
Vannamei Shrimp Hatchery Operations in India

Pangasius Fish Nutrition Revealed

Electrical Stunners & Shrimp Welfare in SEA

Species Specific Feed Processing

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Feeding shrimp at Certitude Farms in Tamil Nadu.
Photo credit: Balasubramaniam V.

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Zuridah Merican

The elusive mass market tropical marine fish

In June, we will gather in Singapore for World Aquaculture 2026 and as we often associate the country with technology in marine fish, namely the Asian seabass, this is the focus of this editorial.

This magazine has long asked why Asia has not developed a credible marine fish aquaculture industry comparable to salmon. A useful way to identify the bottlenecks is to examine the value chain and determine what the integrated ecosystem needs, from genetics to distribution, marketing & branding.

First, a caveat. Asian marine fish aquaculture includes many species, each with its own advantages and drawbacks. While this diversity appeals to consumers, this limits economies of scale and investment. To make this editorial coherent and practical, it is best to focus on one species. Here, that species is the Asian seabass – *Lates calcarifer*, also known as barramundi.

Asian seabass is protandrous, it remains male for the first 3–4 years before naturally and permanently changing to female. For genetic selection, this means waiting about four years for females to produce the next generation, although selection for faster growth can shorten the cycle. Overall, the breeding cycle is long and demands both technology, persistence and investment. By contrast, the hatchery and nursery phases are short, but survival is often low because of possibly weak early-stage nutrition and health management. Their physical footprint is relatively small, and the required infrastructure is land-based with access to seawater.

The technology enablers at this stage are quality formulated feed and vaccination. Formulated feed for early-stage nutrition is a small sector with higher prices and good margins. It is also less crowded with fewer players. Vaccination is recommended during the juvenile stage, but few animal health companies think the ROI is worthwhile. Unfortunately, since fry and juveniles are cheap, many in the industry believe it is more profitable to live with low survival rates than to invest in vaccination. The process of manual vaccinating individual fish is an art few have the experience locally. Fish vaccinating machines can do this better but again, with low volumes, there is no market push to be in Asia.

The grow-out takes 18–24 months to reach a 2kg harvest weight and margins are highly dependent on survival rates. This stage has arguably the highest risk with no stock insurance. The constraints are location, disease and cash flow. The infrastructure requires sea cages in locations with good water quality and efficient logistics. Seabass is susceptible to scale drop disease virus (SDDV), viral nervous necrosis (NNV), infectious spleen, kidney necrosis virus (ISKNV) and bacterial diseases. Viruses mutate quickly so continuous updates to the vaccine is required. The grow-out feed segment is relatively well

developed and the most crowded and competitive.

Post-harvest, table-size fish below 1kg are sold live or chilled in local markets, while export markets typically require fish above 2kg for processing and freezing into ready-to-cook products with a longer shelf life. This follows the tilapia model. The question is whether seabass could also follow salmon into global sashimi and sushi markets, with large whole gutted fish air-freighted to the food service sector.

If all this seems daunting, one solution may be for several countries to collaborate within a shared production ecosystem. History offers many examples of such models. During the Industrial Revolution, Britain's textile mills relied on raw cotton imported from India and the Americas, creating a transcontinental system that supplied global markets. Such ecosystems often emerge when an industry becomes too complex or capital-intensive for one country to dominate every stage. They also allow multinational companies to optimise production and supply chains across borders.

In an Asian seabass production ecosystem, countries strong in the knowledge sector like Singapore and Taiwan could work on genetic selection, early stage nutrition and vaccine development while countries with good natural locations and a lower (both labour and infrastructure) cost base like Thailand, Vietnam, Malaysia and Indonesia could focus on grow-out and post-harvest processing.

The development of an Asian marine fish industry needs investment which will require a forecast of demand, supply and outlook so now the question is: Which comes first, the chicken or the egg?

If you have any comments,
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Smart feeding and farming: Elevating shrimp productivity in Vietnam



Photo credit: Informa.

Vietnam is the world's third largest shrimp supplier, after Ecuador and India. According to S&P Global Energy, shrimp exports reached 413,143 tonnes in 2024, a year on year increase of 13.4%. In 2025, total shrimp production was estimated at 620,000–800,000 tonnes, including 150,000–200,000 tonnes of black tiger shrimp (AAP, January–February 2026). The Vietnam Association of Seafood Exporters and Producers (VASEP) reported that shrimp production has grown by an average of 8.4% annually over the past six years, while farming area expanded by only 5% per year. This productivity gap has been largely driven by gains in vannamei farming. Industry stakeholders, therefore, expect Vietnam to shift increasingly toward closed loop, intensive farming systems.

In 2026, VietShrimp Asia was co located with Aquaculture Vietnam under Informa Markets, bringing the former to Ho Chi Minh City for the first time. First launched in Bac Lieu in 2016, VietShrimp had traditionally been held in the Mekong Delta—Vietnam's main shrimp farming region—including recent editions in Can Tho (2025) and earlier in Ca Mau. By combining these two leading events, the 2026 edition became Vietnam's most comprehensive international aquaculture platform and a key industry meeting point. It

also provided new entrants with a gateway to Vietnam's large and rapidly developing aquaculture market.

VietShrimp Asia & Aquaculture Vietnam 2026, held from 18–20 March, welcomed 7,772 attendees and 150 exhibitors from 47 countries across 8,800m² of exhibition space. The event theme, "Smart Aquaculture – AI Revolution in the Aquaculture Industry", underscored the sector's digital transformation and the adoption of advanced technologies to strengthen the aquaculture value chain. Its extensive conference programme showcased a wide range of innovations and practical solutions for the industry.

At the opening ceremony, Ben Wong, Country General Manager of Informa Markets Vietnam, said, "Aquaculture Vietnam and VietShrimp Asia are not just exhibitions, but part of a long term journey to connect the aquaculture industry, linking international innovation with local practice and regional markets with on the ground realities."



Awards were given to exhibitors. The Uni President Vietnam team won the "Most Dynamic" title. Photo credit: Informa.



The ADM team won the "Most Friendly" booth. Photo credit: Informa.



The Bus in Programme supported organised visitor groups from An Giang, Dong Nai, Dong Thap, Lam Dong, Tay Ninh, Can Tho, and Vinh Long. Photo credit: Informa.

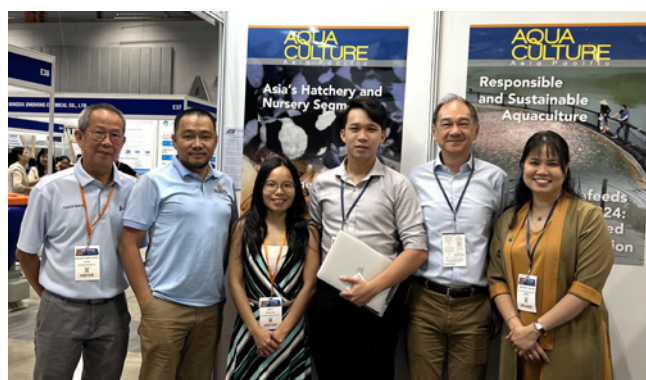


Jeff Jie-Cheng Chuang, General Manager, Sheng Long Bio-Tech International, (fourth right) and his team.

He also welcomed delegations from Cambodia, the Philippines, India and South Korea. Le Viet Binh, Deputy Chief of Office of the Ministry of Agriculture and Environment, noted that the event would create greater opportunities for collaboration, connection and technology transfer in Vietnam's aquaculture industry. Beyond the exhibition, it provided businesses with a platform to build partnerships, exchange expertise and stay abreast of emerging trends—helping improve efficiency and competitiveness.

Over three days, the exhibition showcased the full aquaculture value chain, from advanced farming technologies and nutrition solutions to disease management, water treatment and support services such as logistics. It also saw a sharp rise in international participation, with overseas visitor numbers increasing 228% compared with the 2025 edition.

Another highlight was the bus in programme, which supported group visits from the Mekong Delta—an area that contributes 70% of Vietnam's aquaculture production. This initiative reflects a long term commitment to inclusive development by helping key aquaculture communities access new technologies, connect with industry players and strengthen their production capabilities.



From right, Dr Trần Ngọc Thiên Kim, De Heus Animal Nutrition; Ronnie Tan, USGBC, Malaysia; Hai Nyugen, Eco Seafood; Giang Vu Ngan and Tran Trong, USGBC, Vietnam and Dr Pornlerd Chanratchakool, Thailand.

Insights on Vietnam: Advancing industry knowledge

Local and international industry leaders explored both emerging trends—such as advanced technologies, digital transformation and artificial intelligence (AI)—together

with core priorities including disease management and sustainable development. Beyond sharing knowledge, the conference portion provided a platform for stakeholders to exchange insights, discuss field experiences and identify solutions to current industry challenges.

Aquafeed expertise and current challenges

Vietnam's leading aquafeed producers shared their technical expertise and outlined how they are addressing current industry challenges. A frequently cited issue is Vietnam's higher cost of production compared with other major shrimp producing countries.

Dr Trần Ngọc Thiên Kim of De Heus Animal Nutrition presented data showing that feed conversion ratio (FCR) typically ranges from 1.4 to 1.6, with production costs of USD3–4/kg, compared with USD2.2–3/kg in Ecuador and USD2.5–3/kg in India. On sustainability, Kim questioned whether aquafeed is a true “green solution” or simply shifts ecological burdens. While wild fish use in European aquaculture fell by 13% from 2000–2020, other impacts rose sharply: greenhouse gas emissions (+314%), land use (+594%) and water consumption (+236%). She emphasised that marine ingredients are not inherently “unsustainable”, nor are plant based ingredients always “low impact”. Fishmeal remains the gold standard in shrimp feed due to its high protein content, essential amino acids, digestibility and palatability.

Kim outlined a three phase nutritional strategy to maintain productivity while reducing environmental waste:

- Post larvae stage: extruded feeds for high water stability and optimal digestibility,
- Starter and grower stages: enzyme enhanced feeds to improve protein digestion, FCR, and biomass,
- Finisher stage: probiotics to support gut health, suppress *Vibrio*, improve water quality and accelerate growth.



Shrimp farmers in Bac Lieu, Dragos Mircea, Good Tom (centre) and Tony Dang Quoc Tuan (third left) with Giang Vu Ngan (second right) and Tran Trong Nghia (left), USGBC, Vietnam and Ronnie Tan, USGBC, Malaysia (right).

Managing water quality

According to JJ Chen, Uni-President Vietnam (UPV), concentrations of pathogenic *Vibrio* spp. and *Enterocytozoon hepatopenaei* (EHP) progressively accumulate throughout the culture cycle and cannot be completely eliminated. Shrimp begin to experience physiological stress when nitrite (NO₂) in water exceed 3 ppm and above 5 ppm, is a high-risk threshold for culture performance and survival. Other factors are high hydrogen sulphide (H₂S) concentrations in pond sediments, fluctuations in day-night temperatures and dissolved oxygen (DO), as well as sudden salinity variations.

UPV promotes a formula-based management model using science and data-driven control systems to regulate critical environmental parameters and standardise operational procedures. A key technology is a 24-hour automatic sludge removal system (CDSS), designed to continuously remove dead shrimp, faeces and residual feed in real time, thereby reducing the accumulation of toxins and pathogenic organisms.

Nutritional additives, probiotics and customised farm management logbooks support this system. Records provide detailed recommendations for microbial and chemical product applications, with dosage adjustments based on measured nitrite and ammonia concentrations. The calculation model estimates biomass and survival rates according to initial stocking density, daily feed input and shrimp daily weight gain. It allows for flexible adjustments of feeding programs, animal health products and probiotic application rates. The main objective of this aquaculture formula system is to establish a standardised, safe, and sustainable shrimp farming model while optimising the efficiency of animal health products and probiotics throughout the culture cycle, ultimately reducing overall production costs.

Nguyễn Khắc Hải of Thăng Long Group presented the latest innovation in the company's multi stage shrimp farming model (TLSS – Thăng Long Smart System). This focuses on water quality management using artificial colouring agents instead of natural microalgae. The intensive model uses lined ponds and multiple stages to achieve high yield and economic efficiency. After trials from 2018–2020, it was officially rolled out in 2021.



Juliano Hoffmann, Market Manager at Brazilian Renderers Association (left) and team. This is the commercial promotion body for Brazil's animal rendered products; bovine meat and bone, poultry by products, hydrolysed feather meals, tallow and poultry oils. In 2023, Brazil exported 574,000 tonnes of meals and fats of animal origin. Brazil is strategically important for Vietnam's feed industry due to its large corn and soybean supply.



Xyrex has products to enhance the quality and extend the shelf life of seafood such as Prawn Fresh. Daniel Gilaranz, Aquaculture Product Manager (left) and Gerry McGuire, Managing Director (right) were with Glen Iling, Aquawoo.

The three stages are:

- Nursery: 1,500–1,700 post larvae (PL)/m², targeting 1,200–1,800 pcs/kg in 20–25 days,
- Starter/grow out: 430–450 PL/m², targeting 85–110 pcs/kg by 55–60 days,
- Finisher: 170–200 PL/m², targeting 30–40 pcs/kg by 80–95 days.

Hai reported that farms supported by Thăng Long's technical transfer programme achieved survival rates rising from 71% (2021) to 84% (2025), averaging 79% over five years. He explained that the "no algae" approach—using a synthetic colouring agent (COLORS TL) with *Bacillus subtilis*—avoids the risks associated with algae crashes, such as sudden drops in dissolved oxygen, sharp pH fluctuations and spikes in toxic gases. In a trial pond, pH stability improved 2.7 fold, remaining within the safe range (7.78–7.92). Costs were 8–10% lower in the artificially coloured pond (size 30/kg), mainly due to reduced feed, water treatment, and electricity costs.

Digital traceability platform

Duco Onnes, General Director of Nutreco Vietnam, highlighted the role of traceability in addressing several challenges facing Vietnam's shrimp industry. It can improve food safety, protect product integrity, increase transparency in sustainability practices and strengthen market competitiveness. Given the industry's fragmentation, he called for a unified national digital traceability platform, alignment with ASC/MSC and key market requirements, stronger certification audits and greater investment in digital infrastructure and workforce training.

Looking ahead

Building on this momentum, VietShrimp 2027 is expected to expand further. By rotating the event between Ho Chi Minh City and the Mekong Delta, organisers aim to create a deeper and more sustainable connectivity network. The next edition is scheduled for 24–27 March 2027 in Can Tho City, at the heart of Vietnam's aquaculture region.



Mary Ann Solis, Marketing Manager with the Biosolutions International (Philippines) team.

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Some experiences on vannamei shrimp hatchery operations in India

The team at Vaisakhi Marine Resources describes results from a 12-year case study comparing broodstock lines to production in the hatchery and farm

By Surendran V, Ravikumar Y and Chandrasekhar JYR



In the 1980s, India's black tiger shrimp *Penaeus monodon* farmers were dependent on wild-caught post larvae (PL) for their culture ponds. The Government of India (GOI) under its Ministry of Commerce, then commissioned two hatcheries- TASPARC and OSSPARC which were set up by MPEDA (Marine Products Export Development Authority). This not only led to the availability of monodon shrimp PL for shrimp culture but also helped farmers to switch over to hatchery-reared PL instead of wild-caught ones. More importantly, these projects provided the impetus for the development of the commercial hatchery technology for PL production. We witnessed two paradigm shifts.

The first was that these monodon shrimp hatcheries helped India reach an eight-fold increase in farmed shrimp production within 18 years (between the late 1980s to mid-2000s) to around 160,000 tonnes. The second was the introduction of the white shrimp *Penaeus vannamei*, an exotic species, to India in 2009, which resulted in the rapid development of shrimp aquaculture.

Scenario changes with vannamei shrimp

Since 2009, we have seen hatcheries increase from 200 to 600 in 2024; built-up capacity expanded from 14 billion PL in 2009 to 150 billion PL by 2024, although currently they are operating at about 60% efficiency. Farm production increased from 100,000 to reach approximately a million tonnes in 2025.

Today, these 600 hatcheries produce about 90 billion PL/year from only 4 billion PL in 2009. The average daily production is calculated at around 300 million PL based on 300 days of production. The specific pathogen free (SPF) broodstock imported was around 90,000 pairs in 2024.

Nauplii production was calculated at around 300 billion annually at an average production of 1 billion nauplii/day. Furthermore, nauplii output was estimated at more than 3 million/female. Approximately, 40% of broodstock efficiency is lost due to fluctuating market demand and broodstock mortality.

Views on hatchery operations in India

In this two-part article, we discuss hatchery operations for *Penaeus vannamei* under the following three headings - broodstock management, live feed production (algae culture and *Artemia* hatching) and larval rearing, with special reference to our own experiences at our hatchery projects in India. We discuss these operational aspects at one of the many projects at M/S Vaisakhi Marine Resources (P) Ltd.

Our company operates eight hatcheries, all on the east coast of India in Andhra Pradesh and Tamil Nadu, with an annual production of around 5 billion PL. We import around 15,000 broodstock annually. The mean annual nauplii production is 27 billion. Out of the eight hatcheries, three have the additional broodstock maturation facility.

Broodstock management and nauplii production

Broodstock facilities are isolated and biosecure. All SPF broodstock are imported from several sources. According to regulations, they need to pass through the GOI's quarantine facility before being used by hatcheries.

Broodstock management comprises the following activities, namely: broodstock holding, maturation, spawning and hatching, and nauplii holding and supply.

Maturation

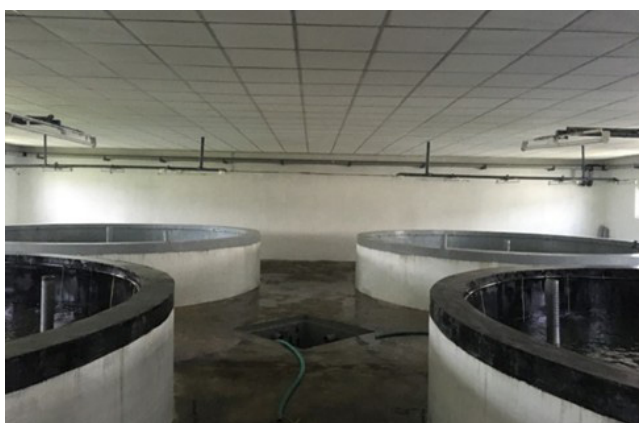
Induced maturation is the general practice; in our case, however, approximately 50% of spawning is achieved from natural maturation. Throughout the maturation process, we ensure biosecurity with egg and nauplii washing, including fortnightly health surveillance of broodstock with laboratory tests for disease/pathogens (mainly white spot syndrome virus and *Enterocytozoon hepatopenaei*-EHP). Locally sourced fresh feeds are pasteurised or frozen before use. Our shutdown disinfection procedure includes an additional sodium hydroxide (NaOH) treatment, expanding on the standard practice of chlorine disinfection and drying.



Above, each morning routine starts with sourcing of female broodstock for ovarian maturation in adjacent light-coloured tank (right) and transferring to the male broodstock (dark coloured) tank for mating.



The major activities in broodstock maturation include broodstock acclimatisation, water and feed management, natural/induced maturation, health and photoperiod management and sourcing for spawners. Male and female broodstock are held separately.



Broodstock maturation tanks at the hatchery in Srikakulam (Andhra Pradesh) belonging to Vaisakhi Marine Resources. These are large 27m² tanks. The size of broodstock holding tanks is similar.

Spawning and hatching

Sourcing is done twice daily, in the morning for spawners and in the evening for mated spawners. Spawning and hatching tanks are bigger, at 10–15 tonnes capacity.



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Mated females (right) will be sourced again in the evening and shifted to spawning tanks (not in the photograph) for spawning; non-mated females will be returned to the female tanks.



Left: Spawning and hatching tanks are bigger, at 10–15 tonnes capacity. These rectangular tanks are meant for mass spawning. Right: Nauplii holding tanks are usually round tanks of 0.5–1 tonne in size.

Nauplii holding and supply

Nauplii are harvested from hatching tanks. They are counted and kept in nauplii holding tanks before supply. In summary, the salient features on technical management of broodstock include the following (Table 1).

"Observations showed that broodstock source does affect performances at three levels: farm production, hatchery larval rearing and nauplii production. "

Infrastructure	Management	Technical
Large maturation tanks	Feeding: @ $\approx$ 30% body mass	Mass spawning
Water exchange: 100–150%/ day	Fresh feeds: frozen/pasteurised	Induced & natural maturation
Photoperiod: light: dark = 14:10	Disease surveillance: (Fortnightly sampling & test for WSSV and EHP)	Sourcing (for ovary development & mating)
Male & female kept separately	Disinfection of facility with NaOH	Egg and nauplii washing
Spawning & hatching separate	No antibiotic use	Approximately 4–5 months in nauplii production
	Chemicals only for prophylactic treatments	

Table1. Summary on some salient features of technical management of broodstock.

Summary on broodstock lines

During the last 12+ years at the Srikakulam project in Andhra Pradesh (Vaisakhi Marine Resources), we have used approximately 25,000 pairs of broodstock in 66 batches of 10 different lines. Observations and results are subsequently detailed. Sources of broodstock used include Kona (Hendrix Genetics, Hawaii); API (American Penaeid Inc, Florida); OI (Oceanic Institute, Hawaii); SIS (Shrimp Improvement Systems, Florida); SyAqua, Florida; Benchmark Genetics, Hawaii and Blue Genetics, Texas.

Broodstock reproductive performance

Within 150 days, we observed that the number of spawning per female was 24.2, but spawning per day averaged around 13.7. Eggs per spawning were 255,000 and nauplii produced per spawning were 191,000, with a mean % hatch of approximately 75%. Overall productivity was observed to be 6.4 million eggs and 4.8 million nauplii per female. Each female produced 28,399 nauplii per day whereas 51,351 nauplii were produced per gram of female (Table 2).

Spawning Performance	13.7%/day	24.2 spawning/female
Eggs & nauplii/spawn	25,500 eggs	19,100 nauplii
Egg & nauplii/female	6.4 million eggs	4.8 million nauplii
Nauplii/female/day & Nauplii/g/female	28,399 nauplii/female/day	51,351 nauplii/g/female

Table 2. Summary of broodstock reproductive performance at the Srikakulam project in Andhra Pradesh (Vaisakhi Marine Resources).

Broodstock vs farm, hatchery and nauplii output

Observations including those from our own farm showed that broodstock source does affect performances at three levels: farm production, hatchery larval rearing and nauplii production. However, while broodstock age does not affect farm production and hatchery larval rearing, age does affect nauplii production.

Selecting broodstock lines

When selecting broodstock, we look at the following four important factors:

- Productivity of broodstock in terms of nauplii output;
- Survival in larval rearing in the hatchery;
- Response of broodstock to natural maturation; and
- Farm performance of PL produced from a particular broodstock line.

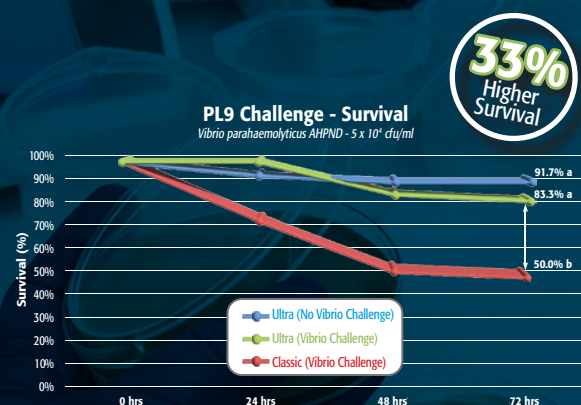
Productivity of broodstock

This is the summary of our observations on broodstock productivity over the last 12 years. We have included data from one of our three broodstock maturation facilities.

In Figures 1A-D, we show the different productivity indices such as broodstock spawning/day, spawning/female and output of nauplii/spawning and nauplii per female, which vary considerably between different broodstock lines. In these figures, we assigned letters to maintain the confidentiality of the broodstock lines used.

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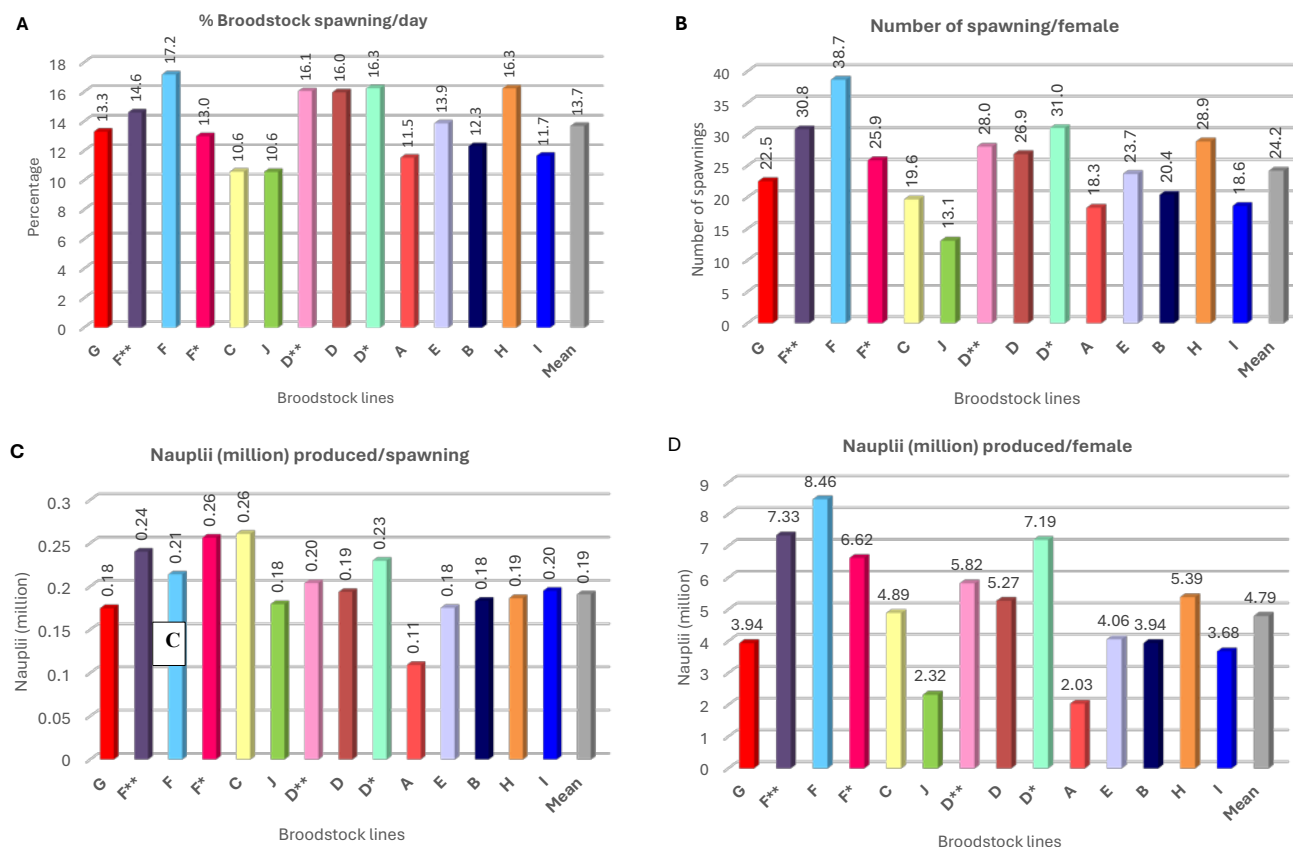


Figure 1. Productivity indices over the last 12 years according to broodstock lines. A. Percent spawning/day; B: Spawning/female; C: Number of nauplii (million)/spawning; D: Nauplii (million) produced/female.

Survival during larval rearing

This year-long observation with different broodstock lines resulted in a mean survival rate of 47% in larval rearing. Although there were some differences in % survival between nauplii produced from different broodstock lines, these were not significant (Figure 2).

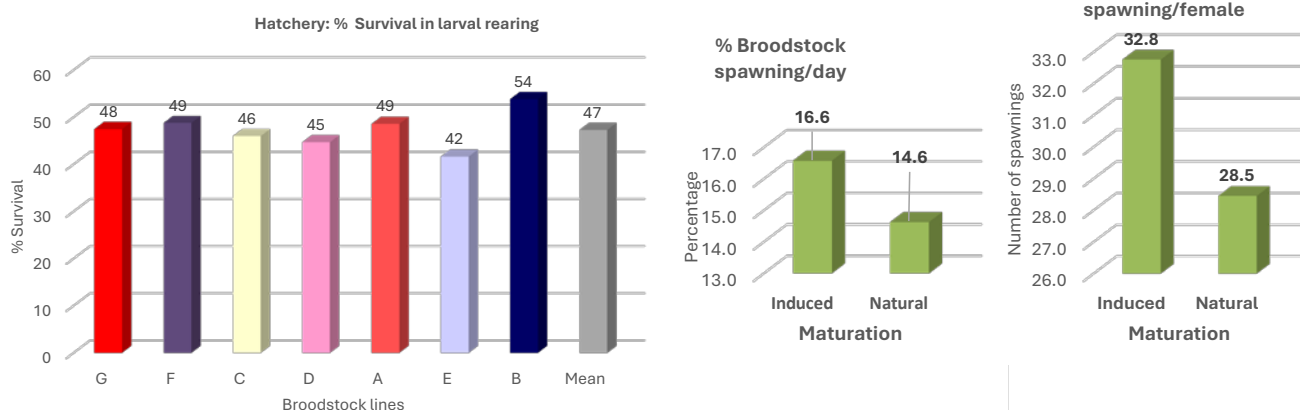


Figure 2. Results of a year-long monitoring of mean survival % at larval rearing in the hatchery.

Induced vs natural spawning

As mentioned earlier, our priority is natural spawning. Unfortunately, not all broodstock lines respond to natural maturation. Therefore, we have been compelled to use induced maturation (via eyestalk ablation) when broodstock do not respond favourably to natural maturation.

This could be a concern in the future. It is not clear why all broodstock sources do not respond equally to natural maturation. This is one major aspect broodstock suppliers may wish to focus on in the future.

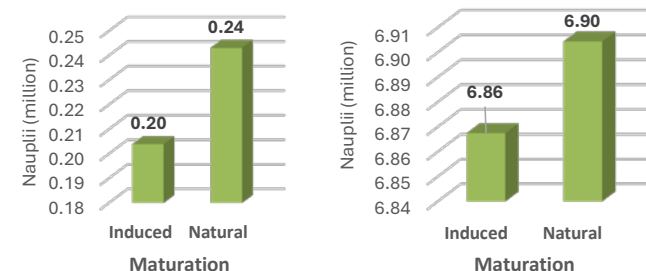


Figure 3. Spawning of broodstock per day and per female and nauplii production per spawn and per female.

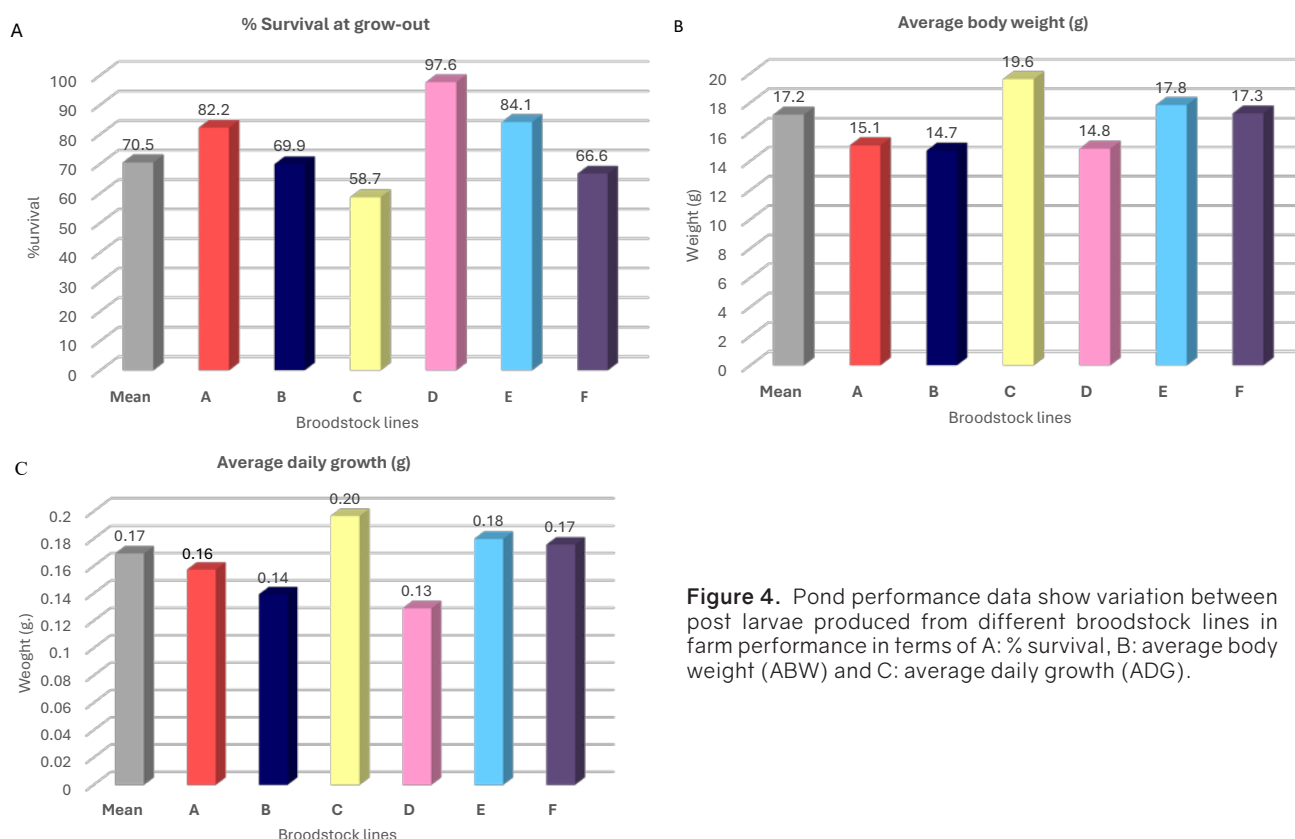


Figure 4. Pond performance data show variation between post larvae produced from different broodstock lines in farm performance in terms of A: % survival, B: average body weight (ABW) and C: average daily growth (ADG).

Farm performance

This is the most important factor we consider when selecting a broodstock source or line. This weighs higher than broodstock performance and larval rearing performance. In Figures 4 A-C, we show that there is considerable variation between PL produced from different broodstock lines in farm performance in terms of % survival, average body weight (ABW) and average daily growth (ADG).

“We also go by farmers’ choice; even if that means, a compromise of nauplii productivity and larval rearing performance.”

However, selecting between different broodstock sources based on farm performance as observed above, is challenging. Often there are seasonal and geographic preferences, and variations in performance. Also, survival and growth are often negatively correlated; hence, it is difficult to find an optimal spot with reasonable growth and good survival. All the same, given the tough farm grow-out situation in India, the general preference for the farmer is observed to be towards ‘robust’ lines. We also go by farmers’ choice – even if that means, a compromise of nauplii productivity and larval rearing performance.

Next issue: The second part of this article will cover live feed production in hatchery operations; algae culture and *Artemia* hatching. It will discuss aspects in larval rearing from costs of production, PL demand to biosecurity in the hatchery.



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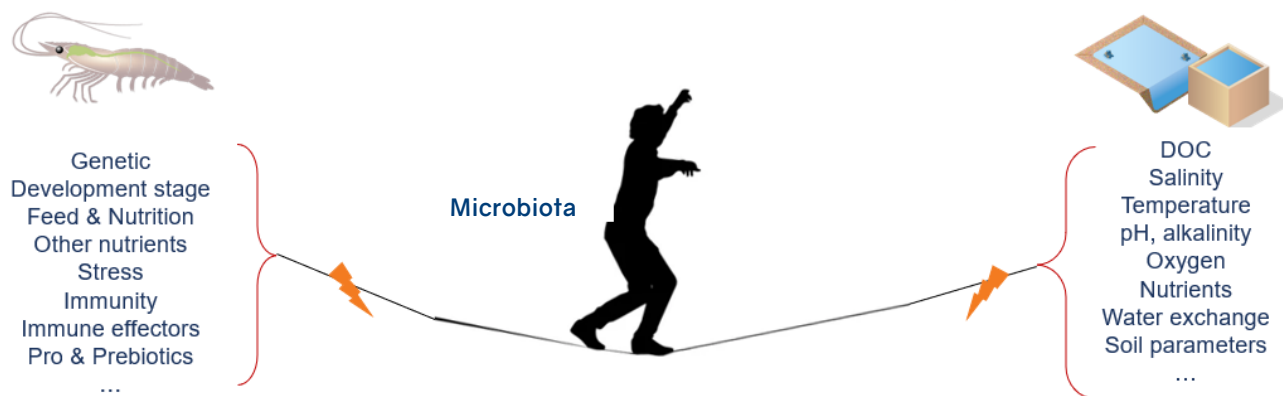
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Safeguarding shrimp microbiota for a profitable shrimp crop

Microbiota in shrimp gut, pond water and environment are variable. This variability depends on many internal and external factors, and managing them is crucial

Gut, water & soil microbiota: a fragile equilibrium



The tricky exercise of walking a tightrope, balancing a stable microbiota environment inside the animal and within the animal's environment.

In March, Lallemand Animal Nutrition's team—Vincent Couture (Global Category Manager), Stephane Ralite (Shrimp Product Manager) and Francois Cellier (Aquaculture Manager, LATAM)—led an online discussion on strategies for safeguarding shrimp microbiota to promote profitable farming. The goal was to share recent field trial data and research, and to highlight practical applications for individual farms. Couture began with the history of the 138-year-old Lallemand.

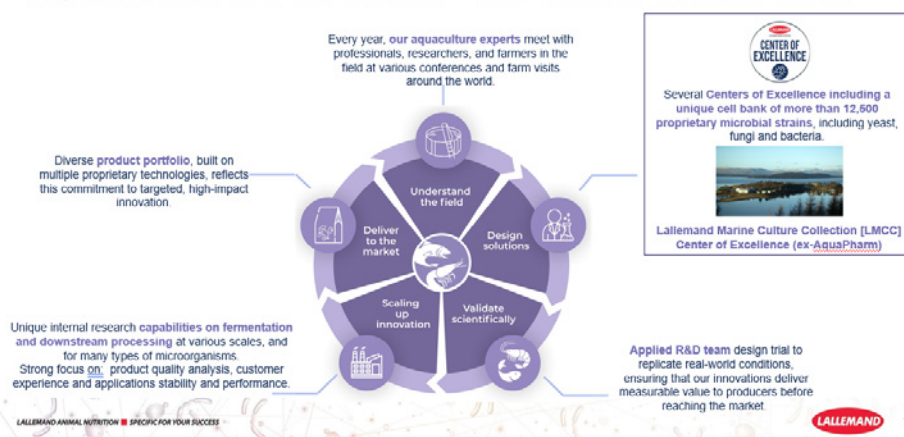
The mission for the Animal Nutrition business unit is to develop and offer microbial solutions and services that enhance animal health and support efficient and profitable farming. "We sell what we produce, and we believe that having this technical knowhow is very important. It guarantees the quality of products. In aquaculture, we have a full cycle of innovation. The R&D team documents and validates our solutions. The Centre of Excellence has more

than 12,500 microbial marine strains that are the base of the product today and tomorrow's inventions," said Couture.

Safeguarding shrimp microbiota

"The more we work with microbiota, the more we understand how crucial it is for shrimp health and its farming," declared Ralite. "However, is microbiota a key functional organ?" On the gigantic role of microbiota, Ralite claimed that today microbiota is as important as other organs. He illustrated the role of microbiota in humans. The microbiota is now "very well documented" in roles ranging from digestibility, immunity, metabolism and even psychiatric disorders. "If one takes all the bacteria present in the gut and body, the weight of this is around 1.5 to 2kg, larger than most organs. Remove it, and you will die."

AQUACULTURE IN LALLEMAND – R&D and INNOVATION driven



An overview of aquaculture at Lallemand Animal Nutrition demonstrates the emphasis on R&D and innovation, to be ahead in challenges managing microbiota in shrimp farming.

Microbiota in shrimp and environment

Shrimp is always in water, so the microbial story extends beyond the gut and into the environment. "The microbiota in water and soil is as important and have strong consequences on the health and profitability of the farm."

Ralite added that unlike humans, shrimp live immersed in their environment, so the water microbiota directly interacts with the shrimp, particularly at early larval stages. Further, the soil microbiota affects water quality and can act as a reservoir of both beneficial and harmful microbes. He also highlighted that several characteristics of shrimp make their gut microbiota less stable than fish or mammals.

The gut microbiota helps to:

- resist external undesirable bacteria challenges.
- support immune homeostasis and host's digestive processes.
- regulate host's metabolic activity.

Water and soil microbiota helps to:

- digest organic matter.
- control the nitrogen cycle and opportunistic bacteria development.
- stabilise phytoplankton bloom.

In shrimp farming, how can we measure whether the gut and water microbiota are safe and healthy? In seeking answers to this question, the classical approach is to look for the core microbiota – species which do not vary from one individual to another and fulfil the minimum symbiotic functionality. However, in the shrimp these are a drop in the ocean of microbiota. The variable microbiota is more abundant, depending on internal and external factors.

Ralite highlighted studies comparing water, soil and gut microbiota at different stages (DOC 70 and DOC 90) that gave two clear conclusions (Figure 1). First, the microbiota in water, soil and inside shrimp are very different. Each requires its own management. Second, all of them evolve significantly over time, changing throughout the shrimp life cycle.

A focus on salinity and immunity

An influential parameter, salinity changes will affect the composition of water and gut microbiota. Analyses across salinity gradients show that variability in salinity and with time is far greater in water than in the gut. This is understandable as the gut microbiota is controlled

by immunity. Salinity has a measurable impact, but also other factors such as pH, light, organic matter, oxygen and minerals all play a role.

Ralite said, "As early as at the zoea stage, when the mouth opens and bacteria first colonise the gut, there is a tremendous impact on immunity and immune development. This dialogue between the microbiota and immunity of shrimp continues throughout the life cycle and is very important to help shrimp adapt with the farm situation."

Instability is the real concern

The result is a very fragile equilibrium. Genetics, immunity, feed ingestion and environmental parameters all shape microbiota. Water exchange is unavoidable but the impact on microbiota composition is very important. Nitrification bacteria for instance are slow growing and fragile. A drop in alkalinity can halt nitrification entirely, leading to ammonia spikes. Likewise, drastic salinity changes, from 0ppt to 30ppt, can stop nitrification for a very long time – 54 days in one research.

In the hatchery's early stages, there is often a peak of *Vibrio* which, for Ralite, represents the instability of the microbiota. While not all *Vibrio* are pathogenic, they are opportunistic bacteria organisms that exploit instability. Their presence often signals that maybe the environmental microbiota is not as stable. The opportunistic *Vibrio* have taken over the space of other bacteria, such as after water exchange or disinfection.

"We analyse the growth of the very virulent *Vibrio parahaemolyticus* causing translucent post larvae disease (TPD); it grows two times faster than a normal *Vibrio*." Figure 2A explains its virulence. TPD *V. parahaemolyticus* is sensitive to salinity (Figure 2B), and decreasing salinity could help control its development. "In farms doing their own bioremediation pre-fermentation, it is advisable to use freshwater," added Ralite.

When imbalance becomes harmful

The consequences of instability are disease outbreaks. In one study, at the start of the cycle, shrimp were healthy and shared similar microbial population. Some shrimp had the genes for acute hepatopancreatic necrosis disease (AHPND), but it took an environmental shock such as heavy rain, impacting salinity, to disrupt the balance allowing pathogenic *Vibrio* to proliferate.

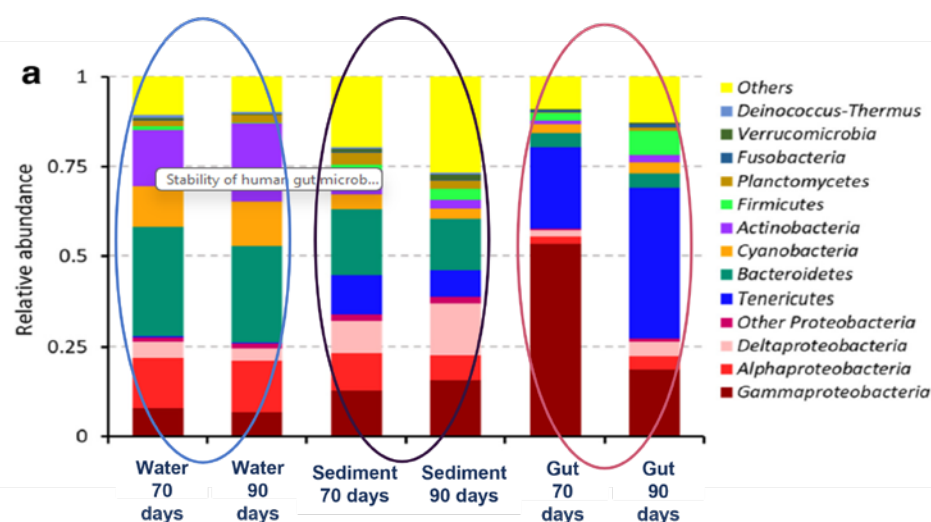


Figure 1. Water, soil and shrimp gut microbiota at different stages – days of culture (DOC) 70 and 90 showing the fragile equilibrium and how these microbiotas change with time. Source: Phuang et al., 2018.

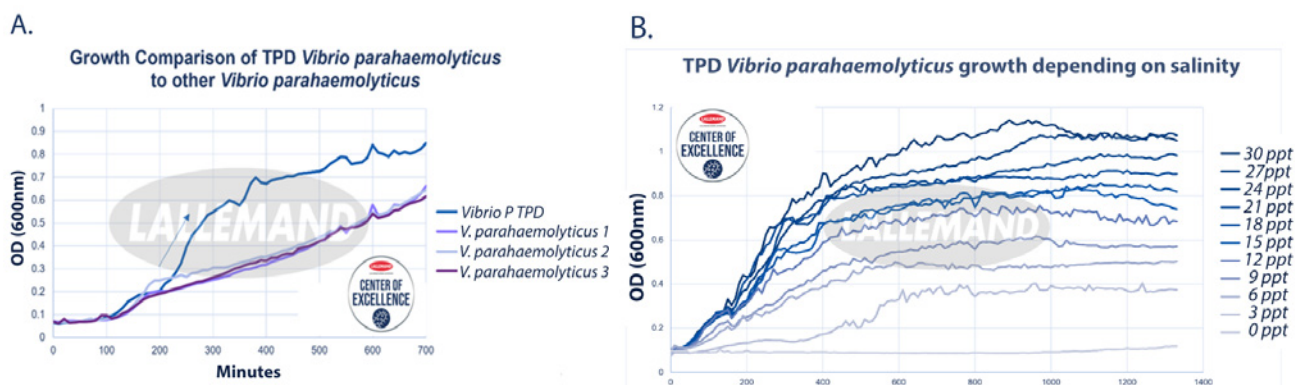


Figure 2. Demonstrating the risk of an unstable microbiota. A. Growth of the TPD *Vibrio parahaemolyticus* versus other *V. parahaemolyticus*. B. TPD *V. parahaemolyticus* is sensitive to salinity.

Research shows that white faeces syndrome (WFS) is not caused by a single pathogen, but by intestinal microbiota dysbiosis. Researchers showed how an entire microbial community shift led to WFS infection. The presence of EHP further complicates matters, weakening immunity and promoting instability of microbiota. "We know that EHP synergistically reduces the immunity of the shrimp and destabilises the microbiota leading to WFS infection," said Ralite.

Chitin provides an ideal surface for *Vibrio*; moulting disrupts microbial balance. Innate immunity is less capable of controlling pathogens. As one researcher puts it, "the shrimp gut is suboptimal for stable microbial colonisation, making its microbiota particularly unstable and a continuous threat to the host survival."

The antibiotic paradox

The message here is that while antibiotics may initially control pathogens, they also disrupt microbial communities. In one experiment, antibiotic use during a *Vibrio* challenge, controlled mortality initially but later led to a spike in mortality due to the peaking of opportunistic bacteria. Therefore, the antibiotic disrupts the microbiota and opens the space for *Vibrio* to proliferate.

Managing stability with probiotics

A beneficial bacteria must be introduced early or in sufficient quantity to compete effectively with opportunistic bacteria. Timing and dosage matter. Speed of growth should be an important criteria of probiotic strains selection, on top of their targeted functionality. Environmental factors can also be leveraged such as lowering salinity to reduce the growth of virulent *Vibrio* strains.



"The Centre of Excellence has more than 12,500 marine strains that are the base of the product today and tomorrow's inventions."
-Vincent Couture

Ralite concluded that understanding what drives instability, whether it is heavy rain, water exchange or stress and acting before problems emerge, is essential. With the right management and tools, microbiota can be stabilised, restoring balance and improving outcomes.

Experiences on microbiota maintenance

Prior to delving into trial results on solutions, Cellier said that at Lallemand, there are three main groups of products; the only EU-authorized probiotic in aquafeed, *Pediococcus acidilactici* CNCM I-4622 (Bactocell®) was designed to maintain gut health, immunity, and growth performance in aquaculture.

A bioremediation solution called Lalsea Biorem which helps to digest organic matter, assimilates ammonia and performs microbial modulation in the environment, specifically in soil and water. The third group consists of yeast cell wall (YCW) called Optiwall, comprising mannan oligosaccharides and β -glucans sharing similar mechanisms such as undesirable bacteria binding and immune support, each acting through different pathways, as well as Yang, a specific multi-strain yeast based product modulating immunity and performing superior targeted bacteria binding.

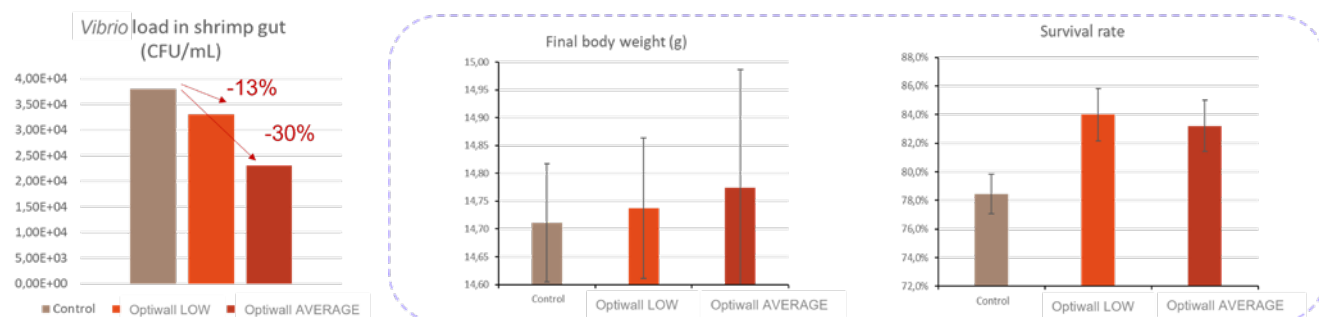


Figure 3. Results of the trial in Mexico with Optiwall. Left, a dose effect; middle higher final body weight and right, higher survival rate.

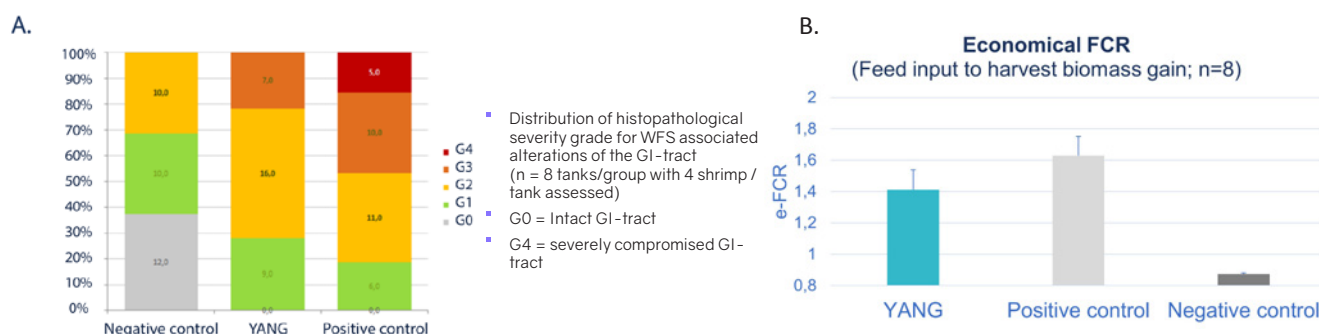


Figure 4. Effect of yeast derivative (Yang) on gut microbiota and gut health under acute vibriosis. A. Decrease imbalance of the gastrointestinal tract (GIT) microbiota with WFS challenge (positive control). B. Better eFCR under WFS provided a stronger financial gain.



Recognising the risk of an unstable microbiota, Stephane Ralite highlights, "The consequences of water or gut microbiota instability are disease outbreaks."

Profitability with low inclusion of YCW

To demonstrate undesirable bacteria binding and immune support, a trial conducted in Mexico used hapas that were in direct contact with the soil microbiota and parasites, closely mimicking real farming conditions where natural inoculation occurs. The experimental design included three conditions: a control group with a normal feed, and two Optiwall groups with low and average commercial dosages.

"We saw a quantity effect, as the dosage of YCW increased, the level of *Vibrio* decreased, reflecting bacteria binding and immune support capability of the YCW group. In terms of growth performance, there was an improvement in final body weight. Survival rates were higher in both YCW groups. Feed conversion ratio (FCR) was reduced in both treated groups and average biomass gain was higher as shown in Table 1," explained Cellier.

There was no obvious difference between the low and average dosages in this trial, suggesting that even low inclusion rates can be effective (Figure 3). Important are the economics of the trial which demonstrated a 14 to 15% increase in profitability, suggesting that the product delivers a return on investment.

	Control	Optiwall -low	Optiwall -average
Initial numbers of shrimp/ha	250,000	250,000	250,000
Survival	78%	84%	83%
FCR	1.7	1.56	1.56
Final ABW (g)	14.71	14.74	14.77
Final biomass (kg/ha)	2883	3095	3072
Profitability difference*		15%	14%

Table 1. Results from a trial in Mexico showed that the low dosage of Optiwall is sufficient to improve survival, FCR and biomass. Inclusion in the feed represents a low investment but with potential economic gain. * Shrimp selling price was local price at the time of the trial for similar count.

Stronger undesirable bacteria binding and immune support

The second 30-day trial focused on another yeast-based product, Yang, which provides stronger targeted binding and broader immune support. This trial simulated bacterial white faeces syndrome (WFS). Three groups were used: a negative control without WFS infection, a positive control with WFS inoculation and a treated group receiving the product at a commercial dosage.

Within just 48 hours after the *Vibrio* challenge, a significant reduction in the *Vibrio* levels was observed in the treated group (Figure 4A). Cellier noted, "The Yang fraction can attach to the *Vibrio* and help to reduce it in the gut." The effect of FCR is shown in Figure 4B.

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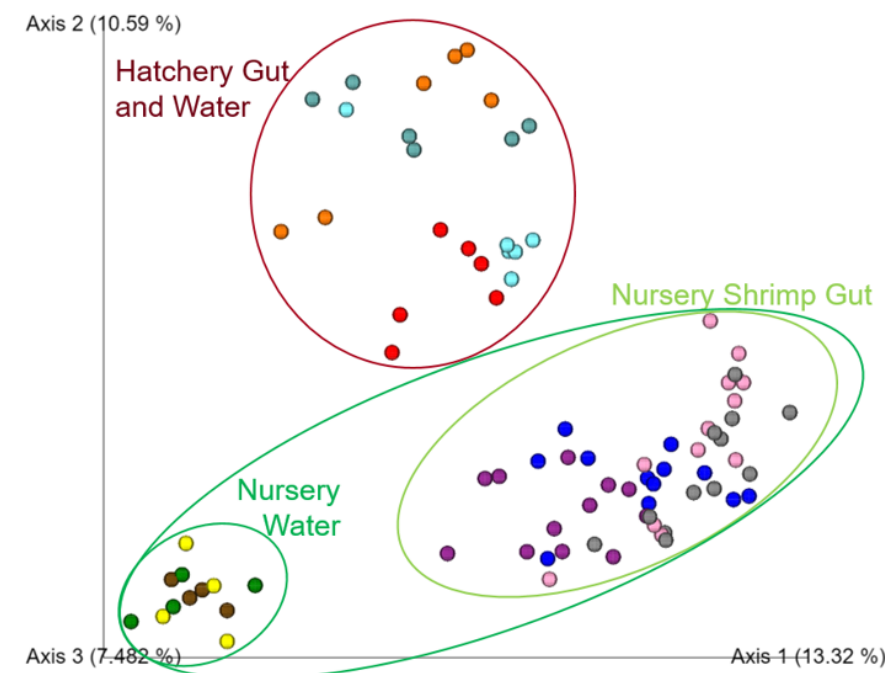


Figure 5. Observations on water and shrimp microbiota showed similarity at the early hatchery stage. Later at the nursery, there was differentiation of both water and shrimp microbiota influenced by feed, immunity and soil.

Microbiota dynamics in early stages

Another method of assessing effects of products on shrimp microbiota and environment was amplicon sequencing. Cellier showed the microbiota dynamics in hatchery and nursery phases – the former lasted 22 days and the latter, 25 days. During the hatchery phase, shrimp were either treated with a combination of products (Lallemand Pack) applied in both shrimp gut and water or with antibiotics. In the nursery phase, three groups were compared: a Lallemand (LAL), a competitor pack of products, and a control group without any additional product.

As shrimp developed, a clear differentiation between gut and water microbiota appeared due to factors such as feed and immune system (Figure 5). The LAL treatment resulted in an increase in beneficial bacteria and a decrease in *Vibrio* abundance. “When the product acts on the water parameters, it has an impact of shrimp health,” said Cellier.

Showing the impact on microbiota in the hatchery phase, Cellier noted a reduction in *Vibrio* and proliferation of ‘positive’ bacteria. In the nursery phase, this translated into improved performance, including higher body weight, better survival and lower biological feed conversion ratio (bFCR). What is clear is that the variability of data is larger for the competitor product as compared to LAL, which could be linked to more stable microbiota in the LAL group.

Effects in intensive grow-out farming

This was in a super intensive grow-out at a stocking density of 150 PL/m² over 40 days. At the end of the trial, shrimp were subjected to a salinity stress test, by reducing salinity from 14 ppt to 0ppt. Four treatments were tested: a control group, an antibiotic group (treated for 10 days), a LAL-only treatment group, and a combination of LAL and antibiotics.

Both in water and gut, the LAL treatment significantly increased the abundance of lactic acid bacteria, which are generally considered beneficial. In terms of performance, survival rates were high across all groups, but growth was significantly improved in both the LAL and antibiotic groups.



Francois Cellier said that a low-cost preventive approach using a specific microbial based product from Lallemand requires only an 0.008 improvement in FCR to cover cost of the feed additive.

However, there was a significant difference in condition factor (length vs weight). Shrimp fed antibiotics were skinnier. Their resistance to stress were also lower.

Suggested feed application strategies

Lastly, Cellier suggested several recommendations for application of their products and protocol examples to help stabilise gut and water microbiota in different risk situations.

Economic evaluation of solutions

Cellier calculated that the different proposed strategies are relatively easy to justify. Based on average international farm gate prices and specific cycle duration, only a very low improvement in FCR, growth or survival is required to cover cost of the proposed feed additive or bioremediation bacteria.

Overall, the key takeaways from the team were that microbiota stability plays a central role in shrimp farming, both in the environment and within the animal.

The risks induced by an unstable microbiota are very high. Instability often goes unnoticed until it leads to disease or performance loss. Environmental factors such as heavy rain or water exchange can disrupt this balance, making proactive management critical. By combining proper farm management practices with targeted product use, it is possible to stabilise microbiota, improve shrimp health and enhance overall farm profitability.

Pangasius fish nutrition revealed

Although Asian pangasius production in 2023 surpassed 3 million tonnes, the absence of comprehensive data regarding essential nutrient requirements is likely impeding improvements in farm efficiency and profitability

By Thomas Wilson



Delivery of feed bags in the Mekong Delta, Vietnam.

The 2023 farm production of several *Pangasius* catfish species (*Pangasius hypophthalmus* – 'tra', *Pangasius bocourti* – 'basa', *Pangasius djambal*, *Pangasius pangasius*, *Pangasius gigas*) across Southeast and South Asia was estimated by the Food and Agriculture Organisation (FAO) at 3.41 million tonnes, valued at nearly USD4.46 billion. The two largest producers, Vietnam produced 51% at 1.75 million tonnes, and Indonesia 10% at 0.35 million tonnes (FAO Fishstat J. 2025 dataset).

In most countries, pangasius are preferably farmed in ponds rather than in cages and pens, requiring different feeding practices. Feeding management and reducing waste feed are often easier in cages than in large ponds, usually, but not always, reflected in lower feed conversion ratios (FCR) and better water quality.

A live fish yield, of course, requires an even greater quantity of feed. Total feed used is dependent on type and intensity of farming, feeding practices and FCRs across the region. Increasingly, due to convenience and improved survival rates, nearly all farmers in Vietnam are using commercially made feeds.

Feed cost is challenged by reduced FCR

While the use of fresh farm-made feeds is declining in Vietnam, in India and Bangladesh, many small-scale farmers use a combination of both types of feed to keep production costs down to a manageable level (Alam, 2011; Mugaonkar et al., 2019). Farm-made feeds are often cheaper for the farmer, but with poorly balanced nutrients and poor water stability, they give FCRs often double that of commercial feeds. Additionally, there is a high chance of feed wastage resulting in deteriorating water quality.

Some recent estimates of FCR for pangasius farming using commercial feeds include:

- Bangladesh: 1.96 – 1.97 (Sarkar et al., 2005; Ali et al., 2013)
- India: In outdoor recirculating aquaculture system (RAS), 1.35 – 1.74 (Rehman, 2023), in cages – 1.63 and ponds – 1.47 (Kumar et al., 2017)
- Indonesia: 1.68 (WWF, Indonesia, 2015)
- Vietnam: 1.57 – 1.69 (Phan et al., 2009; Nhu, 2015; Nguyen and Jolly, 2020; Hai and Ton, 2023).

In a paper that relates to pond aquaculture, Stone et al. (2024) discussed factors affecting FCRs in the US catfish production ponds. These were environmental factors (temperature, salinity), genetics, chemical water quality (dissolved nitrogen), aeration and oxygenation, stocking density, fish age and size, feed quality, feeding strategy, skill of hand-feeders and survival to harvest (reduced by disease, predation).

Since feed cost is responsible for 60 – 85% of total production cost in pangasius farms across the region (Bosma et al., 2009; Griffiths et al., 2010; Nhu, 2015; Seshagiri et al., 2021; Sonvanee et al., 2021), the ability of a farm to consistently obtain a favourable reduced FCR is the single biggest factor ensuring profitability. From the feed perspective, Stone et al. (2024) stated: "It is generally accepted that if the feed is nutritionally balanced, meets all nutrient and energy requirements, and supports optimum fish growth, it will result in a favourable FCR." Going forward, we will focus on the state of knowledge about the nutrition of *Pangasius* species to date.

Requirements for crude protein

In reality, fish do not have a protein "requirement"; they have a requirement for the digestible amino acids the protein provides. Any undamaged protein, coming from any plant or animal source, that can provide digestible amino acids can be used in feed to supply dietary amino acids.

Formulating a feed with an established protein 'requirement' for a species is a convenient way of approximating the quantity of protein from ingredients needed to provide the essential amino acids that the animal needs. Thus, a dietary protein requirement expressed as % protein in the diet without considering protein digestibility or protein quality has limited usefulness in predicting feed performance.

The earliest report on the protein requirement of *Pangasius suchi* fry was by Chuapoehek et al. (1985); other authors in Vietnam, India and Bangladesh had analysed farm data in their countries, and estimated protein requirements. These studies are summarised in Table 1. It is worth noting that all of the studies except one used juvenile fish grown in aquariums or tanks, with a single study using cages in

ponds. Typically, juveniles have a higher daily protein intake requirement on a body weight basis than larger fish.

Specific requirements for amino acids

Currently, there are no reliable published reports using purified research diets on the specific requirements for essential amino acids for the pangasius fish. Deficient intake of any of the key essential amino acids, lysine (LYS) and methionine (MET) in particular (which are the first limiting amino acids for fish in plant ingredients), has a profound effect on feed performance and growth. Therefore, knowing specific requirements is essential to allow fine tuning of amino acid content, leading to improved feed performance and lower FCRs.

In this absence, the best solution is to measure whole body amino acids of the pangasius fish (Men et al., 2005; Danuwat et al., 2016; Aristasari et al., 2020) and then use the Ideal Protein Concept to estimate an approximate amino acid profile for feed formulation.

Additionally, there are a few reports of experimental feeding of amino acids to pangasius.

Species, body weight initial and final (g)	Feeding trial (days)	Protein levels (%)	Diet type/main ingredients	Fishmeal (%)	Test parameters*	Optimum protein (%)	References
<i>Pangasius suchi</i> (now <i>Pangasianodon hypophthalmus</i>) 0.2g – 3g	60	20-25-30-35-40-45-50	Moist diet/ fishmeal soybean meal, rice	17-41	WG, FCR, Survival	Minimum level of 25%	Chuapoehek et al., 1985; Thailand
<i>P. bocourti</i> 37g <i>P. hypophthalmus</i> 7.69g – 24g	28	g CP / kg BW /day) 0-5-15-25-35-45	Lab semi-Practical/ fishmeal	91	WG, FCR, SGR, PER, ANPU	<i>P. bocourti</i> 12-13g/bw/d <i>P. hypophthalmus</i> 11-12g/bw/d	Hung et al., 1999; Vietnam
<i>P. hypophthalmus</i> 2.6 – 63g	90	16-20-24-29-33-37-42			WG, SGR, FCR	37%	Ngan, 1999; Vietnam
<i>P. bocourti</i> 5-6g <i>P. hypophthalmus</i> 5-6g	0, 10, 20, 30, 40, 50	0, 10, 20, 30, 40, 50	Lab semi-practical/ fishmeal	91	WG, FCR, SGR, PER, ANPU	<i>P. bocourti</i> 27.8% <i>P. hypophthalmus</i> 32.2%	Hung et al., 2002; Vietnam
<i>P. hypophthalmus</i> 6.63g – 116-227g	70	20-25-30-35-40-45	3 feeds: 27-32.5		WG, FCR, FI PER,	29%	Kader et al., 2003; Bangladesh
<i>P. hypophthalmus</i> 4.5g – 46.6g	56	34-38-41-45	Lab diets/ high fishmeal	50.7-65	WG, FCR, FI PER,	45%	Liu et al., 2021
<i>P. hypophthalmus</i> 4.21g-11.5g	60	20-25-30-35-40-45	Lab diet/ casein gelatin starch dextrin		WG, SGR, FCR, ANPU, Survival, ANPU	35%	Jayant et al., 2018; Bangladesh
<i>P. hypophthalmus</i> 685g – 1160g	90	35-40-44	Practical Feeds/ fishmeal, soybean meal, wheat bran	10-35	WG, SGR, FCR	40%	Khan et al., 2018; Bangladesh
<i>P. hypophthalmus</i> 5.5g – 25g	56	30-35-40	Moist diet/ fishmeal, soybean meal, corn, gluten	8.5-10.4-13	WG, SGR, FI, FCR, PER, APU	35%	Khattaby et al., 2021; Egypt
<i>P. hypophthalmus</i> 1.3g – 31.1g	72	30-35-40-45	Extruded diet/fish-meal, soybean meal corn gluten meal, wheat flour	21-38	WG, FCR, SGR, body composition survival	≤40%	Bano et al., 2023, Pakistan
*WG – Weight gain, FCR – Feed conversion ratio, FI – Feed intake, SGR– specific growth rate, PER– Protein efficiency ratio, PRE– Protein retention efficiency							

Table 1. Summary of published studies reporting on the protein requirement of *Pangasius* spp.

Yuangsoi et al. (2016) prepared a series of experimental diets (34% CP) using base ingredients very similar to commercial feeds in Vietnam, with 4.76% fishmeal, 48% soybean meal, 23.65% corn meal and 4.59 to 5% rice bran, with 8% added fish and soya oil. Lower cost pangasius feeds would likely use a higher content of full-fat rice bran to reduce oil addition. The researchers then added DL-MET at 0, 0.1, 0.2, 0.3 and 0.4%. Juvenile *P. bocourti* (162g) were raised on these diets for 60 days. Growth performance was measured by % weight gain, FCR, SGR (specific growth rate) and PER (protein efficiency ratio). They concluded that MET at 0.63g/100g dry diet was best for maximum growth and feed utilisation.

In a recent paper, Liqat et al. (2024) fed *P. hypophthalmus* one of six fishmeal-free diets (main ingredients: 40% soybean meal, 29% corn meal, 12% rice polish, 7% wheat bran and 6% canola meal). Diets were supplemented with amino acids LYS, threonine (TRP), and MET at 1.56%, 0.37% and 0.16% respectively, and then together with TRP in several combinations. Their intention was to assess amino acid levels with growth, immune response and disease resistance of *P. hypophthalmus*. Fish (17.9g) were fed pelleted diets for 8 weeks, then challenged with *Staphylococcus aureus* and assessed for 15 days. In addition to assessing feed performance (SGR, FCR, HSI, survival), blood and muscle tissues were collected for additional testing, digestive enzymes were assayed and several tissues were histologically examined. The most favourable outcome was obtained with the basal diet supplemented with 5g/kg each of LYS, MET and TRP on top of the basal levels.

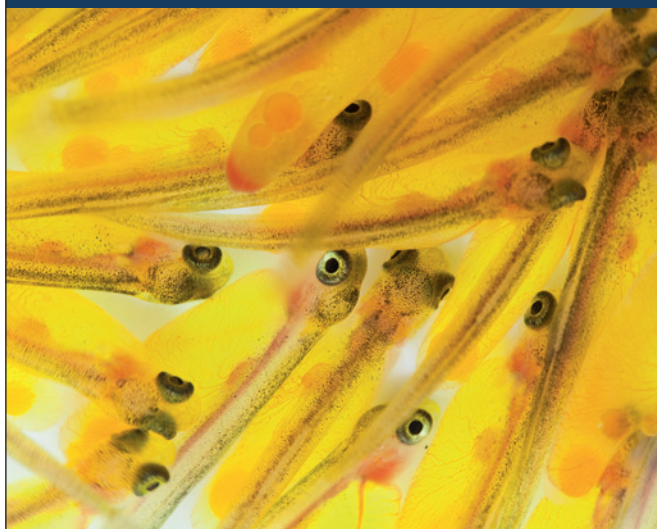
In the latest paper of Liqat et al. (2025), *P. bocourti* fingerlings (10g) were fed essentially the same diets as above for 10 weeks, then challenged with *Streptococcus iniae* and assessed for 14 days. In this experiment, their intention was to assess amino acid levels with growth, immune response and disease resistance. After the challenge, fish were assessed for growth and IGF-1, haematological profile, antioxidant enzyme status and immune response factors IGF-1 and IL-6. Here, the most favourable outcome was obtained with the basal diet supplemented with 6g/kg each of LYS, MET and TRP.

Dietary lipid and fatty acid requirements

There are no published studies on specific fatty acid requirements for the pangasius, but there are studies investigating the appropriate level of lipids to incorporate into feeds. Sivaramakrishnan et al. (2016) fed *P. hypophthalmus* juveniles (13.5-14g) a series of purified casein-gelatin 35% protein diets with oil (1:1 sunflower: fish oil) added at 3, 6, 9, 12 and 15%. They concluded that 10% added lipid was optimal for maximum growth of the fish.

Kabir et al. (2019) fed 3-year-old female *P. hypophthalmus* broodfish (3.3kg) one of three 30% CP diets with 6, 9 and 12% lipids coming from fish oil and palm oil. They were interested in the impact of these diets on spawning and fecundity of the fish. A feed lipid content of 9% or higher gave a significantly better reproductive performance (ovary weight, fecundity, egg weight and fertilisation) than 6% lipid.

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Net pens to conduct feed trials in the Vinh Hoan research farm near Sadec, Vietnam. Photo credit, USGBC, Vietnam.

Related to feed lipid levels, several authors had assessed the best protein to energy balance for pangasius. This is an important factor in determining the amount of visceral fat deposited in farmed fish. Phumee et al. (2009) fed *P. hypophthalmus* fry (3.5–3.8g) 25, 30, 35 or 40% protein (Danish fishmeal) diets having either 6% or 12% lipids (fish oil, corn oil), and found that a 40% protein diet with 12% lipid gave the best results (SGR, FCR), but performance of a 30% protein diet with 12% lipid was not significantly different, suggesting that the lipid has a protein sparing effect. Similarly, Epasinghe et al. (2015) fed 1.1g *Pangasius sutchi* fry with diets (main ingredients: fishmeal, soybean meal and wheat flour) containing 25, 30 and 35% protein, with fat levels at 6% and 10%, and reported the best result with 35% protein and 10% lipid.

Recently, Prakash et al. (2025) fed *P. hypophthalmus* juveniles (168g) nine extruded practical diets (main ingredients: de-oiled rice bran, soybean meal, groundnut oil cake, mustard oil cake, wheat flour, fishmeal) with three protein levels (28, 30, 32%) and three lipid levels (4, 6, 8%), and reported that the best performance (weight gain, SGR, FCR, PER) was obtained with the 28% CP and 4% lipid diet which is somewhat puzzling. There is little to explain why the results are seemingly the opposite of the previous studies. Feed intake data were not provided, but practical experience suggests that there may have been a problem with their groundnut oil cake (perhaps due to palatability or mycotoxins), the only ingredient that increased substantially as protein levels increased.



Harvest of pangasius in the Mekong Delta. Photo credit, USGBC, Vietnam.

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Vitamin requirements

To date there is only one published study on the requirements for vitamins. Daniel et al. (2016) investigated the dietary ascorbic acid (vitamin C) requirement of *P. hypophthalmus* fry (3.2 - 3.4g) using purified casein-gelatin-dextrin diets with dietary ascorbic acid levels 17.5, 35, 70, 175, 350 and 700mg vitamin C/kg diet (from L-ascorbyl-2 polyphosphate). Analysis showed actual levels were 14.5, 32.5, 68.9, 163.5, 341.2 and 682.8mg/kg diet, respectively. The best growth, FCR, SGR, PER and survival was obtained at the 35mg/kg level. Ascorbic acid saturation level in the liver was obtained at about 76mg/kg diet.

In a later work Daniel et al. (2018, 2021) looked at the impact of dietary ascorbic acid on *P. hypophthalmus* haematology, immune and stress responses before and after challenge with *Aeromonas hydrophila*. In this instance, the authors concluded that supplementing ascorbic acid at 350 - 700mg/kg diet gave the highest immunostimulatory effect.

Mineral requirements

As with vitamins, there are few published requirements for any of the macro- or micro-mineral requirements. Several studies on the pangasius have been conducted with zinc (Jintasataporn et al., 2014; Kumar et al., 2017; Singh et al., 2017; Kaliky et al., 2019), and there is a single study with selenium (Thangarani et al., 2024).

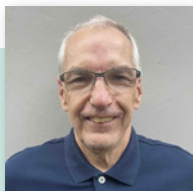
Singh et al. (2017) fed purified diets (casein, gelatin, dextrin, starch) containing 23, 26, 29, 32 and 35mg/kg Zn (ZnSO_4) to *P. hypophthalmus* fingerlings (11.5g), and after measuring weight gain, SGR, FCR and PER, concluded that 32mg/kg was sufficient for maximum growth and nutrient utilisation. In an earlier report, Jintasataporn et al. (2014) fed practical diets, where the main ingredients were 32% soybean meal, 25% wheat flour, 10% rice bran, 10% soy protein concentrate (SPC), 5% fishmeal and 5% rapeseed meal to 209g *P. hypophthalmus* with added inorganic zinc sulphate and/or zinc amino acid complex (ZAAC) providing 0, 50, 100, 150, 200mg Zn/kg diet. Here, the authors concluded 50mg ZAAC as the sole source, or a mixture of 70% Zn sulphate/30% ZAAC gave the best growth performance.

Take home message

Considering that the Asian annual production of the pangasius is now in excess of 3 million tonnes, a near complete lack of data on requirements for essential nutrients is most likely holding farm efficiency back and profitability down. Detailed nutritional information is absolutely essential to develop feeds with the highest performance (precision nutrition), superior fish quality, and optimised health and survival.

Furthermore, considering that the largest quantity of feed is eaten by pre-harvest fish, the lack of studies using large fish prevents the optimisation of feeding management, FCRs and maximising profitability where it counts most.

I believe that if this nutrient requirement knowledge gap is to be addressed, Asian producers will have to step up, since there is no incentive for others to do it. The most sensible approach is to create a research environment managed by Asian researchers in international and national public institutions and private enterprise, similar to the European aquaculture nutrition research model. Such an effort could be funded by Asian governments themselves, as well as the pangasius industry (farmers, processors) checkoff funding based on tonnes of fish produced.



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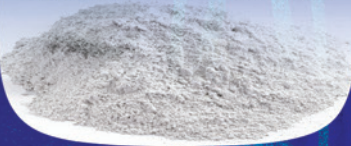
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An effective role of gallic acid in combatting EHP in shrimp farming

A trial in Vietnam demonstrated that after the challenge, the highest inclusion of the feed additive led to an increased survival rate and the lowest EHP load.

By Hiroshi Hashimoto, Kyoshiro Nonaka, Takamichi Kawada and Anh Le

The production of white leg shrimp *Penaeus vannamei* has seen substantial growth, particularly across Southeast Asia, China, India and Latin America. Success in its production can be attributed to the integration of advanced technologies and intensive farming practices. However, as shrimp farming intensifies, there are significant challenges including diseases and environmental impacts, which pose risks to both production and expansion.

In response, the industry is increasingly focused on enhancing shrimp health and productivity through sustainable farming practices. In pursuit of optimal results, industry has explored genetic breeding to high-quality post larvae production, innovative aquafeeds, pharmaceuticals and farming technologies. A significant focus has emerged on the development of novel supplements or additives that enhance shrimp resilience, promoting better disease tolerance and at the same time, maximising growth performance.

The EHP crisis

Among the challenges plaguing shrimp aquaculture, *Enterocytozoon hepatopenaei* (EHP) stands out as a major concern. This intracellular parasitic disease is linked to retarded growth, size variability and high feed conversion ratio (FCR), causing significant economic losses. Moreover, EHP is associated with *Vibrio* infection, widely studied as white faeces disease (WFD). The symptoms are visible – white faecal matter or a whitish gastrointestinal tract or gut in infected shrimp. This correlation intensifies the adverse effects on shrimp physiology, metabolism, growth performance and overall survival. It also complicates efforts in finding effective solutions for mitigating impacts from this pathogen.

Emerging solutions on the horizon

Natural additives have gained significant attention in aquaculture because of their potential to enhance shrimp growth and overall health. The application of different bioactive phenolic organic compounds is popular, due to their efficacy on growth, immunity, antioxidant profiles and stress resistance in cultured aquatic species. Different types of organic acids have demonstrated positive effects in reducing pathogenic attacks.

Among these, gallic acid, an organic phenolic compound found mainly in the form of gallotannins in gallnuts, tea leaves and various fruits such as grapes and pomegranates, has emerged as an innovative solution known for its antioxidant properties that can help to strengthen shrimp immune response amid challenging environments. Dietary gallic acid has significantly

improved growth and health conditions in broilers and ruminants according to various studies. However, the role of gallic acid as a functional feed additive in aquatic species, particularly shrimp, remains largely unexplored.

The presence of EHP, often difficult to detect sub-clinically, underscores the need for such innovative treatments. EHP often goes unnoticed until it becomes a significant issue, highlighting the necessity for proactive measures in aquaculture. By exploring the benefits of gallic acid as feed additives, the industry can open doors to the methodologies that could effectively combat EHP and improve shrimp production in a sustainable manner.

Kao Corporation (KAO, Japan) has introduced two innovative solutions for sustainable shrimp farming – GA-100 BIO, a sugar-derived gallic acid produced using KAO's proprietary microbial fermentation technology (Figure 1). The other product, GAL-MOT, is a value-added co-product generated during gallic acid production; it is enriched with phenolic compounds that can be utilised effectively within sustainable aquaculture systems.

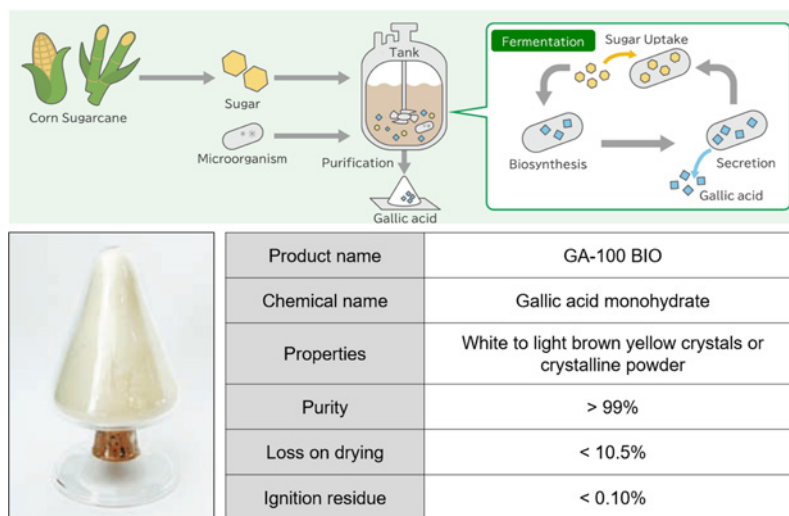


Figure 1. Production and properties of GA-100 BIO.

A breakthrough study

Together with ShrimpVet Aquaculture Research Institute, based in Vietnam, KAO conducted a trial to assess how its new gallic acid-based products, can combat EHP infection in *P. vannamei* farming. The research focused on their ability to improve shrimp survival and growth, when added into shrimp feed and then challenged with EHP. GA-100 BIO was added into experimental feed at 0.5%, 1.0% and 2.0% while GAL-MOT was added at 1.5%. A negative control diet did not include any feed additive (Table 1).

The trial lasted 50 days, starting with 14 days of preventive treatment, a 7-day EHP challenge phase and a final 28-day observation period. There were five replicates for each treatment group (Figure 2).

Group no.	Experimental group	Treatment diets	Challenge factor
G1	Negative control	Basal (control without additives)	None
G2	Positive control	Basal (control without additives)	EHP via per os
G3	0.5% GA-100 BIO	GA-100 BIO supplementation at 0.5%	EHP via per os
G4	1.0% GA-100 BIO	GA-100 BIO supplementation at 1.0%	EHP via per os
G5	2.0% GA-100 BIO	GA-100 BIO supplementation at 2.0%	EHP via per os
G6	1.5% GAL-MOT	GAL-MOT supplementation at 1.5%	EHP via per os

Table 1. Experimental groups with different dietary treatments.

Each experimental group was housed in a 350L tank, and young juvenile shrimp (initial weight 1.08g) were stocked (Figure 2). EHP was delivered via oral route, utilising the contaminated feed coated with EHP-infected faeces. The freshly prepared inoculum feed was given to challenge tanks at two meals per day for 7 days, after which shrimp were observed for clinical symptoms up to a period of 28 days. Survival rates and growth performance indices were determined; EHP load in the hepatopancreas of experimental shrimp were measured using quantitative PCR, post-observation.

Effects of supplementation with gallic acid

The study evaluated the effects of diets supplemented with gallic acid on shrimp growth and resistance against EHP infection. We observed notable clinical symptoms such as empty gastrointestinal tracts, soft exoskeletons, lethargy, and a pale hepatopancreas (Figure 3). Following a 28-day post-infection period, we noted the survival rates across different groups as in Figure 4.

Experimental layout of the EHP study by:

KAO

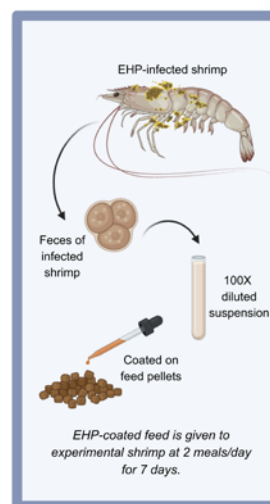
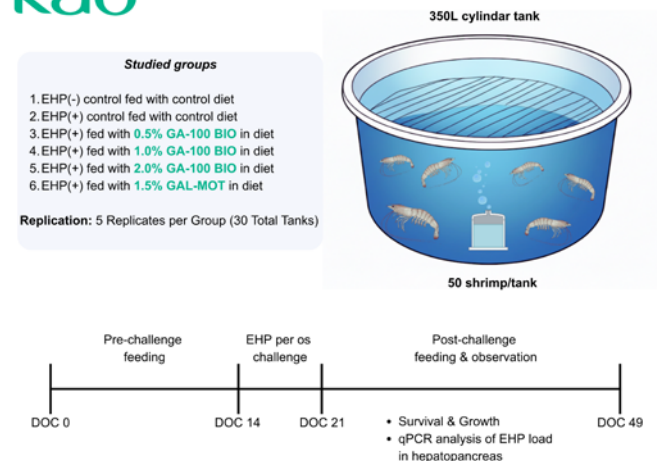


Figure 2. Study configuration and inoculation methodology for EHP challenge.

Experimental design and execution by ShrimpVet R&D Center

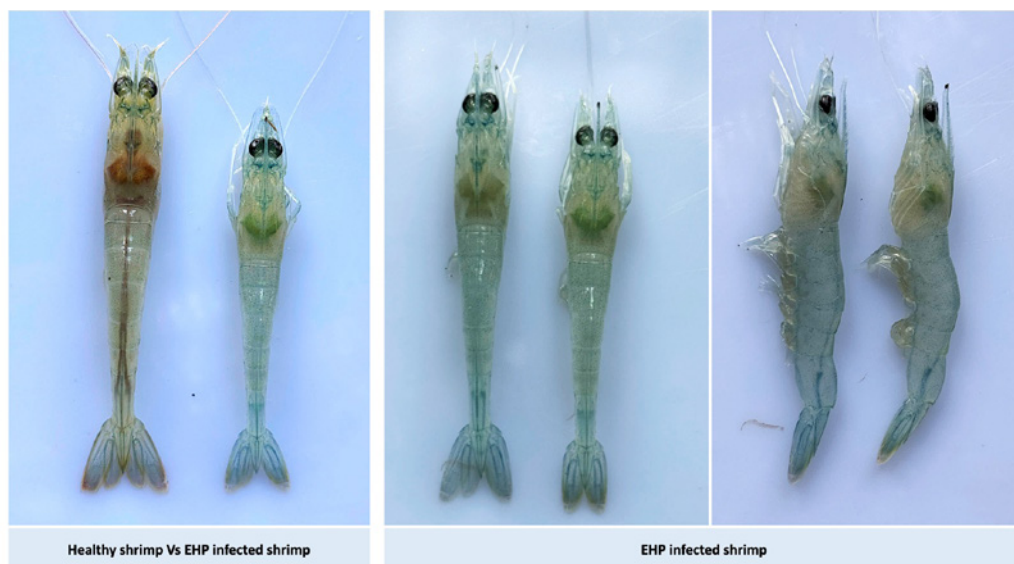


Figure 3. Healthy shrimp (left) vs EHP infected shrimp showing pale hepatopancreas, empty stomach and empty gut (from second left to right).

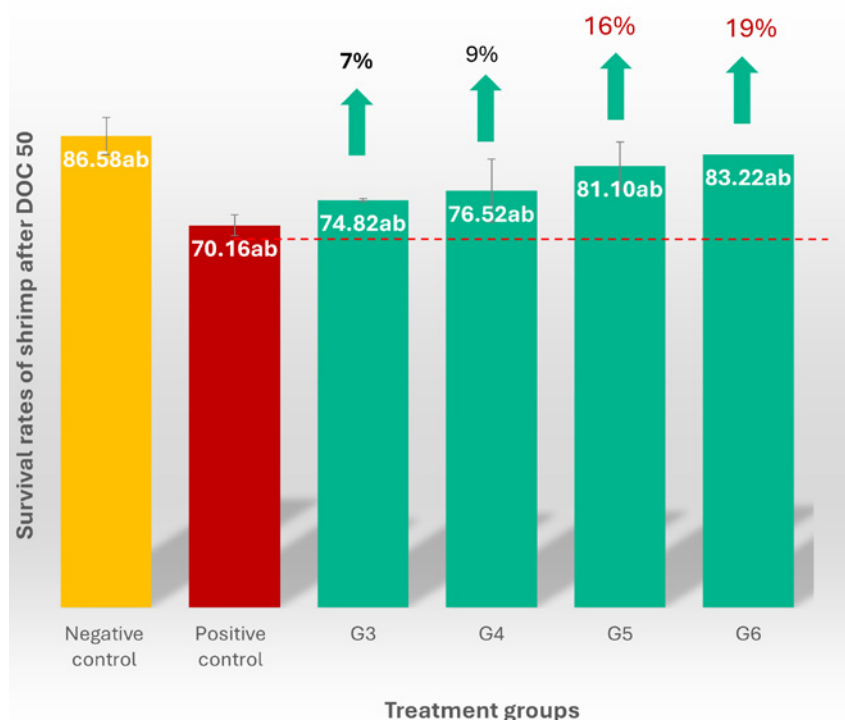


Figure 4. Shrimp survival post challenge with EHP in groups with GA-100 BIO (G3, G4, G5) and GAL-MOT (G6) supplementation. Values are mean $\pm$ SD, n=5. Different letters indicate significant differences ($P < 0.05$).

The EHP negative group, which was unchallenged, displayed the highest survival rate (SR). Among the EHP-challenged groups, G6 and G5 showed the most promising outcomes at above 80% survival, outperforming the positive control which was untreated with gallic acid additives.

In terms of growth parameters, Figure 5 showed that shrimp fed diets with GA-100 BIO at the highest dose of 2% and GAL-MOT at 1.5% demonstrated excellent feed efficiency, with their feed conversion ratios (bFCR and eFCR) significantly lower than those of the positive control and other GA-100 BIO doses. Additionally, groups G4, G5 and G6 had significantly lower coefficient of variation (CV) of shrimp size at 19.83%, 20.23%, and 17.67%, respectively, compared to the positive control group. This clearly indicates more uniform growth and improved consistency in growth rate despite the disease challenge in gallic acid-treated groups.

All groups, including the negative and positive controls and those exposed to the challenge, recorded no detectable levels of EHP by qPCR after 7 days of challenge, suggesting a clean start in EHP infection intensity. However, at the end of 28-day observation period, there were marked significant changes (Figure 6).

All challenged groups displayed an increase in EHP replication, indicating the establishment of chronic infection. Among these, G5 distinguished itself with the lowest EHP load around 10^6 copies/g HP, though this was not significantly different from several other challenged groups, including the positive control at around 108 copies/g HP. Most notably, this group, with added GA-100 BIO at 2%, also showcased remarkable growth performance with superior final weight and mean weight gain, emphasising the potential of gallic acid in mitigating the adverse effects of EHP.

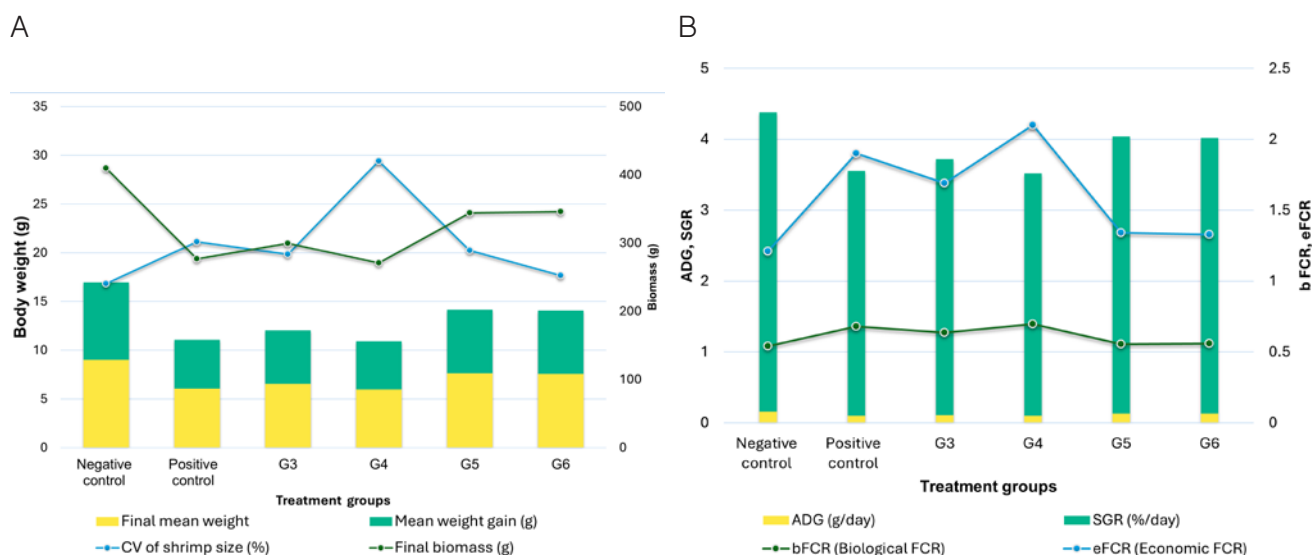


Figure 5. Shrimp performance. A: Weight gain and biomass gain, B: Average daily gain (ADG), specific growth rate (SGR) and feed conversion ratio (FCR) in EHP challenge study with diets supplemented with GA-100 BIO (G3, G4, G5) and GAL-MOT (G6).

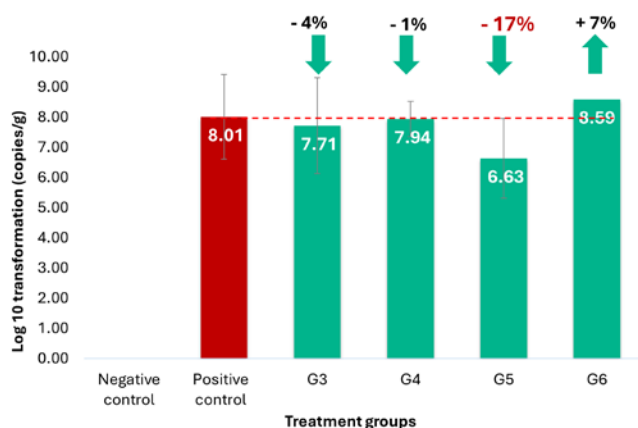


Figure 6. EHP load in hepatopancreas samples on day 28 of post-challenge. Diets were supplemented with GA-100 BIO (G3, G4, G5) and GAL-MOT (G6).

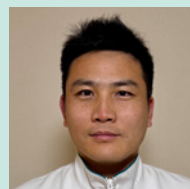
Conclusion

The dietary supplementation of gallic acid improved growth as well as resilience of shrimp against EHP infection, fostering a dual benefit of increased weight and improved health. The overall findings suggest that incorporating these innovative supplements can lead to enhanced economic returns for shrimp producers while addressing the pressing challenges of disease management in aquaculture.

While our results contribute to the growing body of knowledge, we also acknowledge that further research is necessary to fully unlock the comprehensive solutions in shrimp aquaculture. Continuous efforts in exploring dietary supplements and management strategies may provide avenues for enhancing shrimp resilience against EHP.



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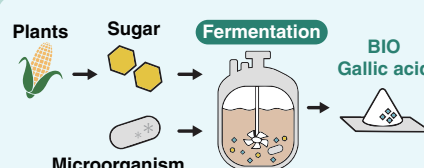
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The biological shield for low-fishmeal aquafeed

Marine protein hydrolysate is a key to health and survival in low-fishmeal aquafeeds for olive flounder and red seabream

By Paul Vincent, Thomas Levallois, Mirasha Hasanthi and Hein Pyae



Healthy uniform-size sea bream fingerlings in an experiment at the Aquaculture Feed and Nutrition Laboratory, Department of Marine Life Science, Jeju National University, South Korea.

In the pursuit of sustainable aquaculture, the industry has aggressively moved toward reducing fishmeal in commercial diets. However, replacing this high-quality protein often comes with hidden biological costs – increased gut inflammation, suppressed immunity and greater susceptibility to disease outbreaks (Robert et al., 2014).

Modern formulation is no longer just about meeting amino acid requirements; it is about providing functional bioactives that can mitigate these negative impacts. Marine protein hydrolysates are proving to be the essential link, acting as a 'biological shield' that enhances the health and survival of both fish and shrimp in intensive systems.

Unlocking cryptides: A mechanism of functional health

The primary strength of marine protein hydrolysates such as PEPTITOM (Aquaproducts, Vietnam), lies in their molecular composition. Produced through a controlled enzymatic bioprocess, these ingredients are exceptionally rich in low-molecular weight peptides, with over 90% typically below 1,000Da. This process releases bioactive cryptides – effector peptides derived from larger protein precursors like haemocyanin (Coates and Nairn, 2014).

In shrimp-based hydrolysates, haemocyanin is the predominant precursor (Robert et al., 2014). Once cleaved, these haemocyanin-derived peptides function as natural antibiotics, offering direct antimicrobial, antioxidant and antiviral properties (Yang et al., 2018; Coates and Nairn, 2014). These small peptides are not only highly digestible but also actively stimulate the host's innate immune system, providing a functional layer of protection that standard fishmeal or plant proteins cannot offer (Robert et al., 2014).

Mitigating the performance gap in fish

Reducing fishmeal can often impair gut health. Trials at Jeju National University, however, show that marine protein hydrolysates can bridge this gap. In species such as olive flounder *Paralichthys olivaceus* and red seabream *Pagrus major*, a dietary inclusion of hydrolysates significantly upregulated anti-inflammatory genes (such as IL-10 and TGF-β) while suppressing pro-inflammatory signalling.

“Fish fed the marine protein hydrolysate exhibited increased intestinal villus height, which expands the absorptive surface area, and a superior microbial balance.”

Beyond gene expression, these functional ingredients optimise the physical environment of the gut. Fish fed marine protein hydrolysates exhibited increased intestinal villus height, which expands the absorptive surface area, and a superior microbial balance. Specifically, the inclusion of PEPTITOM was shown to promote growth of beneficial *Lactobacillus* spp. while significantly reducing potentially pathogenic *Vibrio* counts. This improved gut stability is a critical factor in maintaining consistent growth rates in low-fishmeal diets.

Shrimp health: Resilience against emerging pathogens

For shrimp producers, the challenge of fishmeal reduction is often compounded by high-risk diseases such as early mortality syndrome (EMS) and acute hepatopancreatic necrosis disease (AHPND). Research conducted by ShrimpVet Laboratory in Vietnam highlights the functional role of marine peptides in whiteleg shrimp *Penaeus vannamei*.

The data confirms that supplementing a low-fishmeal diet (5%) with 4% of the marine protein hydrolysates allows shrimp to match or exceed the growth performance of a standard 20% fishmeal diet. This indicates a powerful 'fishmeal sparing' effect, where the bioactive quality of the protein compensates for a lower quantity of traditional marine ingredients.

The ultimate metric: superior survival under stress

The most compelling evidence for the use of marine protein hydrolysates is their impact on animal survival during pathogenic challenges. Nutrition can no longer be viewed in isolation from disease tolerance:

- During a challenge with the pathogen *Edwardsiella tarda*, olive flounder and red seabream fed diets supplemented with the marine protein hydrolysate achieved the highest survival rates across all experimental groups. The enhanced innate immunity markers, such as increased lysozyme and myeloperoxidase (MPO) activities, provided the fish with a robust first line of defence that significantly lowered mortality.
- The protective effects were equally pronounced in shrimp facing an EMS/AHPND immersion challenge. Shrimp fed PEPTITOM recorded a survival rate of 54.17%, outperforming both the low-fishmeal basal diet (45%) and the high-fishmeal control (46.67%).

Practical inclusion strategy: maximising performance while reducing fishmeal

The successful application of marine protein hydrolysates relies not only on their biological functionality but also on a precise and strategic inclusion approach. When correctly implemented, PEPTITOM enables significant reductions in fishmeal while maintaining—or even enhancing—animal performance.

Core replacement strategy

This marine protein hydrolysate is primarily used as a direct functional replacement for fishmeal in aquafeed formulations. Typical replacement ratios range from

1:1 to 1:3 (PEPTITOM:fishmeal), depending on species requirements, formulation constraints and the targeted market positioning of the final feed.

As a general guideline, a baseline inclusion level of 2–5% is recommended for most applications, providing both nutritional and functional benefits without major reformulation constraints.

Species-specific optimisation

The trial data demonstrates that optimal inclusion levels vary depending on species and production objectives:

- Olive flounder: an inclusion of 20% effectively compensated for a reduction in fishmeal from 65% to 25%, delivering the highest growth performance observed in trials and outperforming high-fishmeal control diets.
- Red seabream: an inclusion of 10% is recommended to bridge the performance gap in low-fishmeal diets (30% down to 10% fishmeal). A lower inclusion of 5% already improves weight gain and feed efficiency, though 10% is required to fully match high-fishmeal benchmarks.
- Whiteleg shrimp: a 4% inclusion is highly effective in ultra-low fishmeal diets (~5%), enabling shrimp to match or exceed the performance of conventional 20% fishmeal diets while delivering superior survival under disease challenge conditions.

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Selection and weighing of sea bream and experimental tanks at Jeju University, South Korea.

Targeted functional applications

Beyond simple protein replacement, this marine protein hydrolysate PEPTITOM should be strategically positioned where its bioactive properties generate the highest return:

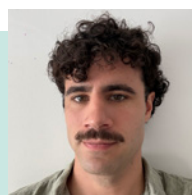
- Larval and early juvenile nutrition: at early stages, survival is the main constraint due to high vulnerability to stress and pathogens. PEPTITOM provides bioactive peptides that stimulate innate immunity, such as lysozyme and myeloperoxidase activity (MPO), reinforcing defence mechanisms when the immune system is still developing and directly supporting improved survival.
- Stressful and transfer periods: inclusion in functional feeds during grading, transport, or environmental shifts helps reinforce innate immunity (lysozyme, MPO activity) and antioxidant defences, reducing mortality risk.
- Sustainable formulations: this marine protein hydrolysate is a key tool for reducing Fish In: Fish Out (FIFO) ratios and improving environmental performance without compromising growth—addressing both regulatory and market-driven sustainability targets.

Formulation synergies and palatability

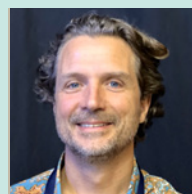
With a high free amino acid content, this marine protein hydrolysate also acts as a powerful natural feed attractant. This allows formulators to incorporate higher levels of alternative, less palatable proteins while maintaining feed intake—an essential factor in the success of low-fishmeal diets.

Conclusion: A strategic necessity for modern feed

As aquaculture moves toward higher inclusion of alternative proteins, marine protein hydrolysates have transitioned from 'optional additives' to strategic necessities. By delivering highly absorbable nutrients alongside a potent array of immune-boosting cryptides, products such as PEPTITOM help maintain animal health and survival. For the producer, this translates to lower production risk and more resilient stocks under the inevitable stresses of farm environments.



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Insights from NASF: Path to elevating aquaculture performance with bioavailable vitamin D

A milestone in 2025 with EFSA granting authorisation for Hy-D® use in aquaculture, reflecting a 25-year effort to bring the benefits to all species in the EU.

By Sebastien Rider

Ensuring adequate vitamin D in aquafeeds starts with the requirements of the fish. Sufficient, bioavailable vitamin D underpins growth, health, welfare and more sustainable production. At the same time, farmed fish are among the richest natural dietary sources of vitamin D, creating for people; creating a practical paradox for aquaculture: to deliver vitamin D to consumers, fish themselves must receive enough of the right form throughout the production cycle.

Vitamin D in nature vs modern production

In the wild, fish obtain vitamin D both from their prey and via skin synthesis stimulated by light exposure, although the relative contribution of each remains unclear. In contemporary systems – recirculating aquaculture systems (RAS), submerged cages, winter production and feeds with higher proportions of plant ingredients – the natural inputs of light and prey are greatly reduced or absent. Inadequate supplementation results not only in diminished vitamin D status in fish (and thus in consumers) but also in measurable effects on growth performance, nutrient utilisation, welfare and final product quality.

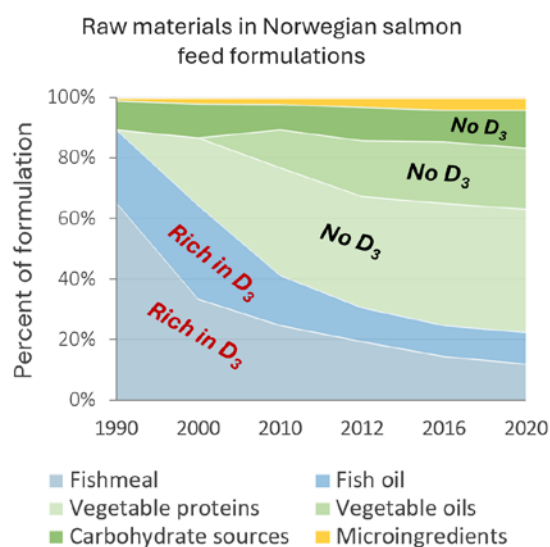
Vitamin D: More than a “vitamin”

Vitamin D is not merely a dietary component. In both fish and humans, despite very small inclusion rates in feed, vitamin D influences roughly 2-5% of the genome: regulating gene expression and affecting immunity, ion balance, skeletal development, nutrient metabolism and growth.

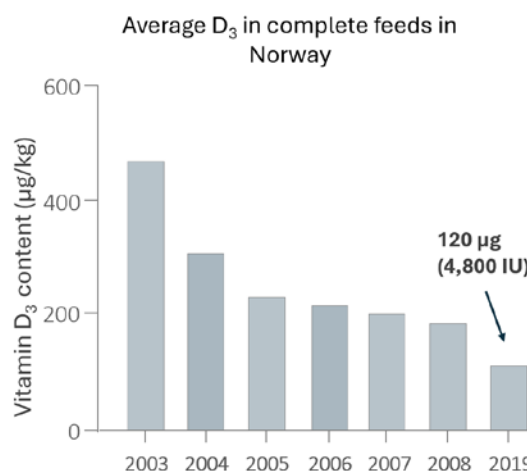
However, cholecalciferol (vitamin D₃) is biologically inactive and must first be converted in the liver to 25-hydroxyvitamin D₃ (25-OH-D₃), then further activated at the tissue level to 1,25-dihydroxyvitamin D₃, the hormonally active form. Only then does it act as a potent regulatory signal. Even so, dietary inclusion levels are tiny – measured in µg/kg.

Historically, fishmeal and fish oil provided a steady supply of vitamin D₃ in aquafeeds. Over the past two decades, however, a shift towards plant-based formulations, driven by sustainability goals and raw material availability, has markedly reduced and increased variability in vitamin D₃ levels in commercial diets (Figure 1).

Figure 1 shows a clear decline in vitamin D₃ content in salmonid diets from the early 2000s through 2019, coinciding with the increased use of plant-based feeds. While some ingredients may contain vitamin D₂, this form has negligible biological activity in fish; vitamin D₃ is the physiologically relevant and required form.



Adapted from: Aas et al., *Aquaculture reports*, 2022



Adapted from: Sissener et al., *Aquaculture Nutrition*, 2013 & Sele et al., *IMR reports*, 2019 & 2020

Figure 1. Declines in levels of Vitamin D₃ in Norwegian salmonid diets. The minimum vitamin D₃ requirement is 1,600 IU (40µg/kg).

This nutritional shortfall has had real, if unintended, biological consequences. In response, EU policy for salmonids increased the upper limit for vitamin D₃ supplementation from 3,000 IU to 60,000 IU, a revision intended to support both animal performance and consumer protection.

Delivering the most bioavailable form

Hy-D® is the pure metabolite 25-hydroxyvitamin D₃, recognised as the most bioavailable form of vitamin D for fish. By presenting vitamin D as 25-OH-D₃, Hy-D® removes one hepatic conversion step and improves bioavailability, representing a meaningful advance for aquaculture in reliably delivering vitamin D benefits to fish and, in turn, to consumers.

The European Food Safety Authority (EFSA) has confirmed the safety and efficacy of dsm-firmenich's Hy-D®, and the European Commission has granted authorisation for use in aquaculture at the end of 2025. This milestone reflects a 25-year effort to bring the benefits of Hy-D® to all species in the EU.

From mechanism to measurable outcomes

Under low-light conditions, conversion of dietary D₃ to circulating 25-OH-D₃ is limited. In fish, both hydroxylation steps occur in the liver (unlike terrestrial animals, where the second step is renal), creating dependence on liver health for vitamin D metabolism.

In trials where trout were fed either D₃ or 25-OH-D₃ for 84 days, plasma 25-OH-D₃ remained barely detectable at recommended D₃ levels, whereas Hy-D® supplementation

produced clear, functional concentrations of the metabolite (Figure 2).

This helps explain why simply adding more standard D₃ often fails to yield consistent field results. From a performance standpoint, inadequate vitamin D compromises growth and feed efficiency.

When Hy-D® was included on top of standard diets containing ~5,500 IU D₃ (typical of many commercial aquafeeds), trout achieved a 5% increase in final body weight and a 3% improvement in feed conversion ratio over 91 days – without exceeding regulatory limits (Figure 3). Given the higher efficacy of 25-hydroxyvitamin D₃, producers can meet vitamin D regulations more easily in certain species and geographies. Commercially, the case is compelling: 25-hydroxyvitamin D₃ has demonstrated an approximate 5:1 return on investment (ROI), as the cost of supplementation is minimal relative to the impact of lost growth, poorer FCR and reduced biomass.

Welfare and wound healing

Low vitamin D status has been associated with thinner skin and reduced robustness – especially relevant during handling events such as well-boat operations for sea lice treatments. Wounds and scale loss diminish whole-fish value and, coupled with reduced immune capacity, elevate the risk of secondary infections. In trout trials comparing standard vitamin packages with OVN™ plus Hy-D®, fish receiving this 25-hydroxyvitamin D₃ showed attenuated wound expansion, indicating enhanced tissue repair (Figure 4). This is promising for regions, such as in Norway, where winter wounds are a recurring challenge.

The conversion of dietary D₃ has limits in salmonids

Trout in indoor tanks receiving D₃ or 25-OH-D₃ (Hy-D®) for 12 weeks

Experimental group	Feed dose (µg/kg)	Avg. blood D ₃ (ng/mL)	Avg. blood 25-OH-D ₃ (ng/mL)
D ₃	200	6.2	Not detected
D ₃	400	15	Not detected
D ₃	800	39	Not detected
25-OH-D ₃	200	Not detected	0.6
25-OH-D ₃	400	Not detected	1.8
25-OH-D ₃	800	Not detected	4.0



Limited D₃ converted to 25-OH-D₃

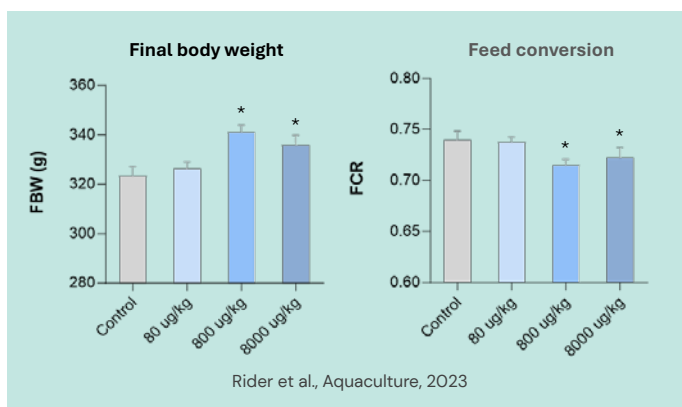
(Not detected = <0.5 ng/mL)

Figure 2. Response of plasma vitamin D metabolites in trout fed diets supplemented with either 200, 400 and 800 µg/kg of D₃ or 25-OH-D₃. The base formulation had 300 IU D₃. Adapted from Rider et al., 2025.

Low D₃ (300 IU) in base formulation – reliance on added sources

Adapted from Rider et al., Aquaculture, 2025

dsm-firmenich



D₃ in base formulation
5,240 IU (130 µg) / kg

- Hy-D® ensures hormonal sufficiency
- Vitamin D system function impacts performance

Figure 3. Mean growth performance of fish fed various levels of dietary 25-OH-D₃ over 91 days, final body weight (FBW) and feed conversion ratio (FCR).

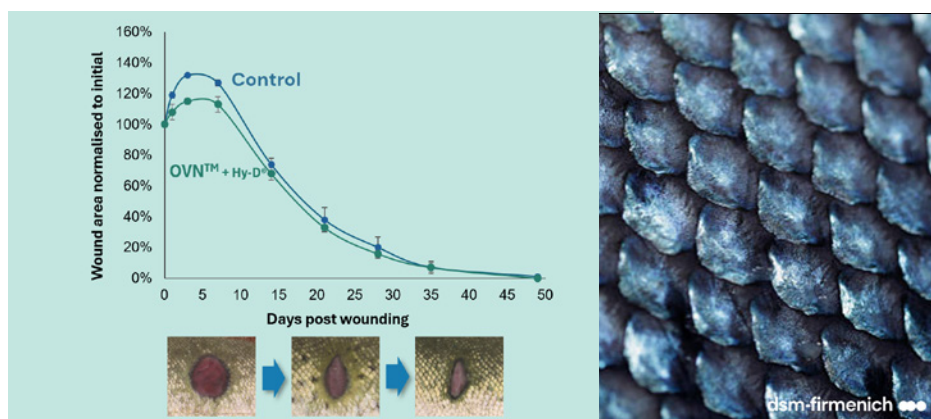
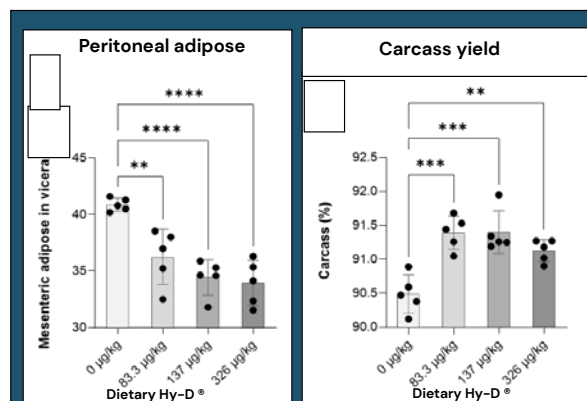


Figure 4. The performance of Hy-D° and OVN™ in terms of wound healing.

Figure 5. Response of adiposity markers to dietary 25-OH-D₃ over 90 days. Left, the proportion of mesenteric adipose tissue relative to the whole body of fish and right, the percentage of carcass was significantly increased in all groups receiving 25-OH-D₃ (ANOVA $p < 0.0001$).



Lipid utilisation, yield and fillet quality

Hy-D° supports lipid metabolism and improves feed-to-carcass conversion efficiency. In Atlantic salmon fed for 90 days, increasing dietary 25-OH-D₃ reduced mesenteric adiposity, improved visceral somatic indices and raised carcass yield by about 1% compared to diets without 25-hydroxyvitamin D₃ (Figure 5). Field observations from Chile also point to reductions in bone deformity and fillet gapping. By supporting connective tissue and muscle structure, Hy-D° contributes to improved texture and more consistent product quality.

Life stage dynamics

Vitamin D requirements are not fixed; they vary across life stages. Evidence suggests older, seawater fish may require roughly three times more vitamin D than early freshwater stages. Today, smolt are often transferred at 300–500g rather than the historical ~100g, with extended early periods under cover in RAS and minimal UVB exposure. Under these conditions, fish depend entirely on dietary vitamin D – even though the required amounts remain tiny (µg/kg), the implications of deficiency are significant.

The consumer connection

For consumers, oily fish provide valuable vitamin D. Yet vitamin D insufficiency remains widespread – around 40% of Europeans and 35% of people in the United States have low circulating 25-OH-D₃. The challenge intensifies during northern hemisphere winters, when shorter daylight hours and adverse weather reduce endogenous synthesis and make diet the dominant source. A 100g serving of salmon can deliver 38–126% of the adequate daily intake of vitamin D₃, with wild fish typically containing higher levels than farmed. Optimising vitamin D in aquafeeds therefore strengthens both fish performance and the nutritional value proposition for consumers.

Putting vitamin D back in diets: what it means practically

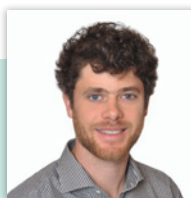
Improving vitamin D in diets is not about adding more of the same; it is about providing the form that fish can use most effectively. That is why the availability of Hy-D° is a significant step forward for producers worldwide: a science-based solution that addresses long-standing metabolic bottlenecks while staying within regulatory frameworks. By enhancing growth, feed efficiency, welfare, product quality and consumer value, precision micronutrition has become fundamental – not optional – to sustainable aquaculture performance.

What's next?

dsm-firmenich has planned trials to examine vitamin D's role in immunity against viral and bacterial diseases, its interactions with uptake of other micronutrients and how 25-OH-D₃ serves the specific needs of key organs, including the gill and intestine.

In the end, 'putting vitamin D back in diets' really means restoring 25-hydroxyvitamin D₃ to the fish – so it can deliver its most important biological effects where they matter most.

Note: This article is based on the presentation titled 'Putting the 'D' back in Diets' by Sebastien Rider, at the North Atlantic Salmon Forum, 3–5 March, 2026, Bergen, Norway.



Dr Sebastien Rider is Principal Scientist at dsm-firmenich Animal Health & Nutrition.

Evolving threats, evolving solutions: The overlooked mycotoxin challenge in Asian aquafeed

Two equally significant contaminants – deoxynivalenol and fusaric acid – frequently remain undetected and therefore unmanaged

By Henry Wong

Aquafeed has undergone significant advancement over the past decades, including improvements in nutritional specifications, feed processing technologies, ingredient utilisation, and formulation knowledge, which have helped drive the aquaculture industry's efficiency and growth.

One of the most notable changes has been the gradual shift away from marine-based raw materials, such as fishmeal and fish oil, toward the larger inclusion of plant-based ingredients. This transition was driven by concerns on sustainability and economic benefits. However, this structural change in feed raw materials has introduced a challenge that has been relatively under recognised – the mycotoxin contamination.

A silent contaminant crisis

While some feed mills have implemented mycotoxin screening programs for incoming raw materials, these monitoring systems often focus primarily on aflatoxins or include only a limited range of mycotoxin tests. As a result, two equally significant contaminants – deoxynivalenol (DON) and fusaric acid (FA) – frequently remain undetected and therefore unmanaged. As more mycotoxin contamination data become available, it is clear that this knowledge gap is no longer a mere oversight. It is a risk the aquafeed industry can take action to improve feed safety for aquatic animals.

Plant-based ingredients: a growing source of contamination

DON belongs to the Type B trichothecenes group – toxic compounds produced by *Fusarium* fungi, the same group responsible for the characteristic pink-white mould commonly observed on cereal grains such as wheat, barley and maize. At the cellular level, DON disrupts protein synthesis, induces oxidative stress and exerts cytotoxic effects that damage tissues and kill cells.

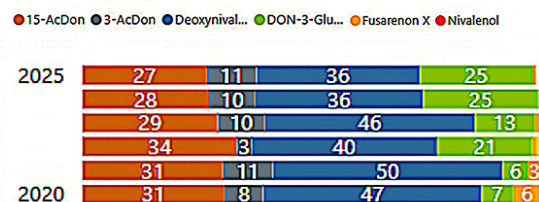
Equally concerning is fusaric acid (FA), which is produced by at least 12 different *Fusarium* species, making it one of the most widely occurring mycotoxins in cereal-based feed ingredients. Most importantly, FA does not act alone; it can interact synergistically with both fumonisins and DON, amplifying their overall mycotoxic effects.

Research has shown that combined exposure to FA and DON in rainbow trout resulted in additive growth suppression, poorer feed conversion ratios and histopathological damage to the liver and gastrointestinal tract (Koletsis et al., 2023).

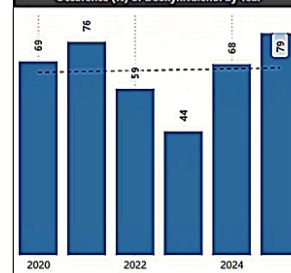
DON and FA in imported feedstuffs (wheat, barley, corn, soybean).

Individual mycotoxins	Occurrence, %	Median, ppb	Average level, ppb	Maximum level, ppb
Fusaric Acid	64.3	20.57	94.89	6 637
Deoxynivalenol	63.0	62.90	685.83	40 512
Enniatin A/A1	52.4	1.62	8.61	1 446
Fumonisin B2	47.3	0.00	85.38	8 197
Fumonisin B1	46.1	0.00	997.48	58 396
15-AcDon	43.3	0.00	71.58	4 040
Enniatin B/B1	41.8	0.00	20.39	2 870
Moniliformin	39.2	0.00	121.46	19 213
Fumonisin B3	33.4	0.00	54.67	3 972
Beauvericin	27.9	0.00	4.55	664
Zearalenone	22.1	0.00	51.16	6 225
DON-3-Glucoside	20.7	0.00	59.70	13 412
3-AcDon	12.9	0.00	6.61	2 015
T2 Toxin	11.2	0.00	3.65	522
HT2 Toxin	9.4	0.00	6.43	1 813
Cyclopiazonic Acid	8.1	0.00	2.27	856
Mycophenolic Acid	7.0	0.00	13.42	7 730
Alternariol	4.2	0.00	3.49	2 952
Fusarenon X	3.6	0.00	5.31	2 534
Ergotamin(in)e	2.2	0.00	2.69	1 948
Aflatoxin B1	2.0	0.00	0.31	150
Roquefortine C	1.4	0.00	2.56	1 361
Ergocryptin(in)e	1.4	0.00	2.03	1 640
Ergocristin(in)e	1.2	0.00	3.33	1 725

Occurrence (%) of type B trichothecenes by year



Occurrence (%) of Deoxynivalenol by Year



Average of Deoxynivalenol by Year (ppb)

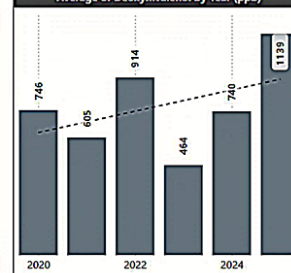


Figure 1. Alltech mycotoxin analysis database – deoxynivalenol (DON) and fusaric acid (FA) in imported feedstuffs.

Mycotoxin contamination in wheat samples in 2024 (globally)

Mycotoxin group	Occurrence, %	Average level, ppb	Maximum level, ppb
Type B Trichothecenes	82.9	264.25	4,483
Emerging Mycotoxins	81.8	86.33	3,114
Fumonisin	72.1	37.87	3,731
Type A Trichothecenes	48.2	7.66	137
Zearalenone	18.9	21.00	2,966
Fusaric Acid	15.7	5.44	292
Ergot Toxins	11.4	11.96	1,036
Other Penicillium Mycotoxins	9.6	3.71	579
Other Aspergillus Mycotoxins	3.2	1.16	303
Ochratoxins/Citrinin	2.5	1.09	279
Aflatoxin B1	0.7	0.71	197
Aflatoxins, Total	0.7	0.71	198

Individual mycotoxins	Occurrence, %	Median, ppb	Average level, ppb	Maximum level, ppb
Deoxynivalenol	77.5	48.17	229.65	3,975
Enniatin B/B1	72.5	10.12	59.00	2,246
Fumonisin B1	65.4	7.64	25.60	3,037
Fumonisin B2	56.4	5.54	8.80	287
Enniatin A/A1	47.9	0.00	18.33	955
HT2 Toxin	47.5	0.00	6.55	110
DON-3-Glucoside	43.9	0.00	18.78	722
Moniliformin	43.9	0.00	6.75	228
Fumonisin B3	41.4	0.00	3.47	408
Fusarenol X	33.6	0.00	10.15	228
T2 Toxin	23.9	0.00	1.11	27
Zearalenone	18.9	0.00	21.00	2,966
3-AcDon	17.5	0.00	1.92	62
Fusaric Acid	15.7	0.00	5.44	292
Beauvericin	11.1	0.00	0.83	110
15-AcDon	10.4	0.00	2.76	116
Mycophenolic Acid	9.3	0.00	3.33	574
Ergotamin(in)e	8.2	0.00	6.62	945
Ergocryptin(in)e	7.5	0.00	1.47	135
Ergosin(in)e	7.1	0.00	0.57	44
Alternariol	5.0	0.00	1.42	239
Ergocristin(in)e	5.0	0.00	2.10	322
Ergocornin(in)e	5.0	0.00	0.88	139
Ochratoxin A	2.5	0.00	0.26	51

Figure 2. Mycotoxin contamination in wheat samples in 2024.

Analysis from the Alltech 37+ database, based on more than 2,400 imported feedstuff samples – including wheat, barley, corn and soybean – revealed that DON was detected in 63% of samples, with an average concentration of 685 ppb and peak levels reaching 40,512 ppb. Fusaric acid (FA) was also widely present, detected in 64.3% of the samples (Figure 1).

More concerning is the trend observed between 2020 and 2025, which showed a consistent increase in both the occurrence of DON and its average concentration. This indicates that mycotoxin contamination is not a static risk, but an escalating challenge that the industry must pay closer attention to.

Given that wheat and its by-products are widely used in aquafeeds, it is particularly relevant to examine wheat contamination more closely. The 2024 global wheat survey, which analysed 280 samples using Alltech's 37+ mycotoxin analytical platform, confirmed DON as the most prevalent contaminant, detected in 77.5% of the samples. Notably, 96% of the wheat samples contained two or more mycotoxins simultaneously (Figure 2).

The biological cost: What research tells us

Research has shown that DON can have direct adverse effects on vannamei shrimp, including reduced weight gain, lower survival rates and decreased tolerance to hypoxia. It can also damage the intestinal mucosa – causing impaired intestinal folds and increased apoptosis – while negatively affecting the hepatopancreas through altered B-cell structure and changes in tubule diameter.

Additionally, exposure to DON has been associated with elevated oxidative stress markers such as SOD and GST, as well as disruption of key immune-related genes, including HSP70, Toll, proPO and the NF-κB signalling pathway. In fish species such as salmon, rainbow trout and catfish, DON exposure has been linked to ribotoxic stress, oxidative damage, reduced feed intake and impaired growth. It can also compromise integrity of the digestive epithelial, immune function and overall performance.

The consequences of DON and FA contamination extend far beyond reduced feed intake – they affect fundamental biological functions that ultimately determine farm profitability. A meta-analysis of rainbow trout studies by Koletsi et al. (2021) quantified this impact with striking clarity; for every additional 1 mg/kg of DON in the diet, feed intake declined by 18.8% and growth by 20.0%.

EC guidance vs research

Even more concerning is that, while the European Commission's current guidance level for DON in feed is 5,000µg/kg, data presented at the World Mycotoxin Forum (2023) indicated that at this concentration, rainbow trout may already experience a 43% reduction in feed intake and a 36% decline in growth. These findings have prompted ongoing discussions about lowering the recommended DON limit for fish to as low as 500 µg/kg.

Proven protection: The science behind YCWE –based mycotoxin management

The aquaculture industry does not face this mycotoxin challenge without its solutions. *In vivo* research across multiple commercially important species has demonstrated that yeast cell wall extract (YCWE) – the core technology behind Alltech's Mycosorb® – can effectively mitigate the damaging effects of mycotoxins.

In DON-challenged turbot, supplementation with Mycosorb® at 0.2–0.4% significantly restored intestinal morphology, improved gut barrier integrity, normalised antioxidant enzyme activity, reduced liver injury markers and helped rebalance the intestinal microbiota (Wang et al., 2021).

Similarly, in vannamei shrimp co-challenged with DON and aflatoxin B1, dietary YCWE at 0.2% significantly improved weight gain rate (85.50% vs 71.11%, $P < 0.05$), restored hepatopancreas antioxidant gene expression, improved muscle texture quality and demonstrably reduced mycotoxin absorption at the intestinal level (Zhang et al., 2025).

These results confirm that yeast cell wall-based mycotoxin management is a scientifically validated strategy for protecting aquatic animals from the performance and health impacts of mycotoxin exposure.

Building on this proven foundation, Mycosorb®Evo represents the next evolution of this technology, designed to address the increasingly complex multi-mycotoxin challenges facing modern aquafeed systems.

An evolving threat needs new generation solutions

Building on decades of expertise in mycotoxin risk management and binder technology, Alltech has introduced Mycosorb® Evo and Mycosorb® A+ Evo. These next-generation, patent-pending formulations build on the proven foundation of the original Mycosorb®, while incorporating a critical innovation: a reformulated yeast cell wall extract enriched with a novel protein-rich bacterial component. This synergistic combination is designed to address one of the most persistent limitations of conventional mycotoxin binders – the poor adsorption of difficult-to-bind toxins, particularly deoxynivalenol (DON) and fusaric acid.

Controlled studies by Alltech have demonstrated that the Evo formulation delivers twice the binding capacity for DON and a threefold improvement in fusaric acid adsorption compared to earlier formulations, while maintaining broad spectrum effectiveness against other major mycotoxins, including aflatoxins, fumonisins, zearalenone, ochratoxins and ergot alkaloids (Yiannikouris, 2026).

Further validation was obtained through *in vivo* trials conducted at Kochi University, where yellowtail fish were challenged with 0.5 ppm dietary DON for 9 weeks. The DON challenge reduced growth performance by 18%, while supplementation with Mycosorb® Evo at 2.0 kg/tonne resulted in significant recovery to growth performance.

"What is not tested cannot be managed, and what is not managed will inevitably impact the bottom line."

Protecting performance starts with awareness

The mycotoxin challenge in Asia-Pacific aquafeed is real, measurable and increasing. As the industry continues its shift toward plant-based formulations, the risk of DON and fusaric acid contamination is likely to intensify – often silently affecting animal health, compromising feed efficiency and undermining farm profitability. What is not tested cannot be managed, and what is not managed will inevitably impact the bottom line.

Through the Alltech Mycotoxin Management Program, feed producers now have the tools to identify, quantify and manage their specific mycotoxin risk profile. With Mycosorb® Evo, they also have access to a next-generation, scientifically validated solution designed to address the growing complexity of today's mycotoxin challenges.

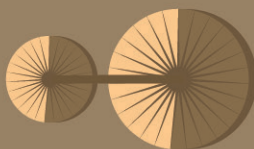
The problems have evolved. Now, so has the solution.



Dr Henry Wong, Regional Commercial Development Director (Asia Aquaculture) at Alltech.
Email: hwong@alltech.com

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Asia Import Risk Analysis 2026





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Aquafeeds in 2025: Disrupted by tariffs

Low soybean meal prices, pushed by US led tariffs supported feed millers, while the benefit of lower fishmeal prices for shrimp feed was short-lived

A bright spot in 2025 was the fall in soybean meal prices, which helped lower feed costs. Despite continued concern over feed prices, many aquafeed players still viewed 2025 positively overall. In Indonesia, shrimp feed millers were affected by the caesium-137 contamination incident, while producers across the sector faced higher fish and shrimp production costs and lower productivity due to disease. This annual AAP report reviews developments in the aquafeed industry across selected countries, based on input from industry sources. It covers 2025 and, in some cases, developments through to May 2026.

Feed commodities

The aquafeed industry is generally affected by the major ingredients – fishmeal and soybean meal, the supply and consequently their prices. International fishmeal prices are highly influenced by Peru. In Q1 2025, prices started at a low of USD1,600/tonne due to a successful late 2024 season and strong H1 2025 landings, resulting in a rebound in supply. By year end, even with an increased supply of +8% Y-o-Y, prices moved up to USD1,825 per tonne.

Soybean meal prices have been in a multi-year low in 2025, driven by higher crush output, weather related supply risks and trade conflicts. Soybean meal traded in the range of USD360–420/tonne FOB US Gulf, while China as the world's largest soybean importer remained the price setter at USD430–480/tonne CIF. The U.S. tariffs pushed U.S. soybean prices down, because China sharply reduced purchases and that decline flowed directly into lower soybean meal prices due to oversupply and weak demand. When whole bean prices fall due to oversupply, soybean meal prices also decline.

This price divergence accelerated the use of poultry byproduct meal as a partial fishmeal substitute, as well as fermented soy, soy protein concentrate and rapeseed meal where available. The trials of insect meal increased, although still a niche ingredient.

Rising feed costs

Rising fishmeal prices pushed up the cost of premium feeds (for shrimp, marine fish). Falling soybean meal prices helped offset some of that increase but not enough for species that rely heavily on fishmeal. Shrimp feed producers in competitive markets – India and Vietnam could not fully pass on costs, thus compressing margins. Overall, feed producers still faced higher average formulation costs.

The industry faced supply insecurity; driven by cost pressures, there was a need to reposition for a more volatile raw material environment. China's aquaculture sector showed stronger demand for marine ingredients, supported by higher farmgate prices for species requiring fishmeal rich diets. Pig farming recovery in China also increased fishmeal demand for piglet feed, resulting in the tightening of supply for aquafeed. Rising prices of soybean meal, corn and rapeseed meal in H2 2025, further complicated feed formulation.

Feed prices

In Vietnam, VASEP reported that prices for key imported raw materials, including soybean meal, corn and wheat, were lower than in the same period of 2024. As a result,

shrimp feed prices fell by about VND1,000–1,500/kg (3%), while pangasius and tilapia/red tilapia feed prices declined by VND500–1,000/kg (5%). Some companies introduced promotional programmes to support farmers as market demand had not fully recovered. Sheng Long Bio-Tech cut prices mainly because raw material costs fell sharply in the first half of 2025. In Indonesia, no changes were reported in fish or shrimp feed prices. Chewen Wei, Export Director, Uni President Vietnam (UPV), said that because fishmeal prices rose to USD1,600/tonne in November 2025, the full impact of those higher costs would likely be felt in April 2026.

In India, Kumaresan, Senior Deputy General Manager and Pan India Technical Head at Sheng Long Biotech India, said that feed millers reduced prices after the imposition of a 50% tariff by the US government. In April 2025, feed companies cut shrimp feed prices by INR4/kg, and increased by INR4/kg in February 2026. At Certitude Farms in Tamil Nadu, Balasubramaniam, said his shrimp feed price in April 2025 was nearly 4% lower per kg than in April 2024. By March 2026, prices had returned to April 2024 levels, before rising by INR8/kg, or nearly 9%, in May 2026.

In May 2026, farmers in Andhra Pradesh protested on proposed feed price increases of INR12/kg for vannamei shrimp feed and INR14/kg for black tiger feed. IPR Mohan Raju, President of the Prawn Farmers Federation of India (PFFI) called for consultation and intervention by the Government of Andhra Pradesh. At press time, the increase had been put on hold.

Aquafeed production in 2025

According to Alltech's Agri-Food Outlook 2026, Asia produced 38 million tonnes, a 2.4% increase from 37.12 million tonnes in 2024. China remained the largest aquafeed producer, while India recorded the fastest growth, rising 5.5% to nearly 2.9 million tonnes, driven by commercialisation and inland aquaculture. The report said China's structural modernisation and industry consolidation continue to support feed demand, although environmental constraints remain a limiting factor. (Table 1).

Country	2025 feed tonnage (million tonnes)	2024 feed tonnage (million tonnes)	Growth (million tonnes)	Growth (%)
China	23.23	22.62	0.61	2.70%
Vietnam	4.40	4.34	0.06	1.38%
India	2.89	2.74	0.15	5.47%
Philippines	1.78	1.55	0.23	14.84%
Bangladesh	1.60	1.59	0.01	0.63%
Indonesia	1.50	1.56	-0.06	-3.85%
Thailand	1.03	1.00	0.03	3.00%
Japan	0.43	0.46	-0.03	-6.52%
Taiwan	0.43	0.43	0	0.00%
Rest of Asia Pacific	1.44			

Table 1. The 2025 aquafeed production in Asia-Pacific countries. Rest of Asia includes the following countries with production in million tonnes: Australia, 0.25; Malaysia, 0.20; South Korea 0.17; Myanmar, 0.14; Laos, 0.05; Pakistan, 0.04 and Cambodia, 0.10. Extracted from Alltech's Agri-Food Outlook 2026. Data from Alltech's Agri-Food Outlook 2025 was provided by Henry Wong, Alltech Asia.

Table 2 presents industry estimates of aquafeed production in 2025. According to the 2026 Shrimp Crop Review by the Society of Aquaculture Professionals (SAP), **India's** shrimp feed production rose to 1.57 million tonnes, supporting shrimp output of 1.05 million tonnes, up from an estimated 1.2 million tonnes of shrimp feed in 2024. India's top five aquafeed producers—Avanti Feeds, CP India, Deepak Nexgen Feeds, Dewi Seafoods and Growel Feeds—account for 82% of this volume.

Country	Aquafeeds in tonnes in 2025	
	Marine shrimp feeds	Freshwater & marine fish feeds
India	1,547,000	1,200,000–5,500,000
Vietnam	800,000–920,000	3,000,000–3,900,000
Indonesia	396,000–404,800	1,435,200–1,460,000
Thailand	500,000	550,000–700,000

Sources: Industry projections; Indonesia - GPMT & industry; Thailand - Thai Feed Mill Association & industry; India - SAP, Ravikumar B, Growel Feeds and Kumaresan, Sheng Long Bio-tech India

Table 2. Some estimates on aquafeed production (tonnes) in 2025 for top producing countries.

Industry estimates put **Vietnam's** shrimp feed production at up to 920,000 tonnes in 2025, supporting shrimp output of nearly 800,000 tonnes. Most of this feed was used in intensive vannamei farming, while black tiger shrimp remained largely in semi-intensive systems. The industry said that farmers were improving disease management, although water quality remained a challenge. The top six producers—Sheng Long, CP Vietnam, Uni President Vietnam, Tongwei, Grobest and Gromax—supplied a combined 640,000 tonnes of shrimp feed.

Fish feed volumes in 2025 were estimated at 3.0–3.9 million tonnes. In the north, U.S. tariffs on China's tilapia exports increased interest in producing tilapia for the U.S. market. Processors, including Dabaco and livestock feed millers quickly diversified into aquafeed – such as tilapia and carp feed production. The estimated fish feed demand was 2.0–2.5 million tonnes for the pangasius, 400,000–500,000 tonnes for the tilapia and up to 300,000 tonnes for the snakehead fish. The estimate for marine fish feeds was 80,000–100,000 tonnes.

According to Jeff Jie-Cheng Chuang, General Manager, Sheng Long Bio Tech has made major investments in southern Vietnam in red tilapia feed production, broodstock breeding and fry production. However, site limitations have prevented large-scale expansion of black tilapia production.

Data from **Indonesia's** Feedmills Association (Gabungan Perusahaan Makanan Ternak, GPMT) showed that total fish and shrimp feed production rose 1% to 1.84 million tonnes. This comprised 0.4 million tonnes of marine shrimp feed, of which 99% was for vannamei shrimp, and 1.43 million tonnes of fish feed, mainly for catfish, tilapia, carp, milkfish and pangasius. In August 2025, the US Food and Drug Administration rejected Indonesian shrimp exports because of caesium-137 contamination. GPMT expected shrimp feed sales to fall, but output remained flat, while feed millers faced delayed payments as farmers sought new markets for their harvest.

For fish farming, the association expected lower feed demand as climate change disrupted freshwater fish production cycles. However, a government campaign encouraging fish consumption once a week helped lift fish prices, and stocking resumed in January 2026, especially for pangasius.

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From left, B. Ravikumar, Vice President – Sales & Technical (Shrimp Feeds Division) and Arun Chintapalli, Director, Growel Feeds India with Ronnie Tan, USGBC, Malaysia at Tilapia 2025, in November 2025.

Thailand's Feed Mill Association (TFMA) projected that 2025 aquafeed production to be stable, with shrimp feed rising slightly to 500,000 tonnes and fish feed reaching 550,000 tonnes. In contrast, an industry source estimated a higher fish feed demand at 600,000–700,000 tonnes, comprising feeds for the tilapia at 300,000 tonnes and Asian seabass at around 80,000 tonnes.

Production versus installed capacity

At TARS 2019, B. Ravikumar, Vice President – Sales & Technical (Shrimp Feeds Division) at Growel Feeds, said India's installed aquafeed capacity was 3.8–4.0 million tonnes. His 2025 update put installed capacity at 5.5 million tonnes, with 3 million tonnes for shrimp feed. The top five shrimp feed millers produced 1.3 million tonnes in 2025. Ravikumar said this shrimp feed capacity was planned to meet seasonal demand: feed mills use at least 80% of capacity during the peak farming season from March to June, but less than 40% at other times of the year. He added that commercial fish feed volumes were 1.2 million tonnes, representing about 60% capacity utilisation.

With no seasonal disruptions, aquaculture in Vietnam operates year-round. With installed aquafeed capacity estimated at up to 5.5 million tonnes, utilisation was 60–70%. In recent years, Indonesia's installed production capacity increased by about 8% for fish feed and 5% for shrimp feed, with much of the investment coming from China. Haris Muhtadi, Deputy Commercial Director – Shrimp Business at PT De Heus, estimated Indonesia's installed shrimp feed capacity at 0.927 million tonnes in 2025, implying utilisation of 42.6%.

Feed certification

Over the past two years, ASC (Aquaculture Stewardship Council) feed certification is a key market requirement, particularly in the EU shrimp market. In Asia, Thai Union Feedmill was the first feed producer with an ASC feed certification in 2024. In November, Sandhya Marines in Andhra Pradesh, became the only shrimp feed mill in India certified to the ASC feed standard.

Wei said, "For UPV, the main driver for its ASC certification was demand from certified farms that wanted feed suppliers to meet ASC sustainability and traceability requirements."

Chuang said, "Sheng Long's ASC certification in 2026 showed that it met international standards for aquafeed quality management, product safety, traceability and supply chain management. The certification is an important gateway for Vietnamese aquaculture products to enter high-end markets such as the EU, the United States and Japan."

Expansion and acquisitions

In June 2025, Cargill exited Vietnam's aquafeed market. Sheng Long then acquired three Cargill factories, including a micro-feed facility, boosting its capacity for grow-out



At VietShrimp Asia & Aquaculture Vietnam in March 2025. From left, Jeff Jie-Cheng Chuang, General Manager, Sheng Long Bio-Tech; Ronnie Tan, USGBC, Malaysia; Chewen Wei, Export Director, Uni President Vietnam (UPV) and Tran Trong Nghia (left), USGBC, Vietnam.

fish and shrimp feed. Sheng Long now operates eight feed mills in Vietnam with total annual fish and shrimp feed capacity of 1 million tonnes. Other expansion and acquisition reports on the AAP website included:

- In June 2025, India's IFB Agro Industries Ltd acquired Cargill India's commercial shrimp and freshwater fish feed business.
- In 2026, Royal De Heus completed its acquisition of CJ Feed & Care's operations in Vietnam, Indonesia, South Korea, Cambodia and the Philippines.
- In 2026, China's Guangdong Haid Group launched two major feed projects in Vietnam and Laos for livestock and aquafeed.

Outlook in 2026

In Indonesia, GPMT expects feed production to grow by 9.8% in 2026. Deny Mulyono of PT Central Proteina Prima, who also chairs GPMT's Aqua Division, said that the industry is focusing on sustainability, farm productivity, disease management and feed efficiency to support long-term growth.

Vinij Tansakul, a consultant in Thailand, outlined the country's strategy for 2025–2026. He said the aquafeed industry aims to shift towards higher-margin functional feeds and expand into high-growth aquaculture hubs to offset limits in the domestic market. In 2026, Thai Union, together with India's Avanti Feeds, entered the Ecuadorian shrimp feed market.

Chuang said, "In 2026, we will continue expanding production capacity. We expect feed sales to rise by 15%. We aim to strengthen our competitive advantage through the Thang Long Smart System (TLSS, see page 6), which integrates feed, seed, animal health products and farming models to improve farmers' efficiency and profitability."

For Wei, stability is his top priority for 2026. "The industry's main challenge is adapting to sharp increases in raw material prices, which are putting heavy pressures on feed formulation, pricing strategy and market response."

Impact of the Middle East war

Wei, said the instability has created major challenges for planning, logistics and market development. "It has significantly affected us because the Middle East is a key emerging market, forcing us to slow our expansion plans."

Chuang added, "This has raised global raw material, fuel and supply costs, increasing costs across the aquafeed industry. Given the uncertainty, we continue to monitor raw material prices, logistics costs and market confidence closely."

Asia's hatchery feed market in 2025

Demand overview and new product marketing



Hatchery in Aceh, Sumatra, Indonesia. Photo credit: Ramir Lee, Zeigler.

Asia's larval and nursery feed market is dominated by brands from Europe, the US, and Japan. The US and European micro-pellets are most widely used in shrimp hatcheries, while those from Japan are used in fish hatcheries. The most specialised feeds are for the zoea and mysis stages, when high digestibility, precise nutrition and water stability are essential for larval performance. As shrimp progress into the early and late post-larval stages, formulations become less complex and particle sizes increase, leading to a gradual decline in cost per kilogram.

On how big the demand for hatchery and nursery feeds is, Mark Napulan, Sales Manager in Asia for US feed producer, Zeigler Bros Inc, estimates that the annual demand, excluding *Artemia*, is dominated by China at 1,800 tonnes and India at 800 tonnes. Southeast Asia and Bangladesh use 980 tonnes.

"Around 70-80% of a larval feed budget in China and Vietnam comprises flakes, allowing hatcheries to sell at a lower price point with flexibility to give away more allowance. The majority of hatcheries feed dry diets and compete on quality," added Mark.

"We are present in the Middle East and in 8 major shrimp-producing countries in Asia. Zeigler is among the leaders in the following markets—India, Vietnam, Indonesia, Philippines and Bangladesh. Our range of larval diets is from 5µm to 350µm and the nursery diets are 400-1200 µm. In the Asian market, our best seller is EZ Larva Ultra,

our liquid feed replacement and supplement for algae, while Z Pro black is leading in the dry larval feed space."

Enhanced marketing in 2025

In 2025, there was more marketing by new regional producers to enter these competitive markets, where most users are also brand-sensitive. "In India, the hatchery segment, as elsewhere, is difficult for new products to enter because hatchery cycles are short and highly sensitive to change," said Dr Victor Suresh, Technical Director at Growel Feeds.

Growel Feeds launched Origin Feed for hatcheries in India in June 2023, after two years of development with hatchery feed specialist Bernard Devresse. This premium post-larval diet comes in 150µm for PL1-5 and 300µm for PL6-12, with a "D" variant formulated to enhance dark pigmentation. In 2025, the company began exporting the feed to Saudi Arabia, Sri Lanka, Seychelles and Bangladesh. It launched these two main size categories first and is now developing additional sizes and variants.

"From the onset, our goal was to develop a product that meets global standards. We worked with Bernard and benchmarked our prototypes against products such as INVE's to ensure there were no performance concerns. In India, we can offer the feed at a lower price because we avoid the higher logistics and import duty costs associated with imported feeds. However, that advantage is lost in export markets, so the product must be priced higher."



"In India, we can offer the feed at a lower price because we avoid the higher logistics and import duty costs associated with imported feeds," said Dr Victor Suresh, Technical Director at Growel Feeds, India.

On its success in entering the Indian market, which uses 70 billion PL/year, Victor commended the marketing team, "They have done an excellent job introducing Origin to customers, encouraging trial use, demonstrating its effectiveness and driving sales. Strong repeat purchases have helped our feed to become one of India's top five hatchery feed products within two years, and possibly one of the top three."

Since 2024, Sheng Long Bio Tech in Vietnam has produced Beikesu, a nursery feed designed for the first 15–20 days of high-density, multi-stage shrimp farming in lined ponds. According to the company, its manufacturing process improves feed stability, reduces water pollution, enhances nutrition and palatability, and delivers uniform particle size for more consistent shrimp growth. The formula with 50% crude protein, 10% fat, and 3% lysine (LYS) is recommended for PL13–26, while a lower-specification formula with 45% crude protein, 6% fat, and 2.1% LYS is intended for larger PL.

In response to the presence of new entrants, Mark said, "We have a solid customer base and unique product offering. Our liquid feed, for example, has been improved with the incorporation of effective *Bacillus* and no competitor, so far, has replicated the ability of these products to enhance shrimp resistance to *Vibrio* challenges. Our strategy is to compete with quality, not with pricing. We launch diets such as Z Pro black that are cost-efficient to adapt to customer needs. Basically, it depends on the new market entrant's positioning strategy, but for the time being, our sales are growing."



"Our strategy is to compete with quality and not with pricing," said Mark Napulan, Sales Manager in Asia, Zeigler.

Market outlook for 2026

Victor believes the market will remain mostly stable because shrimp production is expected to remain stable as well. "We expect our market share to increase, but the overall pie will remain the same. We are ready to launch our nursery feeds. We applied important lessons learnt from developing functional feeds for grow-out shrimp in the development of the nursery feed range. We are working on the zoea-mysis range and expect to conduct large-scale commercial testing this year."

The nursery feed market is expected to remain highly competitive, but Jeff Jie-Cheng Chuang, General Manager, Sheng Long Biotech, remains optimistic. "We believe future growth opportunities are still promising because of our integrated strengths in feed, seed stock, animal health products and farming systems, supported by a strong technical service team. As a result, we expect market share to continue to shift in our favour."

Chuang added that Sheng Long's acquisition of Cargill's fry feed plant, strengthens its ability to supply fry feed with particle sizes below 1.0mm.



The nursery feed market is expected to remain highly competitive, but Jeff Jie-Cheng Chuang, General Manager, Sheng Long Biotech, remains optimistic.

Mark commented that the Asian hatchery market will continue to optimise cost and improve efficiency to compete with Ecuador. "Efficiency does not mean cutting corners by switching to low-quality diets. We have field data (Van Wyk, 2026), showing that profitability is more sensitive to survival rates than changes in feed cost"

"When you look at yearly post larvae productivity, countries that invest in high-quality diets achieve 8,000 tonnes of shrimp production per billion post larvae. Those using lower-quality diets have only 5,000 tonnes of shrimp production per billion post larvae. Consolidation in this market model is happening and will continue in the long term because farmers are realising the value of PL quality. Flakes will comprise the bulk of this market."

"Hatchery feeds will evolve and race to create diets that deliver impact on gut health. Functional diets will develop a niche and unique value proposition. Farmers will continue to demand transparency on larval fitness and health. It's no longer about volume of feed sold but production sustainability."

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Why does aquafeed for different species demand different processing technology?

By Gunnar Hallman



Every species of fish demands a different feed formulation.

The aquaculture industry is expanding rapidly across the globe, and with this growth comes greater complexity in feed production. A common misconception among new entrants to the market – particularly in high-growth regions across Africa and Asia – is that producing aquafeed is simply a matter of making pellets. However, the processing technology required to produce high-quality aquafeed is profoundly species-specific, formulation-dependent and subject to standards that blur the line between feed and food production. Getting these choices right from the start matters – it can mean the difference between an operation that thrives and one that fails slowly.

Species diversity drives process complexity

Aquaculture may be a single industry, but it is far from a uniform one. It spans species as varied as tilapia, catfish, shrimp and salmonids – each with fundamentally different nutritional needs and critically, different feeding behaviours. For salmonid feeds – whether a floating or slow-sinking pellet with high durability, reduction of waste and accurate feed intake is non-negotiable. At the other end of the spectrum, shrimp feed needs water-stable and slow-dissolving pellets that hold together long enough to be eaten without leaching nutrients into the surrounding water. Catfish and tilapia bring their own set of demands entailing pellet size, density and nutrient delivery.

These biological realities translate directly into process requirements. Extrusion parameters, die configurations, dryer settings and coating systems all need to be tailored for the target species. An extrusion feed line optimised for producing floating salmonid pellets cannot simply be switched to produce water-stable shrimp feed without significant reworking. This is why equipment and plant design must be considered as a whole, with species requirements built into decisions from grinding and conditioning through to drying, cooling and fat coating.

The formulation revolution is changing everything

Aquafeed recipes are not what they used to be. Sustainability pressures, supply constraints and cost considerations are changing the ingredient landscape. Fishmeal and fish oil inclusion rates are decreasing, while plant proteins, vegetable oils and new ingredients such as insect meal and algae are increasingly being utilised.

This shift has implications for processing. Plant proteins behave very differently in the extruder compared to fishmeal. They affect melt viscosity, expansion behaviour and pellet density in ways that require careful re-optimisation of cooking conditions, moisture management and die pressure. Insect meals bring their own characteristics, including fat content and particle size distributions that can affect mixer performance and extruder throughput. Algae ingredients, though typically used in smaller quantities, add another layer of variability to manage.

The practical consequence is that equipment chosen today must be capable of handling not just current formulations but the formulations that will be used in five or ten years' time. Producers who invest in inflexible systems risk being locked into yesterday's recipes at a time when raw material landscapes are quickly shifting. This pressure is uppermost in Europe – where policy and market pressure to adopt alternative proteins is most intense – but it is a challenge that will reach all producing regions in time.

When evaluating processing lines, producers should ask directly whether: this equipment can handle higher plant protein inclusion; it can cope with varying fat levels from novel ingredients without compromising pellet integrity; and the parameters can be adjusted as recipes evolve.

“Feed quality is the single biggest variable determining the efficiency and profitability of a fish farm.”



Aerial view of fish farm in Scotland, United Kingdom.

Regional growth and the knowledge gap

The aquaculture industry in Europe is relatively mature, with established producers, developed supply chains and well-understood processing standards. The next wave of growth is expected to come from Africa and parts of Asia, where rising protein demand, favourable aquatic resources and economic development are laying the groundwork for the expansion of fish farming.

This growth not only brings real opportunity, but also comes with risk. Many new operators in these regions are entering the market without adequate understanding or deep expertise in feed processing technology. They may underestimate just how much complexity is involved, overlook the importance of layout and material flow, or make equipment choices based primarily on upfront cost rather than long-term performance and upgradeability. Local engineering ecosystems may still be maturing, making it harder to access specialist knowledge when it is needed most - during plant design and commissioning.

The stakes are high. Feed quality is the single biggest variable determining the efficiency and profitability of a fish farm. Poorly designed or incorrectly specified processing equipment leads to inconsistent pellet quality, higher feed conversion ratios and ultimately lower farm productivity. In regions where aquaculture is directly tied to food security and economic development, the consequences can be as much societal as commercial.

Bridging the gap between feed and food standards

There is an important and often overlooked dimension to aquafeed production: although aquafeed plants typically operate under feed-grade regulatory norms, the product they support - farmed fish - ultimately ends up on somebody's plate. Pet food factories, by contrast, are routinely audited against food-industry standards such as International Featured Standards (IFS) and British Retail Consortium (BRCGS), even though humans never consume their output.

This anomaly is beginning to attract attention. As consumer scrutiny of seafood supply chains intensifies and as export markets impose more rigorous traceability and contamination requirements, aquafeed

producers face growing pressure to demonstrate practices that go beyond minimum regulatory compliance. Many producers in emerging markets are not yet fully aware of these rising expectations - but the plant and equipment design decisions made today will either open that door or slam it shut.

The good news is that modern plant design makes this more achievable than it might seem. The principles of hygienic manufacturing - dust control, material flow design, smooth surfaces, minimised dead zones and accessible cleaning points - can be integrated from day one and cost-effectively. These investments pay back not only in product quality, but in the ability to endure scrutiny from retailers, export customers and certification bodies.

Automation, scalability, and the complete plant approach

A processing plant is only as strong as its weakest link and that is exactly why it pays to think of it as an integrated system rather than a collection of individual machines. Each stage of aquafeed production - grinding, mixing, conditioning, extrusion, drying, cooling, coating, and packaging - interacts with every other stage. Optimising the extruder in isolation while neglecting dryer capacity or coating system design is like tuning an engine while ignoring the gearbox. The gains do not add up.

“Aquafeed production is genuinely complex, and it rewards careful, species-specific and formulation-aware process design.”

This systems perspective matters most when plants need to scale or adapt to new formulations. Automation has a growing role to play here: modern control systems can collect data across the entire process, flag inefficiencies and support more precise control of critical parameters such as cooking temperature, moisture content and pellet density. For producers in regions where skilled operators are hard to come by, well-designed automation reduces dependence on individual expertise and supports more consistent output, day in and day out.

The message for anyone investing in aquafeed processing capacity today, whether an established producer upgrading an existing facility or a new entrant building from scratch, is clear. Aquafeed production is genuinely complex, and it rewards careful, species-specific and formulation-aware process design.

The decisions made at the plant design stage will shape not just the quality of feed produced on day one, but the ability of the operation to remain competitive, compliant and adaptable for years to come.



Gunnar Hallman, Industry Director
Aqua & Pet at ANDRITZ Feed & Biofuel.

Improving shrimp welfare with electrical stunners in Southeast Asia

Driven by retailer demand in Europe, Shrimp Welfare Project is collaborating with farms to replace 'chill kill' methods

By Rob Fletcher



Ponds at PT Brother Indonesia which has embarked on a programme of welfare and harvesting improvements with installation of in-water electric stunning system. Photo credit: PT Brother.

As a growing number of seafood markets adopt increasingly stringent animal welfare policies, the use of pond-side electrical stunners prior to slaughter is emerging as a way to elevate the welfare of farmed shrimp.

While shrimp stunners have been commercially available for only a few years, the technology has recently gained significant momentum. Thanks to Shrimp Welfare Project, whose Humane Slaughter Initiative's most eye-catching promotion is the provision of these devices to select shrimp farms, for free, as well as technical support to help producers to integrate the stunner into their harvest process.

While the non-profit's main goal (as its name suggests) is to promote the welfare of farmed shrimp, they realised that the best way to do so is to provide farmers with effective tools that require minimal intervention and deliver maximum impact. A single stunner has the capability to reduce the suffering of millions of shrimp every year while also opening up high-welfare markets for the farmers' produce.

It is a compelling theory and has been gaining increasing momentum along the shrimp value chain – with 31 agreements to take part in the initiative now signed and over 20 stunners already supplied to producers – in

countries as diverse as Vietnam, Indonesia, Thailand, India, Sri Lanka, Nigeria, Ecuador and Honduras.

"We had the first interest in Latin America and it is still going strong there but now we are having more MOUs in Asia than any other region," notes Lien-Huong Trinh, Shrimp Welfare Project's Director of Programme Implementation, who has played a key role in the non-profit's corporate engagement since the initiative was launched in 2023.

How it works

While traditional slaughter methods involve crowding the shrimp, then transferring them by pumps or nets into an ice slurry, a method known as 'chill kill', the electrical stunners render the shrimp unconscious before they are immersed in ice.

Isamel Wong, CEO of Seajoy, which produces around 4,000 tonnes of shrimp a year in Honduras, has embraced the use of electrical stunning, following initial trials early last year and is currently awaiting the delivery of a third stunner as part of the Humane Slaughter Initiative.

Wong, who has been in the shrimp sector for four decades, points to Seajoy's early adoption of other welfare measures, including the move away from eyestalk-ablated broodstock, an impressive 14 years ago, making them a natural fit for more humane slaughter methods.

From a practical perspective, according to Wong, the technology has been relatively straightforward but not without its challenges, to implement.

"We needed to make some adjustments and small modifications based on our farm conditions, in order to keep the flow of the harvest. It takes time to do all these adjustments and to understand the equipment for maintenance. But it works," he reflects.

William Davies of Young's Seafood, whose shrimp sources include producers in Vietnam who use the stunners, emphasises that process design is critical.

"It is important to make sure the machines are fed right - how the shrimp are moved from their ponds or tanks into the stunner," he stresses.

While initial training is provided by Shrimp Welfare Project, ensuring adherence to best practice is critical from a welfare perspective. As Trinh stresses, shrimp must be stunned as quickly as possible after removal from the ponds and then immediately transferred into the ice slurry under controlled conditions. Delays, insufficient voltage or poorly managed ice temperatures can allow shrimp to regain consciousness, negating welfare benefits.

"We can relate to the challenges, but we really appreciate the effort to improve animal welfare," Trinh notes.



In-water shrimp stunner in operation in Asia. Photo credit: Shrimp Welfare Project.

Welfare, reputation and market access

The case for electrical stunning rests on both ethical and commercial foundations. Shrimp sentience is increasingly backed by research and the precautionary principle is gaining ground, particularly among European retailers.

For suppliers, this shift is already reshaping sourcing strategies. Jozua Koffeman of Umios Food Europe B.V. (formerly Seafood Connection), another supplier that sources shrimp killed with pre-slaughter electrical stunning points to the influence of retailer demand.

"It is not only a prestige project, but there is also a market in Western Europe for products specifically marketed as increased animal welfare. This is absolutely relevant for shrimp as well," he notes.

In an environment of increasing scrutiny, this reputational dimension is significant. Davies highlights the pressure from NGOs: "There have been very targeted direct attacks... creating website content to target the issues on shrimp." Electrical stunning, therefore, serves not only as a welfare intervention but also as a form of risk mitigation.

"Our markets are more and more demanding the use of stunning systems,"
- Isamel Wong

It is a trend that Wong is also very aware of. "It is more ethical and it has been easy to understand the trends in the industry towards more humane slaughter methods. Our markets are more and more demanding the use of stunning systems."

However, while the reputational and access benefits are clear, price premiums for farmers remain elusive.

"There is no increase in price but the buyers show a preference for producers that implement better practices like this slaughter system. It opens doors to clients that appreciate a higher standard," Wong reflects. "And when we go to the Barcelona trade show (Seafood Expo Global), most of the potential buyers from the European Union will ask if we use stunners."

Quality: reassurance with caveats

One of the most persistent concerns surrounding electrical stunning is its potential impact on product quality, but these concerns have largely been dispelled by those using the devices.

"If you pick the right parameters... then it has no negative impact on your product quality," says Trinh, adding that some producers have even seen an improvement in quality parameters.

"Because of the reduction of stress to the animal, we have seen an improvement in the quality of the harvest," agrees Wong. "The slaughter process is faster. The animal does not moult during the harvest process and the product is more homogenous when it arrives at the packing plant."

Davies is less effusive but believes the quality of stunned shrimp is generally high: "We have essentially not been able to find any differences at all... with colour, texture, etc."

Caveat on post-stunning handling

However, he emphasises that post-stunning handling remains critical. "If anyone is not putting the shrimp into an appropriate ice slurry... there will be quality issues," he reflects.

There are also technical risks. As Davies cautions: "If the voltage is too high... it can create burn marks on the shell. That can be a quality negative."



Shrimp stunners in operation in Southeast Asia (left) and in Latin America. Photo credit: Shrimp Welfare Project.

While electrical stunning achieves quality parity with chill-killed shrimp, others favour another emerging technology.

"What I hear in the sector is that the perceived quality of the taste of the product of flash frozen is highest, and ice slurry and electric stunning are about the same," Koffeman explains.

However, according to Davies, flash freezing has not been accepted by animal welfare groups (including reference to the lobster industry) and for the shrimp side, it requires bulky and expensive machines, hence it cannot be done pond-side, meaning that live shrimp can face long journeys between the ponds and the processing plants, raising welfare concerns.

Cost, complexity and uneven adoption

While technological advances have made stunners more compact and accessible, barriers remain. "It still adds complexity and eventually also some cost, because they have to have a longer harvest process," Koffeman explains.

For producers operating on small margins, even modest increases in time or capital expenditure can be significant. Adoption is therefore uneven, with countries such as Vietnam leading the way; however, the geographical spread is expanding as demand for stunners increases and a growing number of producers are demonstrating that adding stunners is feasible.

As Koffeman observes, "When producers hear that others already have installed a shrimp stunner, it becomes a physical thing and they need to compete on this."

However, stunning is unlikely to become an industry standard until there is an increase in the availability, affordability and adaptability of stunners.

As Davies points out: "There is no capacity for all the welfare commitments as it (the availability of stunning technology) stands today. There need to be more supply chains coming online."

Scaling electrical stunning will also support systems, including training, auditing and certification.

Innovation and the road ahead

Encouragingly, the technology itself continues to evolve. According to Trinh, the manufacturers of the two devices, currently being used as part of HSI – Ace Aquatec and Optimar – are working closely with producers in a 'co-creating' process, resulting in more adaptable and user-friendly designs, as well as advances in accompanying software.

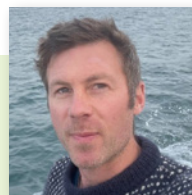
Looking ahead, the development of 'stun-to-kill' systems (combining stunning and killing in a single step) could represent a major breakthrough. "It would alleviate a lot of burden for producers," Trinh says, potentially simplifying operations, while further improving welfare outcomes.

For industry players, the move towards high-welfare production and slaughter protocols is increasingly clear, with shrimp stunning following in the footsteps of the slaughter process expected for other farmed species.

"There is no doubt about the direction of progress," reflects Davies, who has witnessed a move towards more humane slaughter across a wide range of seafood species during his three decades in the sector.

Wong agrees, with plans to have 100% of Seajoy's shrimp electrically stunned by the end of 2027, up from 70% this year. Despite benefitting from the market opportunities of being an early adopter, he would like to see more farmers improve the welfare of their shrimp.

"I hope in the future more farms will be more aware on the importance of programmes like the Humane Slaughter Initiative," he reflects.



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Tilapia and shrimp welfare: A common language for farms, markets and consumers

By Napatsorn Torchareon and Pau Badia Grimalt



Visit to a tilapia farm in Thailand.

In aquaculture, we talk every day about water quality, survival rate, feed cost and farm gate prices. Yet there is another word that is increasingly entering these conversations: 'aquatic animal welfare,' which is not a new or distant concept for farmers at all. The World Organisation for Animal Health (WOAH) defines animal welfare as a state in which;

"An animal has good welfare if it is healthy, comfortable, well fed, safe, able to express its innate behaviour and does not suffer unpleasant states such as pain, fear or distress."

Put simply for farmers, animals with good welfare have good health, live comfortably, receive enough feed, feel safe, can express their natural behaviour and do not suffer from pain, fear or distress.

If you have been farming tilapia or whiteleg shrimp for many years, this definition will sound familiar – it is exactly what you have been trying to achieve all along. The only difference is that, until now, we may not have grouped all these efforts under the formal term 'animal welfare.'

Welfare principles help organise what farms already do

At the farm level, aquatic animal welfare is not about adding another checklist that makes farmers' lives harder for no reason. Instead, it helps to organise the things you already monitor by asking what the basic natural needs of fish and shrimp are and how well we meet those needs in intensive farming systems.

Common examples that most farmers know well include:

- When fish are gasping at the surface, this indicates dissolved oxygen is low, animals are stressed, feed intake drops, growth slows and feed conversion ratio (FCR) will worsen.
- When only some groups of fish come up to feed at certain corners or feeding takes too long and uneaten pellets remain floating, this often signals stress or emerging water quality problems.
- When harvested shrimp show broken antennae, black spots on the body, or reddened tail tips, this indicates stress before and during harvest, which can lead to lower product quality and higher rejection rates at processing.

All of these are, in fact, part of the 'language of welfare' that farms already use in daily practice. Today, scientists and organisations such as FAI are helping to frame this language into practical indicators for tilapia and whiteleg shrimp, covering areas such as suitable water quality ranges, swimming and schooling patterns signalling abnormality, visible lesions or injuries, appropriate feed particle size for animal size and how far feed should be distributed across the pond surface.

FAI has translated species' natural needs into tools that enable farms to assess whether animals in the pond are living in conditions that closely match their natural requirements. When the answer is 'yes,' we know farm management is broadly on the right track; when it is a 'not yet,' this becomes a starting point for stepwise improvement instead of relying only on habit or trial and error.

Good welfare = good health = sustainable production

Looking back at the WOA definition, animal welfare is not an abstract ideal but directly connected to what farmers already value: health, growth, survival and feed conversion ratio (FCR). Aquaculture specialists often say that good welfare underpins good health and good health is the foundation of stable, efficient production.

In Brazil, tilapia farms working with FAI Farms have shown that introducing welfare indicators into farm routines and farmer selection, can reduce the proportion of damaged fish arriving at processing plants, improve fillet quality and lower trim loss, thereby reducing total system cost rather than increasing it. These experiences challenge the common fear that welfare is only an added cost with no economic returns.

The awareness gap between farms and consumers

While aquatic animal welfare is now a familiar term in academic circles and in international standards, many supermarket shoppers and even conference participants still say they have never heard the words 'tilapia welfare' or 'shrimp welfare.' This matches awareness surveys at livestock and aquaculture trade shows in Bangkok in March 2026, where several general consumers are unfamiliar with the term but become more interested in products from welfare focused farms once the concept is explained.

Interestingly, when asked whether they would be more likely to buy products clearly labelled as coming from animals raised with good welfare standards, most consumers answered in the affirmative. However, when asked the follow up question, if they would still consider buying if the price is higher, many shift to 'I'd have to think about it' or 'not sure yet.'

This reflects international research showing that consumers genuinely care about welfare, but their willingness to pay depends on both the level of the price increase and whether they trust that farms are truly doing what the label claims.

For producers and farm managers, this gap presents an opportunity rather than a problem. It means the market still has room for us to clarify, demonstrate and show buyers and consumers how 'animal welfare' links to food safety, meat quality, as well as credibility of the entire supply chain.

From care in the pond to a shared global language

Returning to the WOA definition, aquatic animal welfare does not insist that every farm instantly becomes an ideal model or completely change its production system. Instead, it invites us to ask new questions about our daily work:

- How well are our tilapia or whiteleg shrimp really living, from their own point of view, not just from the farmer's?
- How closely does what we consider normal on the farm match the animals' natural requirements?
- Where could small management adjustments improve both animal welfare and long term production stability?

Online courses from FAI Academy, together with tools such as the Tilapia Welfare App, HydroNeo App's Shrimp Welfare Assessments and FAI's welfare badges, function as the translators between farmers' on the ground experience and scientific or international standard language.

FAI has already done the background work of bringing together what tilapia and whiteleg shrimp need in nature and shows how farmers can provide these conditions in real production systems, whereby turning these into clear on farm indicators that can be measured. When farms use these indicators, they are not just ticking boxes: they are checking whether animals are really living in the conditions they need, correcting problems, and then being able to demonstrate this care to the market.

Within this approach, the welfare badges are not something that you simply 'receive' for signing up; each badge marks a specific level of learning and implementation. Through the Shrimp and Tilapia Hubs, farms and companies can first earn a welfare trained badge by completing the foundation course and building basic skills in welfare assessment. They then progress to a welfare assessed badge by running regular welfare assessments, collecting data, and showing verifiable improvement in farm outcomes. The badges, therefore, help make existing practices more visible and systematic, and provide buyers and consumers with independent proof that welfare is being taken seriously in day to day management, and not just used as a marketing term.



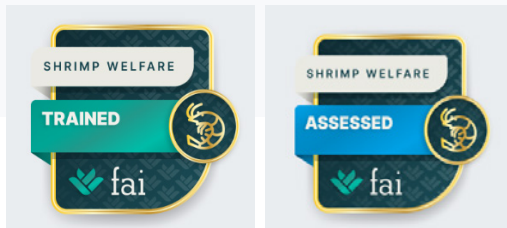
Shrimp from HydroNeo R&D in Thailand. In collaboration with FAI Academy, HydroNeo has an online course on shrimp welfare indicators, a step toward sustainable shrimp farming that aligns with premium markets emphasising animal welfare and environmental friendliness.

Shrimp Hub ช่วยให้บริการทั้งทำเรื่องสวัสดิภาพได้ไวขึ้น เป็นส่วนหนึ่งของ FAI Academy ซึ่งเป็นแพลตฟอร์มการเรียนรู้ระดับโลก

การลงทุนในสวัสดิภาพนำไปสู่กุ้งที่มีสุขภาพดีขึ้น ประสิทธิภาพการผลิตที่ดีขึ้น และธุรกิจที่ปรับตัวดีขึ้น



ติดต่อเพื่อเข้าร่วมโครงการสวัสดิภาพกุ้ง



Farmers can learn these foundations for free through FAI's online hubs or via other organisations, then use the welfare badges and similar tools to show that they have applied this knowledge into practice.

At the same time, these courses and badges are built on the same underlying principles as other animal welfare training programmes, namely the WOAHP definition of animal welfare and its focus on health, nutrition, environment and natural behaviour. Farmers can learn these foundations for free through FAI's online hubs or via other organisations, then use the welfare badges and similar tools to show that they have applied these knowledge into practice.

As global certification organisations such as the Aquaculture Stewardship Council (ASC) introduce requirements on fish and shrimp welfare, these steps also help farms prepare to demonstrate responsible farming and animal health and welfare performance during the certification process.

“This is essential at a time when the world cares about both food quality and the quality of life of the animals behind that food.”

In many supply chains, buyers are already asking producers to demonstrate that they farm responsibly. Therefore, linking welfare badges and indicators to ASC and other international standards is starting to turn better welfare into a concrete marketing and economic advantage, and not just a cost.

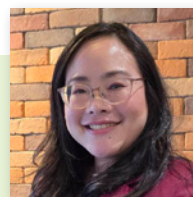
Ultimately, aquatic animal welfare is not a fashionable buzzword or just another item in a long list of standards. It is a way of organising the care that farmers already practice for their animals into a clear strength for the business. This is essential at a time when the world cares about both food quality and the quality of life of the animals behind that food.

Farmers can learn these foundations for free through FAI's online hubs or via other organisations, then use the welfare badges and similar tools to show that they have applied this knowledge into practice.

How to start if you are in the supply chain

For whiteleg shrimp and tilapia farms, processing plants, researchers and all in the seafood supply chain wanting to go beyond slogans and to truly understand aquatic animal welfare, we suggest the following.

- Discover the Shrimp Welfare Hub on FAI Academy, which offers complimentary principles, on-farm indicators, and online courses accessible in multiple local languages. The same resources are also available through the Tilapia Welfare Hub.
- Explore FAI Farms' welfare concepts and their practical application on farms, in processing plants, or research projects. We invite small-scale farmers, large farm managers, processing plant staff, and technical teams to trial these ideas in their own operations.



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Both authors are with Creative Labs Asia, FAI Farms Representatives. Find the Shrimp Welfare Hub at <https://fai.academy/en/shrimp-hub> and Tilapia Welfare Hub at <https://fai.academy/en/tilapia-hub>

Aquaculture at VIV Health & Nutrition Asia 2026

VIV Health & Nutrition Asia 2026 brought the region's animal feed and health community together for three high-impact days in Bangkok. It was held on 10–12 March 2026, alongside VICTAM Asia, GRAPAS Asia and Horti & Agri Asia. The four co-located shows together welcomed 10,639 visitors from 73 countries across the agrifood value chain, showing a significant 23% increase in visitor numbers from the past edition.

According to organisers, VIV Worldwide, VIV Health & Nutrition Asia alone drew 125 industry leaders, making the event a premier gathering for those shaping the future of the animal health and nutrition industry. It had 300 exhibitors occupying over 17,000m² of dedicated exhibition space at BITEC, Bangkok, Thailand.

VIV Health & Nutrition Asia served as the dedicated hub for animal nutrition and health professionals – purpose-built for feed formulators, veterinarians, producers and buyers driving the sector forward across poultry, swine, aquaculture, cattle and dairy. Meanwhile, VICTAM Asia brought together the world's leading feed technology, pelleting and grain processing innovators, providing manufacturers and equipment suppliers with a targeted platform for technology transfer and commercial dialogue.

Milestone reflects growth

Natasha Hall, Vice President of VIV Worldwide, reflected on the milestone: “This edition marks a defining moment – one that reflects not only the growth of this platform, but the momentum of an entire industry. The dedicated national pavilions from Japan and South Korea, two of Asia's most dynamic and innovative markets, speak volumes about the rising international confidence in what this event represents. Their presence underscores a shared belief that collaboration across borders is essential for shaping the future of the sector, and we look forward to the ideas, connections and opportunities their participation brings.”

Jeroen van Hooff, CEO and President of Royal Dutch Jaarbeurs and VNU Group, captured the spirit of the three days: “These days were not just about sitting and waiting; rather, they were about walking the floor, having the

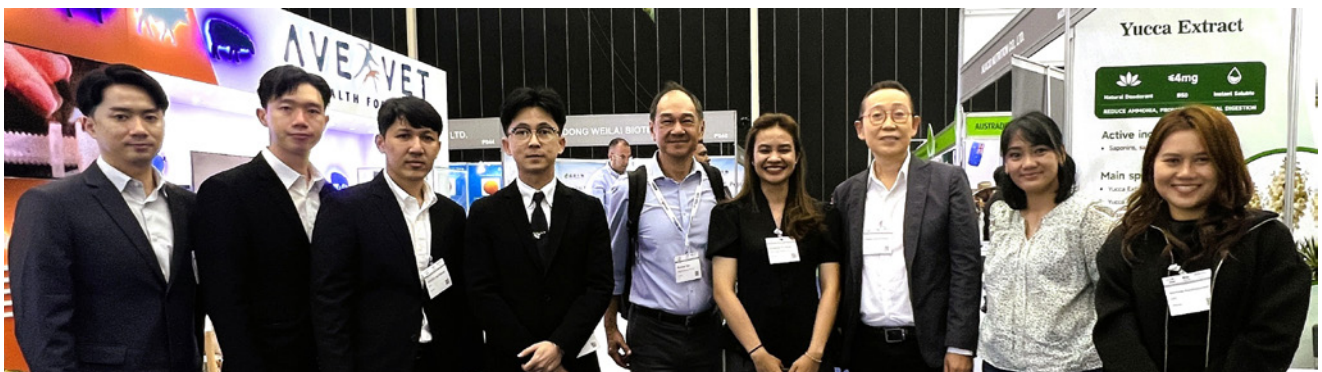
conversations that had been in the pipeline for months, finding the solutions that brought attendees here, or discovering issues they never anticipated.”

Conferences are a great way for visitors to stay up to date on the latest developments in a sector. At this VIV Health & Nutrition/VICTAM Asia 2026, the conference program had seminars spanning the event's four core sectors – poultry, swine, aquaculture and cattle. Held under the theme ‘Shaping the Future of Animal Feed and Health through Sustainability & Innovation,’ the program featured 73 expert speakers across more than 34 sessions. Topics ranged from antimicrobial resistance and precision nutrition to supply chain resilience and next-generation feed additives, with dedicated sessions for each sector.

Aquaculture activity: Modest in profile, significant in impact

Feed ingredients and additives for aquafeeds were featured by 54 booths, including feed processing equipment within VICTAM Asia 2026. The National Center for Genetic Engineering and Biotechnology (BIOTEC), National Science and Technology Development Agency (NSTDA) organised a seminar on ‘Sustainable Shrimp Production through Efficient and Circular Practices’ with collaborating universities and companies. The seminar by the Thai Aquaculture Business Association (TABA), in English and Thai, focussed on global forces, risks, and aquaculture systems and three dimensions of knowledge and strategy for sustainable survival for the aquaculture entrepreneur.

Wenger is now part of **JBT Marel**. Marel acquired Wenger in 2022, adding a global leader in processing solutions for the fast-growing pet food, plant-based protein and aquafeed sectors. In 2024, Marel became JBT Marel following its acquisition by John Bean Technologies (JBT Corporation). At VICTAM Asia 2026, the JBT Marel booth highlighted its combined processing expertise and product innovation in pet food processing. Wenger and Extru-Tech showcased extrusion, forming and drying solutions, while the team also presented JBT's full equipment range for wet pet food.



Dr Prakan Chiarahkhongman, Director of Aquatic Animal Health Care at Charoen Pokphand Group (third right), Ronnie Tan, Consultant, USGBC (middle) and Martha Aulia Mamora, Farm Application Manager Aquaculture APAC/ISC ADISSEO (second right), with the young team at CPF (India) Private Limited, from right, Nanthiwa Mokkhathamsiri, Jakkrit Thananchai, Atiyut Autsa, Thawatchai Panichsudsawat and Sorawis Kanchanaalongkorn.



The APAC JBT Marel team, from left, G Ramesh, Koh Sze Shiang, Paul Chen, Manuel Kaufmann, Korn-Ake and Nimthida Rarernsang.

In the early years of shrimp nutrition, many formulators were familiar with the marine hydrolysates used as attractants in shrimp feed from the French company **Sopropêche**. At the company's booth was third-generation representative Florian Derome. Founded in 1968 by his grandfather, the company has spent more than 50 years marketing hydrolysed fish protein (CPSP®), fishmeal and fish oil. These hydrolysates are used mainly in early-stage feeds across aquaculture and livestock, except for beef. As part of its international expansion, Sopropêche established its Qingdao subsidiary, Seah International, in 2006 under the leadership of Kelly Xue.



Focussing on marketing its hydrolysate and other products was the Sopropêche team of Florian Derome (left) and Aurelien Parent (right) with Kelly Xue, Seah International, Qingdao, China.

Sustainable shrimp production through efficient circular practices

This seminar, organised by BIOTEC and NSTDA and led by Dr Kallaya Sritunyalucksana, Director of the Integrative Aquaculture Biotechnology Research Group, covered shrimp genetic improvement and WSSV-tolerance of the black tiger shrimp, to RAS, AI driven feeding systems and product innovation. The NSTDA team has presented seminars on its latest research at each of the past three VIV Asia and VIV Health & Nutrition events.

Black tiger shrimp genetic improvement program

Dr Sorawit Powtongsook, Principal Researcher and Research Team Leader at the Shrimp Genetic Improvement Center, NSTDA (SGIC), opened with this statement: "Thailand aims to increase shrimp production to 400,000 tonnes and restore its export value to THB100 billion, matching 2011 levels. However, the country cannot rely solely on vannamei shrimp. Through SGIC, we aim to reintroduce black tiger shrimp, *Penaeus monodon*, as a viable economic option."

This is an NSTDA and the Advanced Institute for Food Security at Prince of Songkhla University (PSU) collaboration spanning almost 20 years. SGIC located in Surat Thani has complete facilities: a nucleus breeding centre (NBC) with strict biosecurity; broodstock multiplication centre (BMC), ready for commercialisation of broodstock; a hatchery under PSU for sale of PL15 to farmers and facilities to culture pathogen-free polychaetes and live feeds.

The specific pathogen free (14 diseases) broodstock line, named 'Chaiya1', was developed through selection from 35–40 families. Each generation is produced within one year, selecting shrimp from two months of age to grow to 10-month-old broodstock. Founder animals were collected from several locations since 2018. Now in its fifth generation, Chaiya1 has shown a growth rate 45% faster than wild-caught black tiger shrimp and has good colouration in outdoor pond culture.

Sorawit expects commercialisation in 2027. Meanwhile, the broodstock is used to produce post larvae for sale to local farmers to create a source of revenue for the project. "Results of farming with stocking 420,000 PL in a 6-rai pond yielded 10.8 tonnes, with shrimp weight averaging 29g. Farmers found the shrimp robust with good growth and high survival rate."

This is the result from efforts from three groups of experts: consultant Bunchong Nisapawanich for broodstock culture; Professor Skorn Koonawootrittriron, Kasetsart University for genetics and Dr Kallaya Sritunyalucksana on health and disease.

WSSV-tolerant black tiger shrimp

Kallaya presented on using viral accommodation mechanism to develop a WSSV-tolerant black tiger shrimp. "This concept began from 2000. We always see some shrimp response to a new virus, with a massive outbreak which then goes away. But after some time, the virus returns but shrimp survive."

A shrimp histopathology showed a virus inclusion amid normal cells. "This means these cells are living happily with the virus already, without any signs of disease. Professor Timothy Flegel, head of project, concluded that shrimp can accommodate the virus in long term persistent infections without signs of disease."

Kallaya discussed endogenous viral elements (EVEs). It was hypothesised that EVE represents a record of past infection with a potential immune memory. The platform to screen the protective EVEs has been developed. A recent study has revealed the several levels of control over EVE expression. The offspring of *P. monodon* carrying WSSV-EVE that express RNA exhibit significantly higher survival when challenged with WSSV than offspring that do not carry WSSV-EVE or offspring that carry such alleles without RNA expression.

Finally, Kallaya said, "The EVE platform could be used to screen the tolerance stock of other viruses. However, my take home message is that with this EVE in the shrimp genome, it will affect the PCR detection method that we are using nowadays to screen shrimp"



From left, Dr Kallaya Sritunyalucksana, Dr Sorawit Powtongsook and Dr Yotsakorn Pratumwal from NSTDA. From right, is Weerapat Taweeprada, Prince of Songkhla University and Bordyn Cheevatanakornkulm, Algaeba, Thailand.

Vannamei shrimp in RAS

Dr Yotsakorn Pratumwal Senior Engineer, Engineering Design and Computation Research Group, National Metal and Materials Technology Center said that for the Asian seabass, growth from one inch to four inches in recirculating aquaculture systems (RAS) is much faster - at 35 days versus 42 days. With the shrimp, he showed growth to size 40/kg within 70 days, and cost of production was THB200/kg - with the breakdown comprising 37% for electricity, 32% for feeds and 11% for oxygen.

Monitoring feeding and growth

Algaeba has developed two flagship aquaculture technologies: SeaThru MOBILE and SeaThru CURRENT, with the next-generation platform to be launched as SeaThru VISION. SeaThru MOBILE is an AI-enabled progressive web application for precise counting, sizing and classification of aquatic species using smartphone cameras, while SeaThru CURRENT is a floating AI-powered automated check-tray system for in-pond monitoring and feeding optimisation.



Aquaculture pioneer in Asia, now retired, Dr Philippe Serene with Dr Olivier Decamp, R&D Director and Business Development Director Health, INVE Aquaculture (standing).

The company's 2026 vision is to enable standardized pond management with minimal human intervention through consistent, reliable data acquisition compatible with existing feeding systems and farm best practices. Internal



Rudy Purwono (right) and Samantha Prijadi Purwono, PT Matahari Sakti, Indonesia with Soraphat Panakorn, President: Thailand Aquaculture Business Association (TABA) and Aquaculture Technical specialist at Novonesis Thailand who conducted two seminars on global forces, risks, and aquaculture systems

performance assessments indicate the technologies may improve feed conversion ratio (FCR) by up to 17%, increase production by approximately 5% compared with control ponds and enhance growth rate by an estimated 5%, resulting in projected savings of approximately THB37,000/month per 0.64-ha pond.

Product innovation to create value

Wolffia globosa or duckweed is a fast-growing plant with 35-45% protein (dry weight) and complete essential amino acids. The output from traditional farming is inconsistent. Therefore, the Advanced Institute for Food Security, PSU has a project aimed at production innovation using IoT, high product value creation and market integration to bring research to real world adoption. Weerapat Taweeprada discussed the project and the use of the plant for shrimp feed and mild enzymatic hydrolysis to produce high value protein and peptides which have anti-microbial, antioxidant, anti-inflammatory and has anti-cancer properties.



At the Thai Aquaculture Business Association booth, from left, Krit Kemayan, MSD, Wipavee Thongpiam, Pongpranot Intanop and Niran Warin, TABA.

VIV Asia 2027 will be at Impact, Bangkok from 10-12 March 2027. VIV Health & Nutrition Asia 2028 will return on 14-16 March in BITEC, Bangkok, Thailand.

Vietnam shrimp aquaculture: Search for resilience amid cost pressure

By Ha Thu

At Aquaculture Vietnam/VietShrimp Asia 2026, the prevailing mood pointed to a shrimp industry still searching for where its resilience lies. Disease pressure, particularly *Enterocytozoon hepatopenaei* (EHP), remained a dominant concern. Interest in artificial intelligence (AI) and data-driven tools continued to grow. The event was held in Ho Chi Minh City, from 18–20 March. It had 7,772 visitors and brought together 150 exhibitors from 47 countries.

At shrimp farm level, challenges appeared more grounded. Survival rates of around 30–40% were frequently cited, pushing farmers to shift from cost reduction towards improving efficiency through better pond management, biosecurity and more targeted use of inputs. Across the exhibition, solutions reflected this shift. Rather than breakthrough technologies, most approaches focused on addressing specific bottlenecks in production – from disease prevention and diagnostics to feed strategies and system design.

Disease prevention and shrimp pond stability

With ongoing challenges from EHP and other diseases, shrimp farmers in Vietnam are increasingly focusing on prevention and integrated farm-level management rather than treatment. On EHP mitigation, **R.E.P Biotech JSC** is promoting a three-part approach that targets both the microsporidian and pond management.

“Disease management in shrimp farming should not rely solely on treatment, as most conditions cannot be effectively rectified. Prevention remains the most practical and sustainable strategy,” said Associate Professor Nguyen Ngoc Phuoc, technical advisor to R.E.P Biotech. The approach focuses on maintaining shrimp health, controlling pathogen pressure and improving pond conditions.

This system combines a biological compound to inhibit the microsporidian’s ability to infect host cells, beneficial bacteria to stabilise microbial balance and reduce stress,



At the booth of R.E.P Biotech, from right, Associate Professor Nguyen Ngoc Phuoc, technical advisor; Nguyen Huu Duc, Sales Manager; Tran Thi Hoai Phuong, Marketing Manager; and Tran Nguyen Ngoc, Technical. The team promoted an integrated approach to EHP prevention, combining pond management, microbial balance and shrimp health support.

and immune-stimulating additives to strengthen shrimp resilience. Together, these measures aim to limit EHP proliferation while improving water quality and overall farm stability. Field trials in the Mekong Delta showed no detectable EHP signal and zero mortality over 49 days, suggesting the potential effectiveness of integrated management strategies in reducing disease risk under field conditions.

Vietnam-based **Bio-Floc** Company Ltd is a research-driven producer of native microbial strains that are naturally adapted to the Vietnamese farming environment. Their strategy is to reduce antibiotic use in intensive shrimp farming. The strains are isolated from local aquaculture environments and selected for adaptability to tropical conditions, including salinity and pH fluctuations. This allows faster activation upon application, helping microbes establish quickly and suppressing harmful bacteria such as *Vibrio*.

The products are formulated at high bacterial densities (CFU/g), supporting rapid biomass development and improved response to organic loads in high-density systems. Selected strains also contribute to nitrification processes, including control of nitrite (NO₂), a persistent threat in lined ponds. The approach reflects the use of locally adapted microbes as part of broader pond management strategies aimed at stabilising water quality and reducing reliance on antibiotics.



Bio-Floc showcased native microbial strains and formulations developed for high-density shrimp systems, supporting waste management and microbial balance.

Bringing diagnostics closer to farms

With increasing pressure to detect and respond to disease threats earlier, on-site diagnostics and data-driven monitoring systems are gaining interest among shrimp producers. Australia-based **Aquagen Diagnostics** Pty Ltd presented a mobile PCR device and rapid test kits designed for use directly at farm level.

The system allows farmers and processors to detect pathogens such as white spot syndrome virus (WSSV), EHP and acute hepatopancreatic necrosis disease (AHPND) on-site, helping determine whether infections originate from the farm or occur later in the supply chain.



At Aquagen Diagnostics Pty Ltd, from left, Ross Brierty, founder and CEO; Dr Gus Franco, Chief Scientific Officer and Dr David Croan, Director, presented on portable PCR solutions designed to bring disease testing in the farm.

The approach reflects increasing pressure from export markets. "In 2016, Australia introduced stricter testing requirements for WSSV in imported shrimp, which led to the adoption of rapid diagnostic tools," said Ross Brierty, founder and CEO of Aquagen Diagnostics Pty Ltd.

Designed for field conditions, the kits require minimal technical training and use pre-prepared reagents, reducing handling errors and contamination risks. The system can test multiple pathogens in a single run, without compromising accuracy. It also allows simultaneous verification using two genetic targets to reduce false positive or negative results, according to Dr Gus Franco, Chief Scientific Officer.

By enabling faster and more practical disease monitoring at farm level, the system supports earlier detection and more informed management decisions. The company emphasised that reliable pathogen detection depends on both PCR reagents and sample preparation, particularly DNA or RNA extraction quality, which can significantly influence detection accuracy.

Data monitoring and AI-assisted farm insights

Technology providers are now aiming to translate farm experience into measurable data to support more consistent decision-making. **Tep Bac**, a Vietnam-based aquaculture technology company, is developing systems to monitor water quality and shrimp health while tracking trends over time, rather than relying on single-point observations. "AI and new technologies help farmers see what cannot be observed by the eye, by reading trends in the data," said Tran Phong, CEO, Tep Bac.



Tran Phong, CEO of Tep Bac explained on the data monitoring systems designed to support more consistent farm management through real-time insights.

The company highlighted cases where data analysis helped identify underlying issues, such as algae accumulation which limit shrimp growth. However, its adoption remains dependent on farmers' willingness to move beyond traditional practices. As disease pressure and environmental challenges increase, Tep Bac sees data-driven monitoring as a way to improve farm management and reduce production risks.

AI applications are emerging primarily in farm planning and system design, although their effectiveness depends on data quality and practical implementation. Vietnam-based **Aqua Mina** is applying artificial intelligence (AI) to shrimp farm design, aiming to improve site planning and reduce operational risks often overlooked in conventional approaches.

According to Vu Hong Thai, CTO of Aqua Mina, AI is used at the early stage of project development to assess site conditions and optimise layout. "AI allows us to analyse factors that are often underestimated, even by experienced farmers, such as wind direction and seasonal patterns."

The system evaluates key elements, including water intake and discharge positioning, as well as prevailing wind directions. Poor alignment of these factors, particularly placing wastewater ponds upwind, can increase disease risks and reduce production success.

Thai noted that farm design also depends on the intended purpose, whether for experimental, demonstration or commercial production, with each requiring different configurations. He emphasised that effective use of AI depends on data quality and industry context. "AI should be used alongside experienced partners with strong datasets, such as companies like Rynan and Tomota. At the same time, accurate input data is critical to ensure reliable outputs," he said. Aqua Mina positions AI as a decision-support tool to enhance farm design rather than replace technical expertise.



Vu Hong Thai, CTO of Aqua Mina at his booth. Aqua Mina is using AI-based shrimp farm design solutions, highlighting the role of data in site planning and system optimisation.

RYNAN Smart Aquaculture highlighted a system-based approach to shrimp farming, focusing on maintaining balance across physical, chemical and biological conditions rather than relying on individual technologies. The system integrates pond design, oxygen management, water flow control and real-time monitoring to stabilise production environments under intensive farming conditions. A key feature is continuous waste removal combined with biological control through algae and probiotics to support water quality.

In commercial ponds, this approach has supported stocking densities of around 400 postlarvae/m², while maintaining survival rates above 90%. Feed conversion ratios have improved to around 1.15–1.2, reflecting more consistent pond environments. Energy use has been reduced by approximately 70%, with further savings observed in optimised systems, as oxygen supply is adjusted based on real-time demand and supported by algae-driven oxygen production. The model is best suited for structured, high-investment farms where infrastructure and pond design can be aligned with system requirements.

Functional ingredients

Feed innovation continues to centre on improving performance while reducing reliance on traditional inputs, with increasing use of functional ingredients and alternative protein sources.

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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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JF Nutritech's vacuum-based coating system enhances additive absorption and reduces nutrient leaching in shrimp feeds.

Malaysia-based **JF Nutritech Sdn Bhd** develops and manufactures natural functional lipids using proprietary extraction and processing technologies. These lipids are used in fish and shrimp feeds. However, top dressing of feed additives remains common in many shrimp farms, which often leads to uneven coating, nutrient loss and inconsistent pellet quality. The company introduced a compact coating system designed to address these challenges at the farm level.

The **LipidPro Aqua Infusion Coater** provides deep-vacuum infusion, a process to remove air from feed pellets before infusing coating materials, allowing additives to penetrate into the pellet. This improves coating uniformity and reduces leaching in water. Farmers visiting the booth showed interest in the system's ability to reduce feed waste and simplify on-site operations, with a batch capacity of around 50kg considered suitable for farm use.

Plant-based proteins are gaining traction in aquafeeds, not only as fishmeal alternatives, but also for their functional roles in supporting performance. Dr Nguyen Duy Hoa, Global Technical Director at **Cargill Branded Feed** presented the **Empyrean®75** and **MOTIV™** product lines, with defined inclusion strategies across species. In shrimp feeds, **MOTIV** is applied at around 7.5% inclusion, replacing approximately 55kg of fishmeal per tonne of feed, while maintaining nutrient balance. Field evaluations indicated improvements in biomass and profitability, alongside modest reductions in feed cost.

For Asian seabass, **Empyrean** was tested across inclusion levels from 5% to 12.5%, with 10% identified as optimal for growth, feed conversion and survival. Higher inclusion levels were also associated with reduced feed cost per kg of production.

Formulated hatchery feed reduces reliance on live inputs

Shrimp hatcheries in Vietnam continue to rely on live feeds such as microalgae and *Artemia* during early larval stages, despite challenges related to cost, labour and biosecurity. The culture of diatom algae, while widely practised, requires additional infrastructure and management, and can introduce instability when blooms collapse, leading to oxygen depletion, pH fluctuations and deteriorating water quality.

Japan-based **Higashimaru** presented its formulated hatchery feed designed for shrimp from PLO-PL20 as a partial replacement for live feeds. The company indicated that the feed can substitute up to 50% of *Artemia* when used in combination, while also replacing diatom-based feeding regimes from Zoea 1 to juvenile stages.

The micro-pellet and crumble feeds (0.3–2.3mm) are developed with high water stability to reduce nutrient leaching and maintain cleaner rearing conditions.

By limiting organic waste accumulation, the approach supports more stable pond environments and reduces risks associated with decomposing feed and live biomass. Use of formulated feed allows hatcheries to reduce reliance on variable live feed supply and associated disease risks, including pathogens. The approach also supports more consistent feeding regimes and operational planning, particularly under high-density production systems.



At Aquaculture Vietnam/VietShrimp Asia 2026, the Higashimaru team showed hatchery feeds developed for feeding shrimp at the early stages to replace live feed.

By products utilisation

Shrimp shell waste remains an under-managed by-product in Vietnam's aquaculture sector, contributing to environmental pollution and increased disease risks when left untreated. Estimates suggest that shells account for 5–10% of shrimp biomass, with most discharged directly into ponds or surrounding areas. **Việt Nam Food (VNF)** is piloting a circular model that collects shrimp shells from farms and converts them into biological products, which are then returned to farms. The approach links waste management with farm-level incentives, as collected shells are exchanged for feed additives and functional inputs.

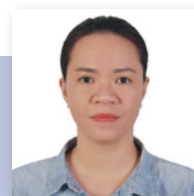
"The objective is to turn what is currently treated as waste into a resource that supports both farm performance and environmental sustainability," said Giang Anh, Sales Executive at VNF. The pilot phase will help assess scalability, particularly given the reliance on farmer participation and daily collection practices.



At the VNF booth, Giang Anh, Sales Executive, showcased shrimp-derived products including peptides, chitosan and astaxanthin, developed as part of a circular economy model.

Next in 2027

Organisers announced that the event will be held on a rotating basis between Ho Chi Minh City and the Mekong Delta. This approach allows the event to strengthen connections with the global industry community while maintaining close ties with Vietnam's key aquaculture hubs.



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

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Vietnam as new market for Thai broodstock

Based in Phuket, Thailand, Thai Pacific Aquaculture has built a strong reputation in shrimp hatchery operations over four decades, beginning with black tiger shrimp *Penaeus monodon* and later expanding to Pacific white shrimp *Penaeus vannamei*. In Thailand, the company produces nauplii and post-larvae, and it is now preparing to sell broodstock in Vietnam.

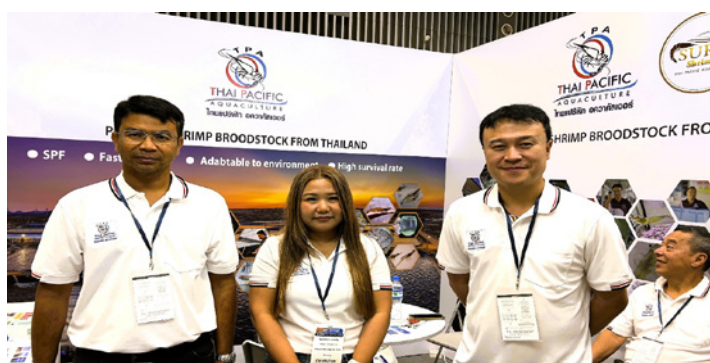
After 14 years of broodstock development, it is offering its 19th-generation line to the Vietnamese market. At Vietnam Aquaculture/Vietshrimp Asia 2026 in March, the team shared its experience in Thailand's shrimp industry and outlined its broodstock development program, while also looking for partners to enter Vietnam's shrimp hatchery segment.

"We expect strong demand in Vietnam, given the industry's challenges with translucent post-larvae disease (TPD). We can supply our 19th-generation broodstock, and we believe Thai Pacific SURE—proven under Thailand's climate and farming conditions—will perform well in Vietnam too," said Aumpon Sathitsilp, CEO of Thai Pacific Aquaculture.

Regarding broodstock attributes, it is specific pathogen free (SPF) for VpAHPND, WSSV, IHHNV, DIV1, BP, MBV, TSV, YHV, IMNV, CMNV and EHP, and it has been selected for fast growth. Khun Aumpon reported growth of 0.3–0.45g, meaning post larvae from this SPF line grow faster than the balance line broodstock available in Thailand. "Shrimp can reach size 30 counts in 90 days. I am confident that Thai Pacific SURE broodstock can easily produce high quality nauplii and post larvae with high survival rates."

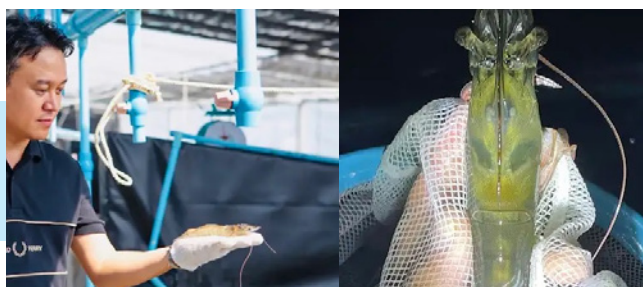
Khun Aumpon prioritises environmental conditions to maximise survival, rather than focusing primarily on growth. "You can see it's a 60:40 split—environment over growth—compared with balance line broodstock. Our motto is: if we're not sure, we don't sell."

In Thailand, Thai Pacific's main customers are low-salinity, low-density farms in central Thailand and intensive farms in Surat Thani. In intensive farms, ponds may be stocked directly at 500,000 PL/rai. When shrimp reach 2g, farmers split the crop into two ponds. After several partial harvests, the final harvest typically reaches 22–30/kg. Some farms use nursery systems, growing PL12 to PL25 and feeding nursery diets with size 400–700 microns.



Thai Pacific Aquaculture at its booth during Vietnam Aquaculture/Vietshrimp Asia 2026 in Thailand. CEO Aumpon Sathitsilp (right), Payom Ouamdang, Broodstock Manager (left), and Karntip Jaihar, Production Manager.

Thai Pacific Aquaculture's 19th-generation vannamei broodstock is available for the Vietnamese market. It was selected for its fast growth.



NEXT ISSUES

July/August 2026

Issue focus: Demand & Supply Equilibrium

Industry Review: Tilapia

Feed & Production Technology: Alternative Ingredients/Functional additives

Deadlines: Articles/Adverts – May 22

Distribution: TARS 2026 Aquafeeds

September/October 2026

Issue focus: Aquaculture Innovations

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Feed & Production Technology: Larval & Nursery Feeds/Feed Management.

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The value of early WSSV detection and a new iRP platform

This is the iRP Series, Innocreate's Isothermal Rapid platform, the latest development from Taiwan's **Innocreate Bioscience**, presented by Dr Jeff Chia-Kai Hsu, CEO, and Marc Juang, Marketing VP. Two years ago, at Vietshrimp 2024 in Camau, Innocreate demonstrated its white spot syndrome virus (WSSV) RP rapid test kit, which provides rapid detection with test results available within 15-30 minutes.

Since then, the Innocreate team has further evaluated the practical value of WSSV RP for early disease detection at the pond site, including the relationship between WSSV RP detection and cumulative mortality. Hsu said that early detection with WSSV RP can provide 3-4 days' warning, giving the farmer enough time to have an emergency harvest or take any immediate action to save the crop. "Meanwhile, if the farmer sends samples to the lab and waits for the results for 2-3 days, the mortality rate may have increased significantly. It means it could be too late to save the crop."

Hsu added, "Unfortunately, many farmers still depend mainly on laboratory testing, such as qPCR, which may take 2-3 days or longer depending on sample shipment and laboratory workflow. We are trying to convince farmers that rapid tests can help; they are faster and can be used at the pond site. I wish that farmers would collect samples when they do the daily checks and find abnormal or dying shrimp. They can run a rapid test with at least 3-5 shrimp, 2-3 times a week. This is an investment so that they can be ahead of any disease that may enter the ponds."

At Vietnam Aquaculture/Vietshrimp Asia 2026, the team also presented the new iRP platform for other important shrimp pathogens. Hsu said, "iRP delivers high sensitivity, is simple to operate and easy to read, and can be used in the field or mobile labs. We are showcasing it here and expect to launch in June across shrimp farming countries."

Hsu explained that, unlike WSSV, for which Innocreate has identified a suitable antigen target for direct rapid test detection, diseases such as EHP (*Enterocytozoon hepatopenaei*), AHPND (acute hepatopancreatic necrosis disease) and TPD (translucent post larvae disease) may not always have highly expressed antigen targets suitable for conventional antigen rapid tests. "So, we focused on making the test more sensitive while keeping it simple to operate, with results that are easy to read," he said. "The iRP Series combines isothermal nucleic acid amplification with rapid test strip detection, allowing sensitive detection with a simple strip readout."

The steps are to prepare the sample, place the tube in a simple heating device, carry out isothermal amplification, and then insert the strip into the tube for detection. The whole process takes about 50 minutes. With specific reagents, the iRP platform is being developed for sensitive detection of major shrimp pathogens such as EHP, AHPND and TPD. innocreatebio.com



Innocreate Bioscience Co Ltd at Vietnam Aquaculture/Vietshrimp Asia 2026 with Dr Jeff Chia-Kai Hsu, President (middle) and Marc Juang, Vice President Marketing (left) and Van Minh Hoa, Sales. Their iRP Series of rapid test kits addresses sensitivity issues.

Asia's dedicated platform for smart aquaculture farming

AquaTech Taiwan 2026, part of Taiwan Smart Agriweek, one of Asia's dedicated events for aquaculture, returns to TaiNEX 1, Taipei, from 8–10 September 2026. The event brings together innovators and solution providers—from AI-based smart farming systems and equipment to alternative aquafeed, additives, and aquaculture biotechnologies—and connects them with aquaculture farmers, seafood processors, aquafeed manufacturers and industry associations.

Building on recent momentum—with over 770 booths, 21,000 visitors from 69 countries generating more than USD88 million in procurement opportunities—Taiwan Smart Agriweek continues to attract both local and international audiences, creating a platform to connect, engage and network across Asia's aquaculture sector. Taiwan Smart Agriweek is organised by MY Exhibition Co., Ltd.

Climate, cost and structural challenges in Taiwan aquaculture

Taiwan's aquaculture industry is shifting amid environmental and climate challenges. Declining production, limited farm areas, fragmented pond operations and constrained water resources caused by extreme weather have affected production stability and increased the need for more resilient and efficient farming models.

At the same time, high operating costs, labour shortages and heavy reliance on small-scale and traditional farming practices have accelerated demand for professional-level solutions — including smart water-quality monitoring, automated feeding systems, oxygenation equipment, environmental control technologies, biosecurity management and facility-based or protected aquaculture systems — to stabilise output and improve day-to-day operations.

There are various government initiatives and subsidy programs as well as international certification and traceability systems. Others are production and marketing cooperation incentives, and subsidies for mechanisation of smart aquaculture equipment, wastewater treatment and indoor production facilities.

Policies such as aquavoltaics are also being promoted to diversify farm income and advance sustainable development, while industry associations continue to facilitate technology adoption through demonstration projects and training programs.

Farm-to-production solutions

The expo will showcase innovations across the aquaculture sector to empower farmers through technological advancement. In aquaculture, these comprise;

- Smart aquaculture systems and equipment
- Fish disease control
- Aquafeed and additives
- Aquatic biotechnology and water quality management equipment
- Cage aquaculture technology
- Turnkey solutions for green energy

Combined with on-site forums and collaborations with key institutions, associations, and government bodies, the event will bring together 100+ industry experts and key players to share insights into market trends and opportunities shaping the future of farming.

Where global aquaculture solutions meet Asia's demand

AquaTech Taiwan is more than an exhibition. It is where global innovators meet Asia's industry. The event connects solution providers with stakeholders seeking technologies that can be deployed across aquaculture farms and support sustainable farm management.

"The aquaculture technology showcased during the show is impressive. Although Taiwan is a smaller country than Brazil, it has made remarkable progress in this field. I see a strong opportunity for collaboration between Taiwan and Brazil through knowledge exchange and technology sharing in aquaculture," complimented Carlos Eduardo Villaca, President of Coletivo Nacional da Pesca e Aquicultura (CONEP) at AquaTech Taiwan 2025.

For exhibitor enquiries and booth proposals, contact: rae_chang@myexhibition.com.tw (Rae Chang).



Photo credit: Aquatech Taiwan, 2025. [Read AAP's report on AquaTech 2025.](#)



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New aquafeed mill in Western Visayas



DA-BFAR Director Remia Aparri, DA-BFAR; Assistant Director for Administrative Services Zaldy Perez and SEAFDEC/AQD Chief Dan Baliao at the inauguration of the new feed mill in Tigbauan, Iloilo, Philippines.

The Southeast Asian Fisheries Development Center Aquaculture Department (SEAFDEC/AQD) in Tigbauan, Iloilo, Philippines, has inaugurated a PHP30 million aquafeed mill. The project was jointly implemented with the Department of Agriculture–Bureau of Fisheries and Aquatic Resources (DA-BFAR). SEAFDEC/AQD conducted the feasibility study, co-funded the project, oversaw construction, and will operate the mill to ensure efficient, science-based production. The facility will produce affordable feeds for key finfish species, including milkfish and tilapia.

Remia Aparri, DA-BFAR 6 Regional Director said, “This is a strategic investment of the government to support aquaculture farmers in the region. The production capacity is 5 tonnes per day but can reach 8 tonnes per day. It will benefit 6,240 farmers annually, demonstrating our aim

to advance aquaculture productivity in Western Visayas. Note too that we are expecting to produce lower cost feeds, compared to commercial ones.”

SEAFDEC/AQD Chief Dan Baliao said, “This plan to establish an aquafeed mill here was put into motion 3 years ago but the journey started years before 2023. This feed mill stands as another way for SEAFDEC/AQD to bridge the gap between R&D and practical application and a sign of the Department’s unwavering commitment to its stakeholders. This aquafeed plant in Visayas will help boost the production of farmers using formulated cost-effective and nutritionally balanced feeds. This would eventually help in increasing and sustaining the aquaculture production of finfish in ponds and cages in the area,”

Assistant Director for Administrative Services Zaldy Perez said, “This feed mill is not simply about producing feeds—it is about transforming the economics of aquaculture. By utilising locally available ingredients and science-based formulations developed through research of SEAFDEC AQD and supported by NFRDI and BFAR, we are making a decisive move towards the commercialisation of the output of research to industry application and benefit.”

The plant includes a hammer mill, mixer, extruder, dryer, oil spray system, cooler, and bag sealer, which ensure efficient processing, consistent feed quality, and longer shelf life. Baliao said that he is hopeful the feed plant will potentially serve 160 ha of ponds.

SEAFDEC/AQD is also assisting BFAR to establish similar feed mills in Bulalacao, Oriental Mindoro, and in Bolinao, Pangasinan that will churn out low-cost feeds using SEAFDEC/AQD’s formulation for milkfish and tilapia.

2026

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 8–10
Aqua Tech Taiwan 2026
Taipei
taiwanagriweek.com/en/about/aquatech

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

December 1–4
World Aquaculture 2026 Tanzania & AFRAQ26
Dar Es Salaam, Tanzania
was.org



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