Latin America). In a *Vibrio* TPD challenge trial, untreated shrimp showed mortality around 91%, while the inclusion of natural antimicrobial blend reduced mortality to below 6%.

Efficacy to overcome WSSV and EHP

John demonstrated how the organic acid/phytogenics blend modulated immune oxidative pathways exploited by the virus. Downregulation of genes such as beta-1,3-glucan binding protein reduced hyperinflammation and cell death. Increased mucin gene expression (Mucin 1 and Mucin 2) improved mucus production and antioxidant activity further reduced oxidative stress. *In vivo* trials demonstrated significant reductions in viral copy numbers and mortality (from 96% in controls to 7% in treated shrimp).

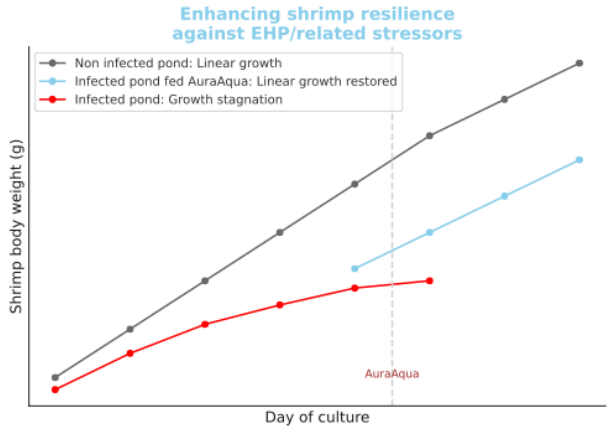


Figure 2. In a field trial in India, a restoration of growth was shown when EHP-infected shrimp with stunted growth were fed the organic acid and phytogenic blend. Source: Functional Nutrition Strategies to Mitigate Key Pathogens in Shrimp Aquaculture: Insights from Asia and Latin America, by John Williamson, presented at TARS 2025: Shrimp Aquaculture, Chiang Mai, Thailand, 20-21 August 2025.

Field trials in Thailand and Ecuador showed reduced white faeces and WSSV prevalence. In a farm in Thailand, WSSV prevalence decreased from over 30% in 2021 to 3% in 2022, which remained between 3–10% throughout 2024. Growth performance and feed conversion ratio (FCR) were maintained in Ecuador. In the Thai farm with 200 ponds, the organic acid blend was added directly into feeds at 5kg/tonne by the feed mill and fed to shrimp all year round. This farm has been successful in overcoming WSSV whilst others in the area encountered disease.

In a field trial in India, the blend was effective against EHP by attacking the parasite's infection process and bolstering host cell defences. Inclusion of the product during an ongoing EHP infection restored linear growth performance (Figure 2). The effect was a significant reduction in EHP copy numbers.

John concluded that undoubtedly, functional nutrition is a critical pillar of health management. However, further research is needed to define nutritional thresholds and identify novel functional ingredients. Clear documentation of performance, cost and ROI is essential to drive adoption by producers. "Often, functional ingredients seem to be expensive. I think what we should focus on is value and cost per kg shrimp produced as opposed to cost per kg of feed or of the functional additive itself. The application strategy is also crucial, necessitating close collaboration between feed manufacturers and farmers."

Reference

Williamson, J., 2025. Natural antimicrobials in shrimp aquaculture: Broad-Spectrum protection against WSSV, EHP and TPD. September/October 2025, pp 32-34. https://issues.aquaasiapac.com/view/879690187/34/

The rising concern of TPD regionally

A panel led Dr Kallaya Sritunyalucksana-Dangtip, BIOTEC/NSTDA, Thailand, with invited industry players noted that while some countries reported no official detection, anecdotal evidence from farmers suggested otherwise. Private laboratory testing in Vietnam confirmed TPD cases. Malaysia has already implemented stricter biosecurity measures, requiring imported broodstock to be certified free of TPD. Thailand has formed a task force for regular surveillance. Panellists stressed that cross-border movement of post larvae and broodstock presents significant risk making coordinated enforcement essential.

Members also cautioned against the misinformation on how to prevent or manage TPD. Practices such as indiscriminate antibiotic baths for post larvae may risk long term consequences, including antimicrobial resistance. The importance of infrastructure and regulation was highlighted. Proper farm design, water treatment systems and reservoir capacity can reduce disease pressure. Meanwhile, stricter oversight of cross-border livestock transfers is essential to prevent pathogen spread.

The promise and skepticism of functional feeds

One of the central themes of the discussion was functional nutrition. In Thailand, with increasing pressure to reduce antibiotic use and move toward antibiotic-free production, functional ingredients could serve as alternatives. Yet, cost remains a barrier. Without clear field data demonstrating consistent performance improvements and links to profitability, feed mills and farmers remain hesitant to fully embrace functional formulations.

John provided a useful benchmark with salmon farming, where functional nutrition is widely adopted during stress periods, such as seawater transfer and has been linked to measurable performance gains. The shrimp sector may learn from this model. In Ecuador, farmers use functional feeds throughout the production cycle as part of a broader strategy to manage the disease. In Asia, premium functional feeds priced significantly higher than standard diets have struggled to gain widespread adoption. Lower cost formulations with select additives like organic acids or beta glucans are more acceptable, but farmers remain cautious due to their high expectations.

The panel with speakers and industry players at the session on 'Pathogen control and disease mitigation: Prevention and integrating disease mitigation into production models' at TARS 2025 on Shrimp Aquaculture, held in Chiang Mai, Thailand, 20-21 August 2025. Moderator, Dr Kallaya Sritunyalucksana-Dangtip, Research Group Director, Integrative Aquaculture Biotechnology Research Group, BIOTEC/NSTDA, Thailand (right) with industry players and speakers, from left, John Williamson, Auranta, Ireland; Dragoș Mircea, Good Tôm, Vietnam; Kit Yong, Forte Biotech, Singapore; Soraphat Panakorn, President, Thailand Aquaculture Business Association (TABA) and Jeffrey Lee Kat Choy, Managing Director, Kembang Subur, Malaysia.

An integrated multiplex digital PCR assay for early detection of major shrimp pathogens in aquaculture

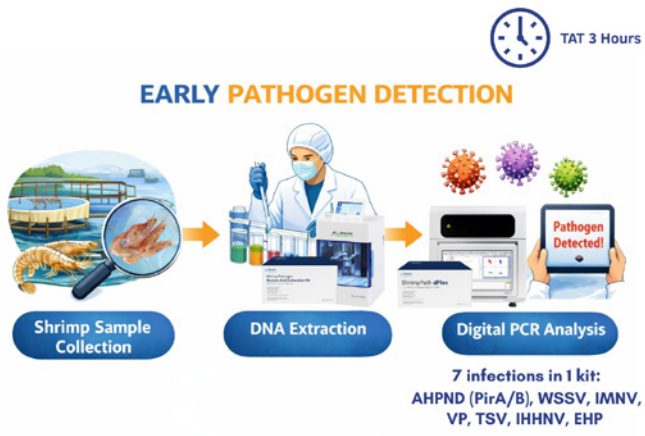
By Shadiqa Malahayati, Agnes R. Hutagalung, Arining V. A. Nadya and Irina Le Barazer

The intensification of shrimp farming has increased vulnerability to infectious diseases, leading to significant economic losses. Major pathogens associated with shrimp mortality and production declines include acute hepatopancreatic necrosis disease (AHPND), infectious myonecrosis virus (IMNV), white spot syndrome virus (WSSV), *Vibrio parahaemolyticus*, Taura syndrome virus (TSV), infectious hypodermal and haematopoietic necrosis virus (IHHNV), and EHP or *Enterocytozoon hepatopenaei*. (Yu et al., 2022). These pathogens can affect shrimp across various life stages and environmental conditions, contributing to both acute outbreaks and chronic production setbacks.

A nucleic acid-based diagnostic tool

Multiplex digital PCR (dPCR) has emerged as a powerful nucleic acid–based diagnostic tool due to its high sensitivity, inhibitor tolerance and ability to provide absolute quantification without standard curves. Its capacity to simultaneously detect multiple pathogens in a single reaction is especially valuable - when sample quantity is limited or rapid, comprehensive pathogen profiling is required for informed decision-making. (Du et al., 2022).

This study developed and validated a ShrimpPath dPlex 7 in 1 Shrimp Pathogen Digital PCR Kit (Biomed AgriTech, Singapore) for simultaneous detection of seven major shrimp pathogens: AHPND, IMNV, WSSV, *Vibrio parahaemolyticus* (VP), TSV, IHHNV, and EHP, in a single reaction across multiple sample types, including post larvae, juvenile shrimp, pond water and sediment. This approach improves diagnostic efficiency, reduces testing costs and supports integrated health monitoring in shrimp aquaculture systems.



Early pathogen detection in shrimp using Shrimp Pathogen Nucleic Acid Extraction Kit and ShrimpPath dPlex 7 in 1 Digital PCR Kit, enabling identification of seven major infections with a turnaround time of 3 hours.

Sample collection

Biological samples included whole post larvae and juvenile shrimp, while environmental samples comprised pond water and sediment. To achieve 2% detection rate, a total of 150 white leg shrimp (*Litopenaeus vannamei*) per biological sample were collected from shrimp farms in Lampung, Indonesia.

Nucleic acid extraction

Whole shrimp were homogenised using a blender and 200uL were used immediately for nucleic acid extraction. Nucleic acids were extracted automatically, using Biomed AgriTech's Shrimp Nucleic Acid Extraction Kit on Auto-Pure Mini nucleic acid purification system (Allsheng, China) according to the user protocol.

Primer and probe design

Specific primers and hydrolysis probes were designed to target conserved regions of AHPND (*PirA/B*), IMNV, WSSV, *V. parahaemolyticus*, TSV, IHHNV and EHP. Each probe was labelled with a distinct fluorophore (FAM, HEX, ROX, Cy5, and Cy5.5) to allow multiplex detection.

Digital PCR assay setup

Digital PCR assays were performed using PCR Amplifying Apparatus Model SG-2000; compatible with ShrimpPath dPlex 7 in 1 Shrimp Pathogen Digital PCR Kit according to the user protocol. After amplification, droplets were analysed and reports generated on Biochip Scanner DropDx-2250 series (Biomed AgriTech, Singapore).

Detecting pathogens in post larvae samples

Six post larvae samples were tested with ShrimpPath dPlex 7-in-1 Digital PCR Kit. All samples were negative for AHPND (PirA/PirB), WSSV, TSV, IHHNV, EHP and V. parahaemolyticus, with no amplification above the limit of detection (LOD). IMNV was detected only in Sample 3 at a low level (1.33 copies/µL), while the remaining samples were below the LOD. Internal Control values (167–17,697 copies/µL) confirmed successful amplification and the absence of PCR inhibition.

Pathogens	Sample No. (copies/µL)					
	1	2	3	4	5	6
PirA/PirB	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
WSSV	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
IMNV	<LOD	1.33	<LOD	<LOD	<LOD	<LOD
VP	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
TSV	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
IHHNV	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
EHP	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
IC	9260	303	17697	167	550	14750

Table 1. Detection of pathogens in post larvae samples.

The post larvae samples were largely free of detectable pathogens, with only a single low-level IMNV detection, and internal control (IC) values confirmed the assay's reliability across varying DNA concentrations.

Detecting pathogens in shrimp samples

Digital PCR analysis of six shrimp tissue samples revealed variable pathogen profiles among individuals (Table 2). PirA/PirB (AHPND) was detected in samples 1 and 3, with higher levels in sample 3, while WSSV was detectable only in sample 3 at a low copy number.

V. parahaemolyticus DNA was the most frequently detected target, present in five samples, indicating widespread occurrence; detection without PirA/PirB in sample 2 suggested non-AHPND environmental strains, whereas co-detection indicates AHPND-associated infection. TSV was detected at low levels in samples 4 and 6. IHHNV showed high abundance in sample 4 and low detection in sample 6.

EHP was identified in samples 4, 5 and 6, indicating potential early or ongoing microsporidian infection. IMNV was not detectable in all the samples. Internal control (IC) values confirmed successful amplification and absence of PCR inhibition across all samples.

Pathogens	Sample No. (copies/µL)					
	1	2	3	4	5	6
PirA/PirB	1.58	<LOD	162	<LOD	<LOD	<LOD
WSSV	<LOD	<LOD	1.77	<LOD	<LOD	<LOD
IMNV	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
VP	1426	1380	491	<LOD	836	720
TSV	<LOD	<LOD	<LOD	64.3	<LOD	11.5
IHHNV	<LOD	<LOD	<LOD	2570	<LOD	7.75
EHP	<LOD	<LOD	<LOD	15.7	1159	2811
IC	169	74.4	154	122	180	832

Table 2. Detection of pathogens in shrimp samples.

The ShrimpPath dPlex 7-in-1 Digital PCR Kit effectively enables sensitive, simultaneous detection of viral and bacterial pathogens, revealing complex co-infections in shrimp populations. Frequent detection of *V. parahaemolyticus* and EHP highlights ongoing environmental exposure and underscores the need for routine multiplex screening to support early intervention, even in apparently healthy shrimp with subclinical infections.

Detecting pathogens in water samples

Digital PCR analysis of six pond water samples showed low-level detection of PirA/PirB (AHPND), WSSV, and *V. parahaemolyticus* (VP), indicating possible environmental contamination and pathogen persistence (Table 3).

PirA/PirB was detected in Samples 3 and 4, suggesting the presence of toxic *V. parahaemolyticus* in pond water. WSSV was detectable at a low level in sample 2, while VP was detected in samples 1, 4, and 5, with the highest concentration in sample 4.

IMNV, TSV, IHHNV, and EHP were not detected in any water samples. Internal control (IC) was targeting shrimp's housekeeping gene it was either detected at low levels (samples 2-6) or undetected (sample 1), indicating low level of shrimp DNA in water samples.

Pathogens	Sample No. (copies/µL)					
	1	2	3	4	5	6
PirA/PirB	<LOD	<LOD	3.5	6.3	<LOD	<LOD
WSSV	<LOD	1.88	<LOD	<LOD	<LOD	<LOD
IMNV	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
VP	1.51	<LOD	<LOD	33.3	4.32	<LOD
TSV	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
IHHNV	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
EHP	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
IC	<LOD	2.89	10.1	5.34	15.7	8.02

Table 3. Detection of pathogens in water samples.

These findings demonstrate that digital PCR can sensitively detect low pathogen concentrations in pond water, for the presence of WSSV, PirA/PirB, and *V. parahaemolyticus* indicating environmental reservoirs and underscoring the importance of routine water quality surveillance in shrimp aquaculture systems.

Detecting pathogens in soil samples

Digital PCR analysis of three pond sediment samples detected low levels of PirA/PirB (AHPND), WSSV, and *V. parahaemolyticus* (VP), indicating the pond bottom as a potential environmental reservoir (Table 4). PirA/PirB was detected in sample 3, while WSSV was identified in sample 2. *V. parahaemolyticus* (VP) was present in samples 2 and 3, supporting its persistence in pond sediment and potential contribution to recurrent outbreaks. IMNV, TSV, IHHNV and EHP were not detected in any sediment samples these were below the limit of detection (LOD) in all soil samples.

Pathogens	Sample No. (copies/µL)		
	1	2	3
PirA/PirB	<LOD	<LOD	37.8
WSSV	<LOD	1.85	<LOD
IMNV	<LOD	<LOD	<LOD
VP	<LOD	122	29.3
TSV	<LOD	<LOD	<LOD
IHHNV	<LOD	<LOD	<LOD
EHP	<LOD	<LOD	<LOD
IC	<LOD	<LOD	<LOD

Table 4. Detection of pathogens in soil samples.

These findings identified pond sediment as a potential long-term reservoir for pathogenic DNA, particularly *V. parahaemolyticus* and AHPND-associated genes, underscoring the importance of regular monitoring and effective pond bottom management in order to reduce disease risks in shrimp aquaculture systems.

Comparative detection across samples

Multiplex digital PCR analysis across post larvae, shrimp tissue, pond water, and sediment revealed distinct pathogen distribution, reflecting the complex disease ecology in shrimp farming. Shrimp tissue showed the highest pathogen diversity, particularly *V. parahaemolyticus*, IHHNV, EHP, and PirA/PirB, while post larval samples had minimal detectable levels, with a single low-level IMNV.

Environmental samples indicated persistent pathogenic DNA, especially *V. parahaemolyticus*, PirA/PirB, and WSSV. Sediment acted as a potential reservoir, highlighting the importance of management practices.

These results demonstrated the value of multi-matrix testing, and the ShrimpPath dPlex 7-in-1 digital PCR assay enables sensitive, simultaneous detection and absolute quantification of major shrimp pathogens, supporting early, risk-based disease management and proactive interventions in aquaculture systems.

Conclusion

The digital PCR assay evaluated in this study enables sensitive and reliable simultaneous detection of seven major shrimp pathogens across shrimp, post larvae, pond water, and soil. All samples tested positive for infection can be promptly subjected to appropriate treatments, thereby preventing further stock losses.

This integrated approach supports early detection and monitoring in shrimp and farming environment, and facilitates timely, evidence-based disease management to enhance biosecurity, reduce economic losses and improve sustainability in shrimp aquaculture

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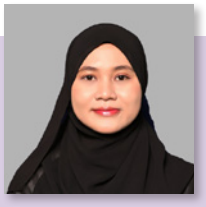

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How salinity shapes shrimp immunity: A multi-omics perspective on *Vibrio harveyi* resistance?

By Zulaikha Mat Deris and Li Lian Wong

The Pacific white-leg shrimp, *Litopenaeus vannamei* is a euryhaline species and well-known for its adaptability. It can tolerate a wide range of salinities (3 to 45 ppt). However, this flexibility also has its limitations. In aquaculture practice, salinity is a crucial parameter affecting the survival, growth and reproduction of aquatic organisms and is shaping the bacteria communities within the host and pond environment.

Most of the shrimp farms operate along coastal areas where salinity fluctuates widely due to tides, rainfall, and evaporation. When salinity increases or decreases, shrimp require enormous energy for pumping ions in and out to maintain their internal osmotic pressure for osmoregulation. This leads to physiological stress and eventually weakens shrimp immune system and increases the risk of disease outbreaks.

Shrimp is constantly challenged by environmental stress and microbial enemies. Among the disease outbreaks, *Vibrio*-related diseases such as *Vibrio harveyi* remain a significant and persistent threat to the global shrimp aquaculture industry. *V. harveyi* is a luminous bacterium armed with virulent toxins able to wipe out entire ponds within a short period, causing huge losses to farmers and urging them to seek solutions.

Multi-omics tools: A frontier in tracking shrimp health at the molecular level

Advanced multi-omics technology, such as metagenomics and transcriptomics, is an aid for researchers and farmers to diagnose and prevent disease outbreaks while improving shrimp farming. These approaches help to detect harmful bacteria, monitor pond microbes, and understand how shrimp react to stress. This allows farmers to be a step ahead to prevent any disease outbreak in their ponds.

Transcriptomic profiling has been widely applied in aquaculture for effective detection and expression analysis of candidate genes involved in the development, growth, reproduction, disease, host immunity, and stress response. Transcriptomic analysis reveals activity of genes and molecular pathways (Costa et al., 2010), thus enabling the early warning of disease in shrimp. For instance, when salinity decreases or increases, shrimp redirect energy to maintain osmotic balance, leading to the downregulation of immune-related genes. This molecular signature can signal vulnerability to infection even when shrimp still appear healthy.

Conversely, metagenomics has uncovered the unseen microbial world, which is more diverse and complex (Pedrós-Alió, 2012; Nwachukwu & Babalola, 2022). Marco (2011) described this approach as a 'powerful lens' for observing the microbial world. Metagenomic studies also reveal unknown genes and the genetic diversity of microbes in the gut of shrimp and in the pond. It tracks shifts in microbial communities in response to environmental changes such as how beneficial bacteria decreased with the increase in pathogenic *Vibrio* species under stress conditions.

Combined with transcriptomic analysis, these approaches provide a comprehensive overview of shrimp health, linking host immune function with microbial balance. In fact, aquaculture management is shifting from reactive treatment to proactive disease prevention, a crucial step toward a more resilient, sustainable shrimp production.

Practical applications in aquaculture

To further investigate how salinity influences the interaction between *Vibrio* sp., gut microbiota, and shrimp immune responses, we cultured *L. vannamei* juveniles (average initial weight = 2g ± 0.04g) at three different salinities: 5ppt, 20ppt and 30ppt. These salinities were selected based on prior tests on lethal concentration 50 (LC50): 5ppt represents near-freshwater conditions in which *L. vannamei* can survive; 20ppt reflects moderately brackish water; and 30ppt served as the control salinity treatment.

After 60 days of culturing in these assayed conditions, all shrimp were challenged with *V. harveyi* (2.7×10^6CFU/mL). We observed that different salinity levels influenced the hosts' response to *V. harveyi* infection. To understand this response at the molecular level, we employed a multi-omics approach, combining both metagenomic and transcriptomic analyses to capture how host immunity related genes and gut microbiome in response simultaneously to salinity stressors and to a *V. harveyi* challenge (Figure 1).

Metagenomics and transcriptomics analyses revealed that shrimp cultured at 20ppt were distinctly separated from the *V. harveyi* infected group (Figure 2). PCA findings showed that the distribution pattern of the bacterial community and host genes expression were similar (Figure 2). Beneficial bacteria including *Pseudoruegeria*, *Rhodovulum*, *Ruegeria*, *Shimia* and *Lactobacillus* were dominant in shrimp gut microbiome cultured at 20ppt compared to those reared at 5ppt and 30 ppt, suggesting that these beneficial bacteria could potentially outgrow pathogenic bacteria from the *Vibrio* and *Photobacterium* genera (Figure 3).

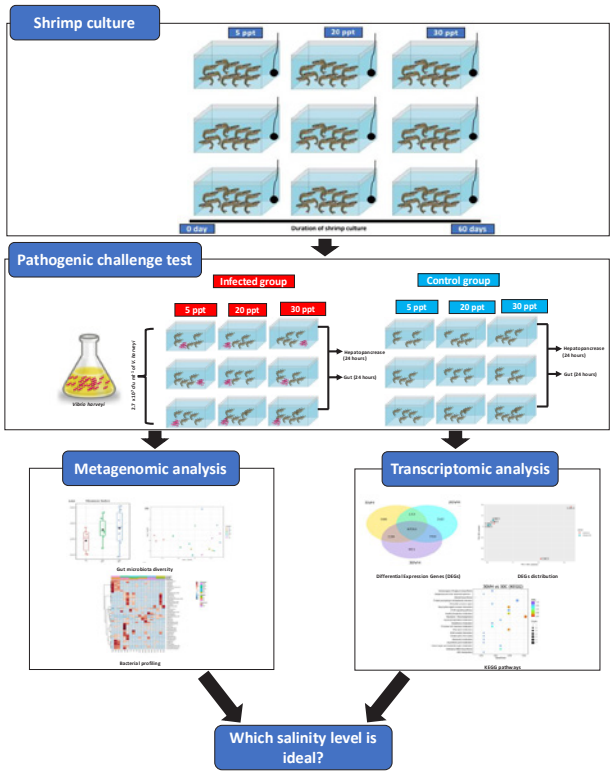

Figure 1. Experimental design for determining the optimal salinity level supporting health and resilience of *Litopenaeus vannamei* under a *Vibrio harveyi* challenge. Shrimp were cultured for 60 days at three different salinity levels (5ppt, 20ppt and 30ppt) and subsequently were subjected to pathogenic challenge test using *Vibrio harveyi* ($2.7x10^6$ CFU/mL). Hepatopancreas and gut tissues were collected 24 hours post-infection for metagenomic (assessment of gut microbial composition and diversity) and transcriptomic analyses (identification of genes and pathways related to stress and immunity response).

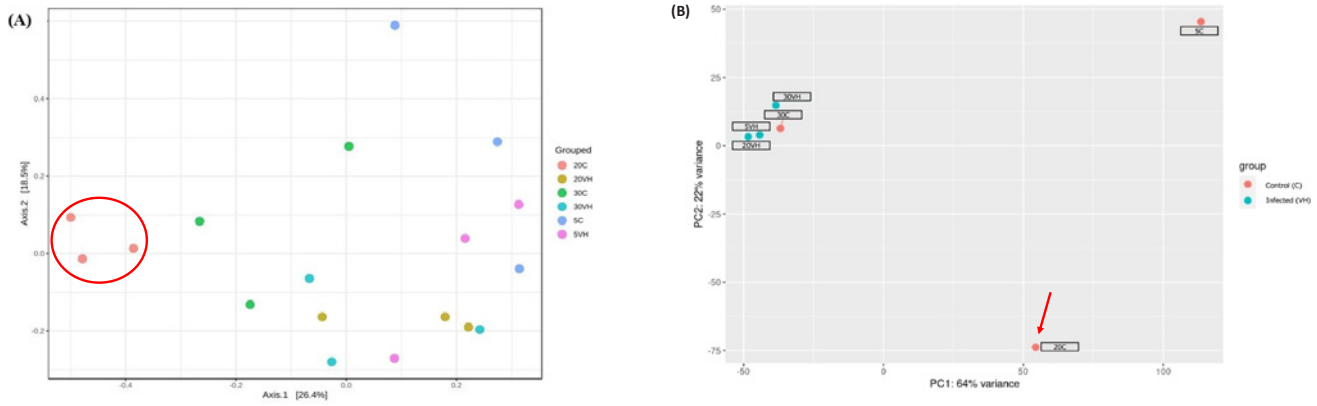

Figure 2. (A) Principal Coordinates Analysis (PCoA) plot based on the Bray-Curtis dissimilarities of gut bacterial community structures; and (B) Principal Components Analysis biplots (PCA) of differentially expressed genes (DEGs) in hepatopancreas, of *Litopenaeus vannamei* cultured at different salinity levels (5ppt, 20ppt, and 30ppt) and challenged with *Vibrio harveyi* (C: Control group and VH: Infected group).

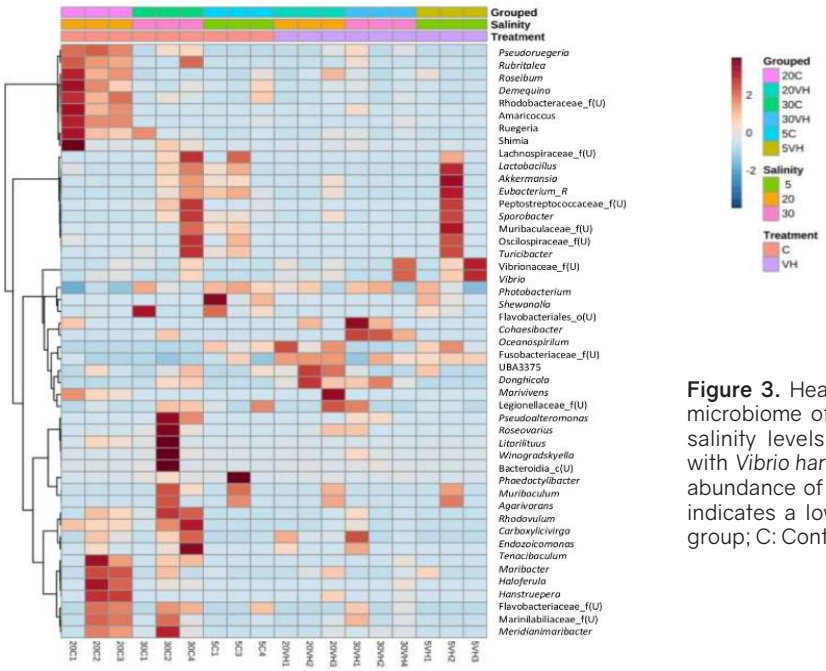

Figure 3. Heatmap analysis of top 50 genera in the gut microbiome of *Litopenaues vannamei* cultured at different salinity levels (5ppt, 20ppt and 30ppt) and challenged with *Vibrio harveyi* infection. Red colour indicates a higher abundance of the microbial genera, while the blue colour indicates a lower abundance (VH: *Vibrio harveyi*-infected group; C: Control group).

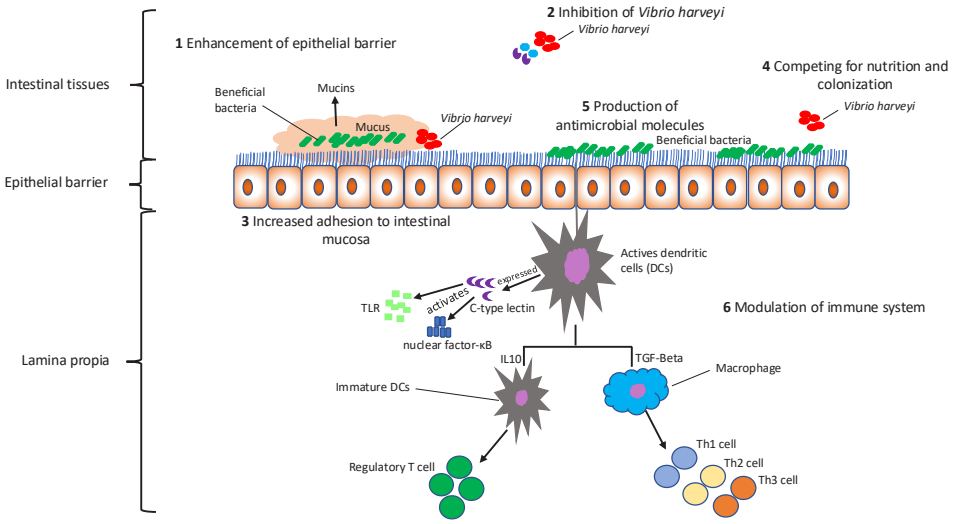

Figure 4. Schematic representation of how beneficial bacteria interact with the intestinal immune system through: 1) enhancement of epithelial barrier via mucus production; 2) inhibition of *Vibrio harveyi*; 3) increased adhesion to the intestinal mucosa; 4) competition for nutrients and colonisation sites with *Vibrio harveyi*; 5) production of antimicrobial molecules, and 6) modulation of the immune system.

On the other hand, shrimp cultured at 20ppt increased the expression of glutamate receptor ionotropic-2C and C-type lectin, suggesting that their immunity mechanism was more capable of recognising, binding, agglutinating, and destroying bacteria such as *V. harveyi* (Feng et al., 2023; Sun et al., 2021). Under low salinity (5ppt), these responses weakened.

The expression of C-type lectin decreased, rendering the shrimp more susceptible to risk of pathogenic infection (Ning et al., 2024). Osmoregulation genes, such as sodium-dependent nutrient amino acid transporter 1-like (SNA) and sodium-coupled monocarboxylate transporter 2-like (SMCTs) were among the most overexpressed in shrimp cultured at 5ppt and 30ppt, reflecting the shrimp's struggle to maintain osmotic balance. The beneficial bacteria are involved in the modulation of the immune systems through activation of immune signaling pathways, such as toll-like receptor (TLR), nuclear factor-κB (NF-κB), interleukin-10 (IL-10) and transforming growth factor-beta (TGF-β, Figure 4).

Collectively, shrimp cultured at 20ppt maintained strong immune defences, balanced ion regulation, and a healthy gut, rich in beneficial bacteria. At 5ppt, osmotic stress diverted energy from immunity, disrupting microbial balance and allowing pathogenic *Vibrio* to dominate. Shrimp cultured at 30ppt showed slight reductions in both microbial diversity and immune performance. Thus, 20ppt offered the most favourable conditions for *L. vannamei* culture among the three salinity levels investigated (5, 20 and 30ppt).

Conclusion

Beneficial gut bacteria act as an immune modulator, promoting host immune tolerance, inducing the training of immune cells, and strengthening the gut barrier against pathogenic infections. Ultimately, the abundance of beneficial gut bacteria in shrimp cultured at 20ppt showed promising salinity conditions in maintaining an optimal shrimp immune system.

Acknowledgments

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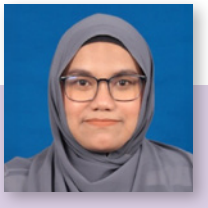

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Cebu hatchery strengthens milkfish fry supply amid climate changes

By Zuridah Merican

Size 3 milkfish fry (graded length 10-12 mm) ready for delivery to farms in Cebu, Visayas and Mindanao.

Cebu's Oversea milkfish hatchery is scaling up production of size 3 fry to meet growing demand from farms across the Visayas and Mindanao. While the hatchery has maintained a steady output, consistency remains a challenge due to fluctuating weather patterns, particularly reduced sunlight and lower temperatures.

Milkfish *Chanos Chanos*, commonly known as 'bangus' remains the Philippines' most widely consumed marine fish. Farmed in brackish water ponds, pens and marine cages in almost all provinces in the Philippines, milkfish is the most accessible and affordable marine fish at a farmgate price of PHP180/kg (USD3.1). Production of farmed milkfish was 400,246 tonnes in 2025 (PSA, 2025).

Industry challenge: Persistent national fry deficit

However, a shortfall in local fry production is creating a long-standing supply gap affecting the entire industry. The national milkfish industry requires at least 4 billion fry annually. In the first half of 2025, collectively, local and government hatcheries produced 530 million fry and fry imports totalled 2 billion (Table 1). In 2024, the total milkfish supply in the country was 3.04 billion.

Current production levels and structural constraints continue to keep the country dependent on imports. To reduce reliance on imports, since 2018, SEAFDEC-AQD (Southeast Asian Fisheries Development Center-Aquaculture Department) and Department of Agriculture – Bureau of Fisheries and Aquatic Resources (DA-BFAR) have been reviving and constructing several milkfish hatcheries nationwide under the Fry Sufficiency Program.

Broodstock management: High investment for large inventory

A recent trip to the Oversea milkfish hatchery in Cebu revealed that running such a facility is challenging. While it is not the largest hatchery in the Visayas, it has consistently produced size 3 fry (graded length 10-12 mm) to supply local and regional farms.

Month	Number of milkfish fry (pieces)				
	Imported fry	Wild caught fry	Private hatcheries	Government Hatcheries	Total
January	190,456,953		25,296,000	481,800	216,234,753
February	365,446,419	4,747,200	50,592,000	722,700	421,508,319
March	491,377,796	19,780,000	101,184,000	7,227,000	619,568,796
April	529,048,056	22,944,800	126,480,000	6,022,500	684,495,356
May	316496530	23,736,000	111,302,400	6,745,200	458,280,130
June	186,678,490.00	7,912,000	91,065,600	2,890,800	288,546,890
Total	**2,079,504,244**	**79,120,000**	**505,920,000**	**24,090,000**	**2,688,634,244**

Table 1. Total supply of milkfish *Chanos chanos* fry by sources in January-June 2025. Source: Christopher Co, Oversea Feeds Corporation Inc.

The indoor tanks at the Oversea hatchery in Cebu hold a total of 600 milkfish broodstock, each weighing between 10 and 20kg.

Gina Melendres, Manager of the 2ha hatchery complex, part of Oversea Feed Corporation aquaculture business which encompasses feed production for shrimp and fish (tilapia and milkfish), farming and milkfish and shrimp hatcheries said, "In the Philippines, milkfish hatcheries maintain their own broodstock. This is a big challenge as broodstock takes up most of the space here. Imagine, we have 600 spawners, each around 10-20kg. We maintain them over 7 years until they are ready for spawning. We also have some 30-year-old broodstock, donated by SEAFDEC-AQD which still provide good quality eggs."

"We also get wild fry and grow-out in cages and at 5 years old, we then choose the shooters to transfer to tanks," added Gina who started her aquaculture career in 1988 in this hatchery.

Gina Melendres (second right) with Ramir Dacullo, National Feed Sales Manager (left) and technical staff Romar Destreza (second left) and Pedro Dobleros (right).

Left: At the Oversea Cebu hatchery, feeding and caring for the broodstock are handled by two technicians (Pedro Dobleros and Romar Destreza). During spawning mode, feed rations increase to 9kg per 100 fish per day. Right: Monitoring 'body fatness' of milkfish, a key indicator of spawning readiness.

Tank conditions and water management

"It is costly to maintain such a large number of broodstock," added Ramir Dacullo, National Feed Sales Manager. "We keep them in large cement rectangular tanks in a covered area. These are 2.5m deep and each hold 250cm^3 of water. Both males and the larger females are kept together at a ratio of 1:1. Reflecting milkfish sensitivity to temperature and water quality, the daily water exchange for these broodstock tanks is 100%." The current cold-season temperatures have prompted the hatchery to explore heating incoming water as well as partial water recirculation options.

Nutrition and conditioning

The Oversea Feed mill produces slow sinking extruded broodstock feeds for both the maintenance and spawning phases. Technicians monitor body condition or fatness to determine spawning readiness. "During spawning mode, feed rations increase to 9kg per 100 fish per day," said Gina. Technicians spend a lot of time feeding the broodstock to satiation.

Spawning performance and environmental control

"Peak fecundity is between 6–10 years but it all depends on broodstock management, nutrition, and spawning environment," explained Gina. Natural spawning is practised exclusively, with temperature control as the primary trigger. Successful spawning occurs at 27°C, while temperatures below 25°C inhibit egg release. Technicians observe fish activity. Overnight splashing of water indicates the start of the courting process. The next day they gently siphoned out the eggs from the spawning tanks.

Peak spawning aligns with natural cycles, March, April, June and July. This is a pattern that Gina said matches the natural spawning cycle seen in the wild. There is only natural spawning at this hatchery, induced by controlling temperature at around 27°C. Although SEAFDEC has developed induced-spawning protocols, the hatchery avoids them so as not to stress the fish; furthermore, technicians must have the skill required to handle frequent handling.

Larval rearing: An 18 day cycle to size 3 fry

First feeding larvae starts with live feed at two days post hatch (DPH2). These are *Brachionus plicatilis* (L type rotifers) mass produced in outdoor tanks. This is then followed by rotifers plus powdered feed. "This 45% crude protein, 300µm micro diet is produced exclusively by our feedmill for internal use. Three days before harvest (DPH18), fry receive *Artemia* to improve energy reserves for transport," said Gina.

The live feed team indicated that rotifer production drops during rainy periods due to reduced sunlight. Gina noted, "We prefer to use powdered feeds rather than depend on the live feed. We enrich the rotifers with vitamin C."

Technician Maharleka Destreza feeds DPH5 fry with powdered feed, produced in-house by Oversea Feeds, exclusively for its hatchery.

The production cycle from eggs to size 3 fry takes 18 days. Fry are supplied to local farmers for direct pond stocking for grow-out to marketable fish of 400-500g in 4 months or to produce juveniles over 2 months for stocking cages and pens. Distribution is focused on Cebu, Visayas, and Mindanao. While growing fry to juveniles could increase profitability, Gina said that space constraints limit the hatchery to fry only operations. Furthermore, it is difficult and costly to transport juveniles.

Survival rate: Incremental gains and higher targets

This determines the success of hatcheries. SEAFDEC-AQD benchmarks egg-to-fry survival at 20–30% for well-managed hatcheries. Ramir noted that over the years, the Oversea hatchery team has improved survival rates from egg hatching to DPH18. Years ago, survival was only 20% and this gradually increased to 25-30%.

The team said that the most critical stage is from DPH2 to DPH9, when the larvae is very sensitive to environmental changes. At DPH9, fry is bigger and eat well. In 2025, the survival achieved up to DPH9 stage was 50% and consequently to the fry stage, it was 35%.

Scaling up: Infrastructure adjustments and production goals

The hatchery produced 24 million size 3 fry in 2025. Its January 2026 output has already reached 2.3 million fry, attributed to infrastructure improvements—specifically shifting from fully covered to partially covered live feed areas to optimise sunlight exposure. Poor performance in January 2025 at 800,000 fry was linked to frequent rains and insufficient sunlight. This year, management has set an ambitious 50% survival target which the team is confident of fulfilling.

Good market position

Local fry are priced at PHP480 (USD8.3) per 1,000 fry compared to PHP200 (USD3.4) per 1,000 fry imported from Indonesia. Despite the price gap, farmers prefer locally produced fry due to significantly higher survival. Most imported fry go to farms in Iloilo, according to Gina.

“Although our fry costs more, our customers are happy with a high survival rate of 70-80% compared to reported survival of less than 20% with imported fry from Indonesia. At one time, farmers complained on size variation which we addressed through improved grading,” said Ramir.

Outlook

With strengthened broodstock management, refined larval protocols, and infrastructure upgrades, Oversea’s Cebu hatchery is positioned to contribute more significantly to regional fry sufficiency. Continued improvements in environmental control and survival rates will be critical to meeting the 2026 production target and supporting the broader national goal of reducing dependence on imported fry.

Gina Melendres (middle) and Ramir Dacullo (second right) with some of the milkfish hatchery staff. From left, Romar Destreza, Airen Mae Gepilano, Kenth Cabigon, Maharleka Destreza, Jesus Asok, Reynalisa Bordios and Pedro Dobleros.

Indian pompano: an emerging candidate for coastal aquaculture and mariculture in India

Farming in coastal ponds, often in rotation with shrimp, is an option for this pompano, but large quantity seed availability is a bottleneck

By Sekar Megarajan, Ritesh Ranjan, Biji Xavier, Joe K. Kizhakudan, Jayasree Loka, Boby Ignatius and K Madhu

Harvesting Indian pompano from sea cages at Visakhapatnam Coast, India. Photo credit: ICAR-CMFRI, Visakhapatnam Regional Centre.

India has emerged as a global leader in fisheries, ranking second in aquaculture production, third in capture fish production, and second in total fish production, contributing to 8% of global fish output. India is a global player in shrimp farming in brackish and low saline waters. However, it lags behind in production from mariculture and coastal aquaculture despite having vast marine resources, supported by an 11,098.81 km-long coastline. The projected mariculture production potential is 4-8 million tonnes annually, yet current mariculture production remains below 0.1 million tonnes.

Therefore, to enhance mariculture production, several fisheries research and development organisations have taken initiatives under various government schemes, such as the Pradhan Mantri Matsya Sampada Yojana (PMMSY) through the National Fisheries Development Board (NFDB), Hyderabad. The promotion and adoption of some mariculture technologies and practices will certainly require established husbandry protocols; well-developed breeding and seed production systems; and nursery, farming and feeding protocols for selected commercial species, with adequate hands-on training and skill-sharing to support upscaling.

However, availability of fish species with closed-cycle and hatchery seed production and suitability for farming is key to developing a mariculture industry.

Together, institutions such as the Central Marine Fisheries Research Institute (CMFRI) and Central Brackish Water Aquaculture (CIBA) under the Indian Council of Agricultural Research (ICAR) have achieved breeding for more than a dozen marine and brackish water finfish species. At present, half a dozen finfish, namely the Asian seabass (*Lates calcarifer*), pearl spot (*Etroplus suratensis*), cobia (*Rachycentron canadum*), orange-spotted grouper (*Epinephelus coioides*), silver pompano (*Trachinotus blochii*) and Indian pompano (*Trachinotus mookalee*) have been introduced for farming in different farming systems.

The Indian pompano is one of the fast-emerging candidate marine finfish for mariculture and coastal aquaculture. Success in captive breeding and seed production was achieved in 2016 by ICAR-CMFRI at Visakhapatnam Regional Centre (CMFRI), according to Ranjan et al. (2018). Following this success in seed production, the farming feasibility of the species was tested, and technology standardised for sea cages, coastal cages, and coastal earthen pond-based farming systems under the All India Network Project on Mariculture (AINP-M) funded by ICAR.

All the developed farming methods were demonstrated on a large scale under the Blue Revolution Schemes by NFDB. Following successful farming demonstrations and performances in a range of systems, farmers are interested in farming the Indian pompano. The species has several advantages. It is easy to breed, readily accepts formulated pellet feed and adapts well to different farming systems. It can be farmed with other species such as white shrimp, mullet and milkfish. It also demonstrates moderate growth, has a pleasing appearance and offers good taste and nutritional value. Strong consumer preference and solid domestic and export market potential have attracted growing interest from a diverse range of stakeholders (Megarajan et al., 2021).

Community participation in cage farming in backwaters at Peddapalem Village, Nagayalanka Mandal, Krishna District, Andhra Pradesh.

R&D have helped promote the species through several schemes implemented by the Government of India (GOI). For example, the Indian pompano is included as one of the major thrust areas of research in aquaculture and marine biotechnology programs by the Department of Biotechnology (DBT) and the species has been prioritised to be developed and scaled up under a Nucleus Breeding Centre (NBC) for marine fish species under the PMMSY scheme of the Department of Fisheries, Ministry of Fisheries, Animal Husbandry & Dairying, GOI.

View of coastal cages in backwaters at Nagayalanka, Krishna District, Andhra Pradesh, India.

Farming systems for the Indian pompano

Marine finfish farming can be carried out in land-based artificial facilities such as tanks and ponds, cage-based onshore aquaculture and recirculating aquaculture systems (RAS) with complete control over water quality parameters. In well-sheltered land-based aquaculture systems, fish are closely monitored according to management practices.

"Studies have shown that the fish species is suitable for nursery rearing in RAS and grow-out farming in sea cages, coastal cages and coastal earthen ponds."

In offshore aquaculture which involves enclosed sections in open waters, fish are kept in cages and exposed to diverse natural conditions such as currents and nutrient cycles. Each approach has its unique advantages and challenges. The selection of culture system depends on species, environment, sustainability, and technology. Years of trials and commercial demonstrations for Indian pompano farming have produced an evolved, turn-key approach for standard operations. Studies have shown that the fish species is suitable for nursery rearing in RAS and grow-out farming in sea cages, coastal cages and coastal earthen ponds.

Sea cage farming

In India, trials on sea cage farming were initiated under research and demonstration activities by ICAR-CMFRI from 2006-2007. The cage culture technology has undergone several modifications in terms of design, anchorage, materials, minimum stocking sizes, stability in different climatic conditions and standardisation with different culture methods and material fabrication. At present, sea cages with HDPE frames of 6m diameter and a 4m depth (~110m^3 volume) are considered to be best suited for marine finfish farming in India's coastal states.

To increase cage culture production, a preliminary survey estimated that a total of 134 sites covering an area of 46,958.2ha are suitable for marine cage farming in India's territorial waters. Sea-cage fish farming demonstrations have been carried out in Andhra Pradesh and Odisha on the east coast under NFDB-sponsored programmes. Also, research on larger-diameter (15m) cages for Indian pompano farming is being conducted by ICAR-CMFRI at the Visakhapatnam Regional Centre.

The developed technology suggested stocking pompano fish fingerlings of around 20g and growing for ~10 months to reach 750g-900g, with a feed conversion ratio (FCR) varying from 1.8 to 2.2. The recommended stocking density is 25 fingerlings/m^3 and the optimum carrying capacity is a maximum of 15-18kg/m^3. Sea cage farming of the species in a cluster of 10 cages will generate an annual profit of approximately INR1.7 to 2.0 million (1USD = 85 INR). However, the profit margin varies with factors such as feed cost, FCR and farmgate price at harvest.

Sea cage farming of Indian pompano at Visakhapatnam, India (maintained by ICAR-CMFRI, Visakhapatnam Regional Centre). Photo credit: ICAR-CMFRI, Visakhapatnam Regional Centre.

Coastal cage farming

Estuaries and backwaters are important ecosystems for improving the livelihood of marginal coastal farming communities. India has about 2.0 million ha of backwaters, coastal lagoons and low-lying areas, potential sources for cage farming.

At present, coastal backwater cages made of galvanised iron (GI) pipes (5x5m in size with a 3m net depth and ~75 m^3 volume) are considered the best-suited design for marine finfish farming in different regions. Coastal cage farming technology for Indian pompano was initially standardised and demonstrated in more than 300 cages under different schemes by NFDB. ICAR-CMFRI promoted community-based development schemes.

The culture period for coastal cage farming is limited to a maximum 7-8 months due to the different monsoon seasons in India. The established farming technology showed that pompano fingerlings of 15-20g stocked at an optimum stocking density of 20 fingerlings/m^3, reach an average size of 650-700g in 7 months. Feeding fish with formulated floating pellet feeds with 40-45% crude protein (CP) and 10% crude fat (CF) gave better results. FCR ranged from 1.7 to1.9. The net profit was calculated at up to INR70,000-85,000/cage when there was a cluster of 10 cages. Coastal cage farming of pompano has emerged as an important livelihood option for coastal fishing communities and small-scale aquafarmers near the backwaters.

Coastal pond-based farming

India has significant potential for coastal aquaculture, with approximately 1.2 million ha of suitable brackish water areas, of which only about 15% is currently developed. India's coastal aquaculture is predominantly dominated by farming of shrimp *Litopenaeus vannamei* and *Penaeus monodon* and a small portion is used for fish such as Asian seabass, milkfish, mullet and, more recently, pompanos (silver and Indian pompano).

Coastal pond farming technology for the Indian pompano was initially demonstrated under an NFDB-funded project from 2018-2020 in Andhra Pradesh. Now the species has been cultured in approximately 100ha in different Indian states. Observations on coastal pond-based farming showed that the pompano can be cultured at salinities ranging from 5-35ppt, either in newly constructed ponds or existing shrimp ponds. The optimum stocking density for 10g fingerlings is 1.5 fish/m^2. Under these conditions, the fish can grow up to 850 to 1000g within 11-12 months, achieving a maximum production of 8.5 to 9.0 tonnes/ha.

Rotation of pompano and shrimp

However, many farmers prefer to culture the species in shrimp ponds as part of a short-term crop rotation cycle. Nursery-reared fish of 30-35g are stocked in ponds and harvested at 500g in 5-6 months. Thereafter, the same pond is used for shrimp farming in the next cycle. In coastal ponds, fish are fed a commercial formulated feed of 40-45% CP and 10% CF. FCR ranges from 1.5 to 1.8 and can still be further reduced with higher natural productivity in pond waters. The average profit margin was INR100/kg and better margins achievable through effective feed management.

With uncertainties in shrimp farming operations, farmers can now look at finfish species in demand in domestic markets as alternatives. Thus, Indian pompano has become an emerging species due to immediate acceptance of pellet feed and comparatively fewer issues with size variation, cannibalism, marketability and growth duration.

Indian pompano farming in coastal earthen ponds at Komaragiripatnam, Allavaram Mandal, Konaseema District, Andhra Pradesh.

Harvesting from coastal earthen ponds.

Packing of coastal pond-farmed Indian pompano for marketing.

Conclusion

Globally, the pompanos are emerging as an important marine finfish. Among the 20 different species in the group, the snubnose pompano (*Trachinotus blochii*) and golden pompano (*Trachinotus ovatus*) have a high market value. They are widely farmed in Asia, including China, Taiwan, India, and Indonesia. Florida pompano (*Trachinotus carolinus*) is a highly desirable species in the United States, with a significant market price. As a result of increased farming operations, the pompano is now listed in FAO's marine and coastal aquaculture finfish production statistics, with 1.9% (0.16 million tonnes) of marine finfish production in 2020.

Similar to other pompano species, the Indian pompano is gaining momentum in Indian aquaculture and adding value to the existing farmed pompano species. The farming of pompano is gaining interest to its appealing characteristics such as quick adaptation to different farming conditions, acceptance of formulated feed and low likelihood of cannibalism.

The fish is highly esteemed among culinary circles for its mild flavour and delicate, flaky texture, and it lends itself well to whole-fish preparations, especially when grilled and presented in various styles. With these positive characteristics, pompano farming is gaining popularity among farmers, but the lack of seed availability is a bottleneck to its potential expansion.

To overcome this issue, ICAR-CMFRI have entered into a Memorandum of Understanding (MOU) with various private and government hatcheries. Progress in the seed production and farming technology for the species will help expand the production of farmed pompano.

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Learning through restraint: A marine fish hatchery in an industry still evolving

In Khanh Hòa province, Dao Van Chuong, founder of Fish World, innovates by producing large grouper fingerlings.

By Ha Thu

Vietnam's marine fish farming sector is often described as the next growth frontier for the country's aquaculture industry. The number of coastal cages continues to expand, industrial farming models are being tested, and offshore aquaculture is frequently featured in policy discussions.

At the farm level, production outcomes are inconsistent. Survival rates fluctuate and technical practices vary widely. As a whole, the sector is still searching for a stable operational system.

The hatchery segment is key in this scenario, positioned where biological needs, technical skills, and market demands all meet.

Fish World grouper juveniles ready for transfer to commercial grow-out systems.

For Dao Van Chuong, founder of Fish World in Khanh Hòa province (formerly part of Ninh Thuan), this intersection has influenced more than a decade of operating a marine fish hatchery.

Chuong entered the marine fish sector after many years of operating shrimp hatcheries. This experience from shrimp post larvae production, particularly in larval management, live feed culture and water quality control, provided an important foundation when he began developing a marine fish hatchery.

As market conditions evolved, his operational focus gradually shifted toward marine fish. The transition did not occur as a sudden strategic pivot but rather through gradual adjustments based on market realities.

Marine fish farming in Vietnam is still in the process of developing its production structure. Many farms rely heavily on accumulated experience rather than standardised protocols. Variability in survival rates and fingerling quality continue to affect grow-out performance, particularly during the early period after stocking.

Rather than expanding rapidly, Chuong has taken a more cautious approach. "Over time, we realised that scaling up too quickly can create more problems than it solves," Chuong said. "Our focus gradually shifted from expanding production to observing and refining the rearing process so that each fingerling has better survival potential."

Size grading to improve survival

Size grading begins very early in the hatchery process. Marine fish are naturally cannibalistic, particularly species such as cobia, grouper and Asian seabass. Even within the same cohort, size differences can widen quickly over time. Larger fish may attack smaller ones, causing injuries that lead to mortality and increased disease risks.

At Fish World, technicians grade fish every three to five days during the hatchery phase. Separating fish by size helps reduce cannibalism, improves size uniformity and allows fish to feed more efficiently.

The process requires constant monitoring. "If size differences are not managed early, larger fish will quickly dominate the smaller ones," Chuong said. "Regular grading helps reduce cannibalism and keeps size within a batch more uniform."

Refining feeding protocols

In addition to size management, feeding strategy is another critical element in marine fish hatchery operations.

During the larval stage, Fish World produces its own microalgae and rotifers to ensure a stable supply and consistent quality of live feed. Through collaboration and exchanges with researchers at local universities, the hatchery has also refined rotifer enrichment protocols by adding nutrients and highly unsaturated fatty acids (HUFAs), to improve their nutritional value for early-stage larvae.

Formulated feeds provide consistent nutritional composition, reliable supply and improved pathogen control.

"The objective is not to push growth as fast as possible," Chuong said. "We focus more on stabilising fish health and helping them adapt early to formulated feeds."

Adjusting feeding strategies for grow-out

In many traditional marine fish farming areas, particularly among small- and medium-scale farms, trash fish remains a common source of feed.

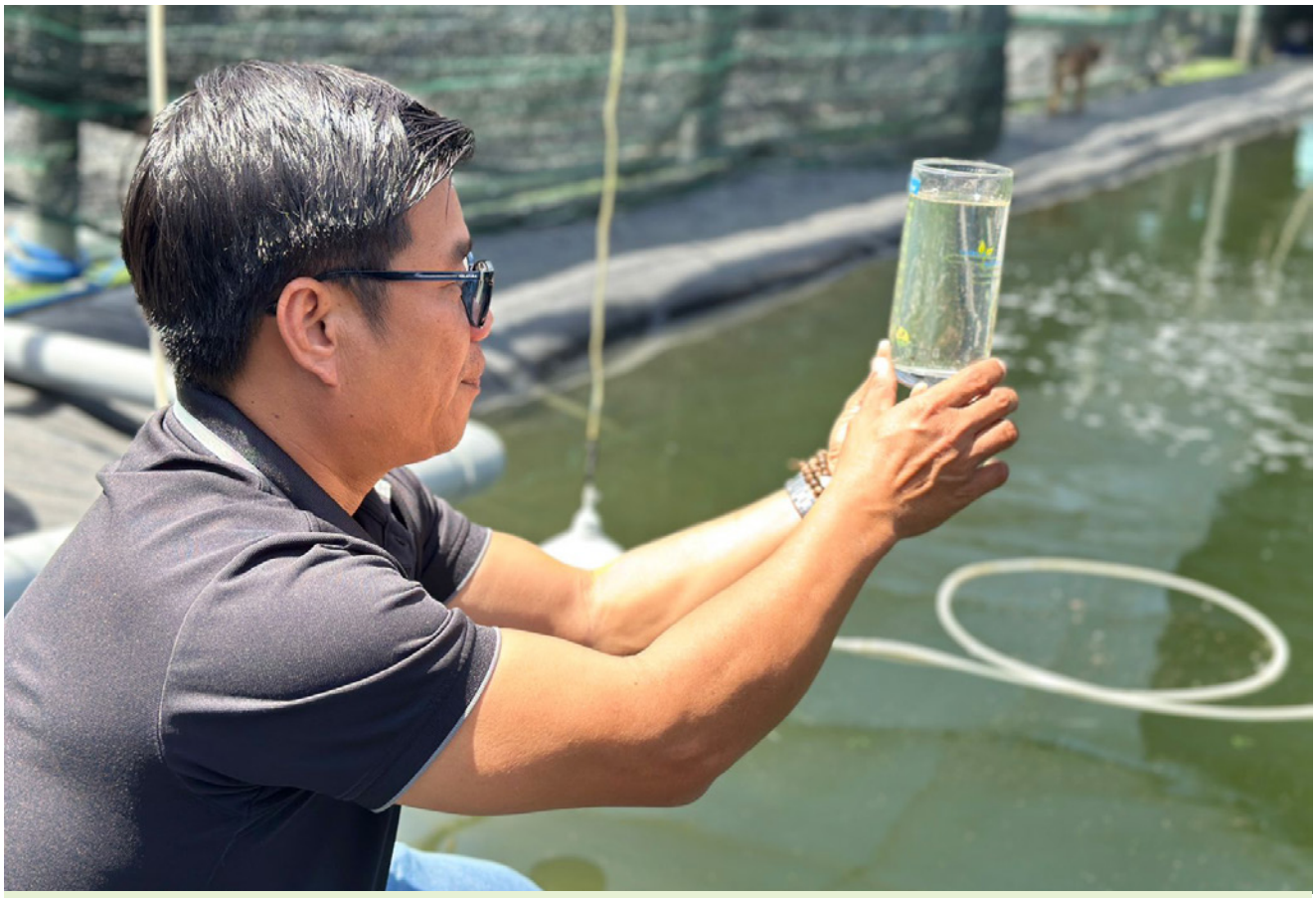
According to Chuong, trash fish can promote rapid growth during the early stages of grow-out. However, its use also carries several risks. Feed quality is difficult to control, prices fluctuate, and if poorly managed, the feed can increase organic loads in the culture environment, raising disease pressure.

For this reason, he recommends that farmers purchase fingerlings that have already been weaned to accept formulated feeds at the hatchery stage. Maintaining formulated feeds during the first months of grow-out may result in slightly slower early growth, but it can help stabilise survival rates.

Over time, once the fish have adapted, combining different feed types may help improve growth while maintaining better control over environmental and disease risks.

Larger fingerlings to reduce risk

One important adjustment at Fish World to increase the size of fingerlings for sale. Larger fingerlings come at a higher price, but Chuong considers this a way to reduce risks for grow-out farmers. Bigger fish tend to adapt better to environmental fluctuations such as temperature, salinity and wave conditions.



Dao Van Chuong examines early-stage marine fish juveniles. Careful grading and conditioning at the hatchery level secures downstream survival performance.

Fish World's nursery system in Khanh Hòa. Covered tanks, aeration and controlled lighting support early-stage marine fish development prior to commercial transfer.

For example, in grouper farming, fingerlings at 5-8cm often face higher risks due to their sensitivity to environmental stress after stocking. Fingerlings of 9-11cm are currently common in the market, while fingerlings in the 12-15cm range often achieve better survival rates in many farming situations.

Fingerlings larger than 15 cm may even be more suitable for offshore cage systems such as HDPE cages, where environmental conditions fluctuate more.

Learning through experience

International collaboration has also reinforced Chuong's cautious approach. Before establishing Fish World, he participated in supplying fingerlings for a marine fish farming project in Dubai, where production systems were operated with a high degree of automation and tightly controlled environmental monitoring.

Survival results, however, did not fully meet expectations even though fingerling quality remained stable. "That experience showed us that survival does not depend only on the quality of the seed," Chuong said. "Even with highly automated systems, farmers still need to observe fish behaviour closely and adjust feeding, density and management in real time."

In that project, environmental monitoring systems were highly automated. Yet observing fish behaviour and making timely adjustments to factors such as feeding, stocking density and fish health still required direct human observation.

Experiences like these have reinforced his belief in refining operational practices rather than attempting to overhaul entire systems.

An industry learning together

Vietnam's marine fish sector is still shaping its operational structure. In many cases, hatcheries and grow-out farms are learning simultaneously.

When customers report increased mortality at certain stages, the response is not to assign blame but to review the entire production chain. Factors such as feed training, stocking density, feeding management and fish behaviour are reassessed based on feedback from grow-out farms.

According to Chuong, progress in the sector may depend less on rapid expansion and more on strengthening biological stability at each stage of production.

Vietnam's coastal conditions are highly favourable for marine fish farming, and global demand for marine fish remains strong. However, without consistent coordination between broodstock supply, hatchery practices, feed availability and grow-out management, ambitions to expand export production may continue to face limitations.

In a sector still evolving, restraint — in scaling, in technological adoption and in the interpretation of results — may provide a steadier foundation for long-term growth.

Ha Thu is a writer on agriculture and aquaculture, based in Ho Chi Minh City.

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Acquisition marks significant expansion in Asia

In March, **De Heus Animal Nutrition** announced that it had completed the acquisition process of CJ Feed & Care from CJ Cheil Jedang. This strategic step is an important milestone in De Heus' long-term growth strategy and confirms the company's ongoing commitment to supporting farmers across the Asian region. This acquisition strengthens De Heus' position in fast-growing markets such as Vietnam, Indonesia and Cambodia, while providing direct access to South Korea and the Philippines. In total, this transaction covers 17 feed mills and livestock operations spread across the Asian region.

Leadership in animal nutrition

With this strategic move, De Heus further strengthens its leadership in animal nutrition as well as its long-term commitment to empowering aquaculture farmers and cultivators in Asia. By combining De Heus' global expertise in animal nutrition and livestock management with CJ Feed & Care's deep technical capabilities, De Heus is well-positioned to deliver higher added value to farmers, business partners and local communities.

Stronger together

De Heus' on-the-farm approach means working side-by-side with farmers to share knowledge, tools and practical guidance to optimize production and performance. The team is now more complete and ready to support farmers in professionalizing operations, increasing productivity, and strengthening business profitability. This direct collaboration strengthens farmers' businesses while supporting the development of the local agriculture and livestock sectors.

"This acquisition is an important milestone in our long-term strategy to strengthen De Heus' presence in Asia," said Gabor Fluit, CEO of De Heus Animal Nutrition. "By combining CJ Feed & Care's technical expertise and customer relationships with De Heus' more than a century of experience in animal nutrition and livestock management, we can accelerate growth and deliver higher value to farmers. Together, we are building a future where farmers and their communities can grow and contribute to a sustainable and resilient animal protein sector."

Kay De Vreese, President Director of De Heus Indonesia added, "This acquisition further strengthens De Heus' long-term commitment to developing the animal nutrition sector and the livestock value chain in Indonesia. We grow with farmers through integrated nutrition solutions, strong technical support, and close collaboration along the value chain to support food security while supporting rather than competing with independent farmers and partnering with MSMEs and local nursery breeders." www.deheus.id

Joint venture to build the world's largest single-cell protein plant in Saudi Arabia

SIIG and Unibio formalise their partnership through the signing of the agreement.

The **Saudi Industrial Investment Group** ("SIIG"), a prominent investor/operator in the chemical industry in Saudi Arabia, and **Unibio International PLC** ("Unibio"), a leading biofermentation company, will build the world's largest single-cell protein plant in Saudi Arabia in an 80:20 (SIIG:Unibio) joint venture to feed the world's growing population and improve food security.

Unibio welcomed SIIG as an investor in 2023. Since then, the partners have made significant progress preparing to build the world's largest single-cell protein plant in Saudi Arabia based on Unibio's patented vertical loop bioreactor technology. With its abundance of natural gas, Saudi Arabia is an ideal location to use Unibio's unique fermentation technology to produce single-cell protein – Uniprotein® - with natural gas as feedstock. As part of it's Vision 2030, Saudi Arabia is looking to diversify its economy and create dynamic opportunities for its citizens through education, entrepreneurship and innovation. Unibio's transformational technology and SIIG's strategic aspirations mark a significant milestone by bringing the most sophisticated industrial fermentation to the Kingdom.

The plant will be located in Al Jubail and will produce an initial 50,000 tonnes of Uniprotein® annually with plans to increase to over 300,000 tonnes in the coming years. The plant aims to reduce Saudi Arabia's dependency on animal feed imports. The Uniprotein® produced is expected to be sold both domestically and internationally.

Gas turned into feed

The plant will use Unibio's proprietary vertical loop bioreactor technology, a continuous-flow fermentation process that replicates nature in converting methane into a high-quality and sustainable single-cell protein for animal feed. Uniprotein® has been tested successfully in various animal species. Non-GMO, free from pesticides, and fully traceable, it is approved for aquaculture in Saudi Arabia, for feed in the EU and has additional registrations globally.

Uniprotein® is on par with other high-quality proteins such as fishmeal and soy protein and its amino acid profile is very close to that of fishmeal. The product has been introduced commercially, drawing significant interest from customers all over the world.

The front-end engineering design (FEED) was completed last year, and construction of the plant is anticipated to commence in the second half of 2026, with commercialisation expected to start in 2028. This facility will be the largest single-cell protein facility ever built in the world. A gas allocation for the plant has been received from Saudi Ministry of Energy, and a site has been nominated by the Royal Commission for Jubail and Yanbu. The project has also received strong support from a number of related Saudi Government entities.

The Joint Venture agreement follows a USD70 million investment in Unibio from SIIG in 2023. SIIG's strategy to grow and diversify its business – will be accelerated by its investment in Unibio. Commenting on the JV, David Henstrom, CEO of Unibio said,

"The world needs innovators who collectively want to find a solution to provide food stability for future generations. We believe that our fermentation technology, which incorporates the most efficient reactor of its kind in gas fermentation, is ideal for Saudi Arabia. We are delighted to join with SIIG as a JV partner to bring industrial scale fermentation to the Kingdom and look forward to working together to address an authentic problem - how to feed a growing population with minimal impact on the planet".

Unibio and BIO PROTEIN Company, a newly established joint venture between SIIG and Unibio, at SIMEC 2026 in Riyadh, Saudi Arabia.

Abdulrahman Alismail of Saudi Industrial Investment Group, added, "We are excited to work on developing this project alongside our partner Unibio, and look forward to bringing sustainable protein production to the Kingdom of Saudi Arabia, our region, and the rest of the world. We see this as a strategic investment for our company and the long-term growth in shareholder value. Using Unibio's technology, we aim to make Saudi Arabia the leader in single-cell protein production and improve food security for both Saudi Arabia and the world's growing population". www.unibiogroup.com

World Aquaculture in Singapore to spotlight innovation and sustainable development

World Aquaculture Singapore (WA2026) will bring the global aquaculture community to Singapore from 2–5 June 2026 at the Singapore EXPO Convention and Exhibition Centre, reaffirming the city-state's position as a leading hub for aquaculture innovation, technology, and knowledge exchange in Asia and beyond. The event is expected to attract international scientists, researchers, and industry stakeholders to discuss the future of sustainable aquatic food production.

AquaPolis launches Asian seabass R&D programme

The Singapore Food Agency has awarded S$18.5 million (USD14.5) to the AquaPolis for the Asian Seabass R&D Programme. Announced in November 2025, the programme brings together eight research institutions and 19 industry collaborators to lower production costs and enhance the quality of locally farmed Asian seabass.

The R&D is anchored on three core pillars: selective breeding, nutrition optimisation, and disease management. Building on advances in previous genomic selection programmes of Asian seabass, the team will develop next-generation, parasite-resistant fingerlings with improved robustness and lower mortality.

These breeding efforts will be complemented by advanced feeding strategies and a comprehensive disease management framework to improve growth performance and fillet quality. Together, these innovations aim to strengthen the competitiveness of locally produced Asian seabass against imports. The AquaPolis Asian Seabass R&D Programme sits within the broader Singapore Food Story (SFS) R&D Programme and supports the national goal of building a resilient, productive local food supply. More on the SFS R&D Programme at https://www.sfa.gov.sg/recognition-programmes-grants/grants/singapore-food-story-rd-grant-call

A special AquaTropics session

Given the confluence with World Aquaculture 2026 (WA26), AquaTropics will take the form of a full day themed session on Day 1, commencing immediately after the trade show opening and the associated coffee break — starting at 11:00 am and running through the rest of the day. The programme will start with a keynote address by Ronnie Tan, Aquaculture Lead at US Grains Bioproducts Council to set the tone, priorities and framing from an industry leading perspective. This will be followed by presentations on successful local R&D projects. The aim is to highlight to international WA 2026 participants the depth of science and applied aquaculture work being done in Singapore, and to actively encourage future collaboration opportunities.

A global platform for collaboration

WA 2026 will feature plenary session and keynote sessions, technical presentations, industry exhibitions, and extensive networking opportunities designed to address both global challenges and regional opportunities in aquaculture. The event theme, "High Yield Production Through Nutrition, Health, Genetics, and Resources," reflects the sector's shift toward integrated, science-based solutions for sustainable growth.

A key highlight on the first day of the program on 3 June at 9:00 am, will be the plenary session featuring national speakers, followed by a keynote presentation by Richard Barry, Senior Market Analyst and Director of Programs at the National Fisheries Institute, USA. His presentation, "U.S. Seafood Market—Sourcing Dynamics and Consumer Behaviors in a Tariff Trade Environment," will examine global aquaculture trends and the strategic importance of sustainable aquatic food systems.

Richard Barry is Senior Market Analyst and Director of Programs with the National Fisheries Institute, a trade association for the U.S. seafood industry. His work includes the NFI Sushi Council, industry education (i.e., sensory workshops and the NFI Seafood School) and planning and programming for NFI's annual event, the Global Seafood Market Conference. He is a NFI Future Leader alum, class of 2016. He graduated from James Madison University in 2010 and spent a year in the Jesuit Volunteer Corps Northwest in Omak, WA working in legal aid.

More information:
Submit abstract online for WA 2026
(abstract submission deadline April 1).

Web: www.was.org.

Contact apcsec@was.org or Mario@marevent.com for the trade show and/or sponsorship

World Aquaculture Singapore 2026

June 2 - 5

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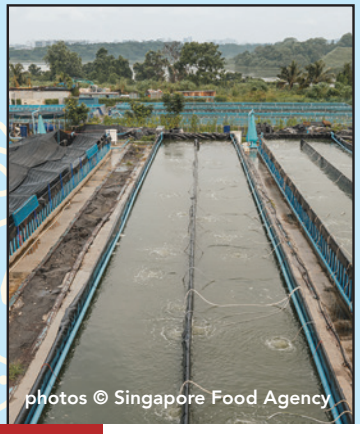

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Global Commercial Director, Genetics Services

Benchmark Genetics has announced the appointment of **Bruno Decock** as Global Commercial Director, Genetics Services, effective 1 March 2026, while continuing as Head of Benchmark Genetics Shrimp during a transition period. In this role, Bruno will lead the global commercial development of the company's Genetics Services portfolio, supporting the strategy to expand advanced breeding, genomics, and analytical services for aquaculture producers worldwide.

Based in Asia, one of Benchmark Genetics' key growth regions, Bruno will work with clients and partners globally to develop long-term collaborations and deliver integrated genetics solutions that support sustainable production and measurable performance improvement.

Bruno has more than 25 years of experience in aquaculture, including extensive work in shrimp breeding, hatchery systems, and international business development across Asia and Africa. He joined Benchmark Genetics in 2017 and has held several key roles with the company's shrimp genetics business.

Dr Morten Rye, Director of Genetics Services and Global Strategy at Benchmark Genetics, said, "Bruno brings deep industry knowledge and a strong international network. His experience working at the interface between breeding programs, production systems, and commercial partnerships will be highly valuable as we continue to expand Benchmark Genetics' genetics services activities globally." bmkgenetics.com

Regional provider of aquaculture solutions

The Blue Aqua International team at WAI 2025, seated from left, Amornrat Boonchuay, Group CFO, Co-founder; Farshad Shishechian, Founder, CEO. Standing, Dr Wiphada Mitbumrung (left), Product Manager, Thailand and Erika Chong Yen Xin, Executive Assistant - Chairman's Office.

At World Aquaculture India 2025 in Hyderabad, premium sponsor **Blue Aqua International** showcased its aquaculture solutions. It is well known for its intensive shrimp-farming systems, patented Mixotrophic™ technology, feed and farm-care products. The company is one of Singapore's most visible players in land-based shrimp farming where Founder and CEO, Dr Farshad Shishechian has confirmed "solid progress" on a 3,000 tonne high tech trout RAS farm, with Phase 1 expected to begin operations in 2026. Blue Aqua's high tech rainbow trout RAS Farm is targeted to produce 1,200 tonnes of fish annually.

In India, the company has Blue Aqua Farmers Center in Bhimavaram —a specialised hub to support India's shrimp farmers with diagnostics, advisory services, and training. This is currently the company's flagship initiative in Andhra Pradesh. Shishechian said that the BAFC is designed as a technical, diagnostic, and farmer-support hub, offering digital PCR diagnostics — India's first such system for shrimp farming, laboratory analysis for disease detection and water quality and advisory services on stocking, biosecurity, and farm management. blueaquaint.com

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Construction starts of major hatchery project for NAQUA

Norway's **MAT-KULING,** a company dedicated to the fabrication of recirculating aquaculture systems (RAS) and filtration equipment for land based fish farming, has officially kicked off the procurement, supply, and construction phase of a major hatchery project for FBU-NAQUA (National Aquaculture Group- NAQUA) in Al Lith, Saudi Arabia. This project showcases the strength of its Compact Recirculating Aquaculture Systems (CRAS) in delivering advanced hatchery solutions for large-scale fry production. Designed to produce up to 40 million barramundi or Asian seabass (*Lates calcarifer*) fry annually, the facility is built around the company's compact, efficient, and biosecure system philosophy.

At the heart of the hatchery are CRAS units applied across the most critical production stages. The project includes 4 broodstock systems, 3 larval rearing systems, and dedicated live feed production systems for Rotifers and Artemia, demonstrating how this technology supports reliable production, efficient use of space, and high operational control within one fully integrated hatchery concept.

A further distinguishing feature is the inclusion of 85 prefabricated tanks of various sizes, all design-built in-house, combining durable thermoplastic solutions with advanced system design for consistent engineering quality. With a main building area of 3,412m² and a total construction area of 4,143m², the hatchery is designed not only for scale but also for smart, controlled, and efficient operation at every stage. Advanced feeding technologies, PLC-based automation with HMI interfaces, independent recirculation loops, and strict biosecurity zoning ensure precision, reliability and sustainability.

This project sets a new benchmark for modern hatchery development in the Middle East, highlighting the company's ability to deliver large-scale, integrated, and high-performance aquaculture infrastructure for demanding environments.

In May 2025, MAT-KULING had announced a major milestone: the signing of a new contract with one of the largest aquaculture operations in the world and a key player in the Kingdom of Saudi Arabia's rapidly growing seafood industry. This strategic partnership marks the beginning of an exciting project—the development and delivery of a next-generation hatchery for barramundi, a premium species with increasing global demand. The hatchery is set to become the most advanced and technologically innovative facility of its kind in the region, supporting NAQUA's vision for sustainable growth and expanded production capacity.

"This project is more than a contract—it is a commitment to excellence, sustainability, and innovation in aquaculture. We are proud to bring our expertise and cutting-edge solutions to support NAQUA's ambitious development goals," said Taner Bilgic, General Manager & CTO of MAT-KULING.

Looking towards the future, by combining NAQUA's strong operational foundation with MAT-KULING's advanced hatchery design and engineering, this partnership aims to set a new standard for aquaculture infrastructure in the Middle East.

The project includes systems for broodstock, larval rearing and dedicated live feed production for rotifers and Artemia, all carefully engineered to work as one cohesive unit. Source: matkuling.com

11th Annual Extruded Pet Foods & Treats

A one-week "Practical Short Course on Extruded Pet Foods and Treats" will be held on 6-10 July 2026, at Texas A&M University in hybrid format by staff, industry representatives, and consultants. The program will cover information on pet food nutrition, material handling, preconditioning, extrusion of pet foods, extruded and non-extruded treats, baked pet treats, raw material, extrusion hardware, automation, product analysis, meat handling in pet food, drying, cooling, and enrobing, food safety, pet food and treat shelf life, trouble shooting and pet food related class activities. Reservations are accepted on a first-come basis. For more information:

https://teesedge.tamu.edu/courses/extrusion/
E-mail: mnriaz@tamu.edu (Mian N. Riaz, Director, Extrusion Technology Program, Professional & Continuing Education- TEES Edge, Texas A&M University, College Station, TX 77843-2256

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Seafood Expo Global/Seafood Processing Global, the world's leading seafood trade event, will bring the global seafood industry together for its largest edition to date. The Expo has over 52,907m² of exhibition space sold to date. The event reinforces its position as the essential global meeting point for the industry, occupying the main halls of Fira de Barcelona's Gran Vía venue. The international presence confirmed for this edition highlights the event's global scale, featuring exhibitors from a growing list of over 80 countries and 62 national and regional pavilions.

Aquaculture Innovation Zone

This year is the debut of the Aquaculture Innovation Zone; a dedicated platform geared towards first-time exhibitors showcasing aquaculture solutions. This space will connect companies at the forefront of aquaculture technology, software, and equipment with the global sector. The pavilion features suppliers, startups and researchers delivering breakthrough solutions in critical areas such as management and monitoring, animal health and welfare and sustainable feed. It will also feature an aquaculture meet-up for professionals to network and learn about the latest advancements, as well as expert-led conference sessions diving into the innovations driving the aquaculture sector forward.

The 2026 conference program will feature more than 20 educational sessions, presented by top seafood industry experts. Key sessions will explore the integration of automation and machine learning alongside sustainable blue food policies and strategies, emerging market trends, and product innovation. Other sessions will address critical topics such as supply chain compliance, traceability and transparency, corporate due diligence and seafood business and finance. More: seafoodexpo.com/global

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The **Blue Food Innovation Summit** brings the aquaculture industry together to explore the opportunities and challenges in scaling blue food production while protecting and restoring the ocean ecosystem. Join 300 global decision makers in London on May 27-28, 2026, to unlock potential partnerships, make new connections and learn from international experts in aquaculture and ocean systems. There are eight key themes – covering diversifying diets, regenerative oceans, AI & digital aquaculture, future farming models, next gen aquafeeds, health and genetics, scaling capital, and retail pull.

Featured start-ups

The event is encouraging start-ups seeking capital investments, R&D collaborations, and corporate partnerships, to spotlight their innovations at the Blue Food Innovation Summit. Early-stage innovation is an integral part of the summit, from start-ups connecting with global producers, feed suppliers, health providers, retailers, and investors to aquaculture leaders searching for next-generation solutions. More:bluefoodinnovation.com

2026

April 21-23
Seafood Expo Global/Seafood Processing
Barcelona, Spain
seafoodexpo.com/global

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

May 27-28
Blue Food Innovation Summit
London, UK
bluefoodinnovation.com/

June 2-5
World Aquaculture Singapore 2026
was.org

August 19-20
TARS 2026: Aquafeeds
Bali, Indonesia
tarsaquaculture.com

September 1-3
Global Shrimp Forum
Utrecht, The Netherlands
shrimp-forum.com

September 2-4
Seafood Expo Asia Singapore
seafoodexpo.com/asia/

September 21-24
The Responsible Seafood Summit/ Shrimp Summit
Bangkok, Thailand
events.globalseafood.org/responsible-seafood-summit#navbar_global

September 24-26
Future Fish Eurasia
Izmir, Türkiye
eurasiafairs.com/eng

September 28-October 1
Aquaculture Europe 26
Ljubljana, Slovenia
aquaeas.org

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eas 50 european aquaculture society years

Since 1976, EAS has been bringing people together for the sustainable development of European aquaculture. As we celebrate our 50th birthday, we look back on key moments and key persons that made EAS what it is today. And we also look forward - continuing to expand our student activities and network and propose benefits for members that are suited to their profile and needs. We will celebrate this milestone throughout the year on social media, and in person at Aquaculture Europe 2026 in Ljubljana, where we invite EAS members to join the celebrations.

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