

# AQUA CULTURE

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Achieving Successful Shrimp Crops in Vietnam

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Navigating the Challenges of Responsible Aquaculture

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Rising Costs of Shrimp Production

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Operculum Deformity in Asian Seabass Fingerlings

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## Aquafeeds in 2022: Margins under Pressure



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Feeding shrimp in Thailand. Photo: Courtesy of AquaBiz Magazine.

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Zuridah Merican

# Shrimp Aquaculture: Outlook, Challenges & Sustainability

The recent Seafood Expo Global, Barcelona April 25-27 and the DSM-Firmenich's World Nutrition Forum (WNF), Cancun, May 9-10 have taught us that sustainability along the value chain will be the centre of aquaculture discussions for years to come. What does this mean for shrimp aquaculture since it is the biggest revenue generator in Asia?

SEG's conference sessions comprised a) Building seafood consumers; b) Alternative ingredients – no longer novel or discretionary and c) Strategies to ensure social acceptance and meet demand for high quality food through sustainable aquaculture. All promoted sustainability as the key to the long-term survival and future proofing of this industry. At WNF, Louise Buttle focused on sustainable nutrition in aquaculture and meeting the feed protein gap in a sustainable way.

Let us review the outlook and challenges for shrimp aquaculture. Supply is exceeding demand and prices are easing. The major supply growth has come from Ecuador as production has increased more than 70% from 2019 to 2022 giving a CAGR of 20%. Although this is due to the modest intensification of the

Ecuadorian model, they are moving from 5 to 15/m<sup>2</sup> density and it allows the country to triple production, *ceteris paribus*. However, the Ecuadorian model is keeping to its sustainability agenda. Meanwhile, Asia has already lost market share to 64% in 2021, according to CPF's Robins McIntosh. But shrimp demand is stagnating. Inflation and higher supply chain cost have increased US seafood prices by 12%, year over year (September 2022), and consumers are pushing back by buying less.

Supply chain disruptions may be easing but aquafeed costs remain the major challenge. High commodity and feed ingredient prices have forced feed companies to increase shrimp feed prices by 25%. With ex-farm prices declining and the aquafeed segment unable to support farmers, the prognosis looks dim. This is further complicated by disease issues whereby Asian shrimp farmers are 'living with' comorbidity i.e., not just a primary causative factor, hence Asia faces a higher cost of production. During VietShrimp 2023 conference and trade show, held from April 12-14, both Minh Phu's Le Van Quang and Dr Loc Tran, ShrimpVet, quoted production costs of USD4.2/kg to USD4.8/kg for size 50/kg, basically because of low success rates, as low as 40%. To be competitive, the consensus is that its producers need to improve survival rates and bring down costs of production to at least USD3.5/kg.

The current Asian model is untenable, and we have to adopt new methods and systems which allows for more control over culture conditions. This includes RAS, round tank technology, real-time monitoring and predictive modelling which will all be discussed in The Aquaculture Roundtable Series (TARS), August 16-17 in Bali. A session at TARS will focus on 'Future-proofing Asia's shrimp aquaculture industry'.

We believe that Asia can produce good quality shrimp, but it lacks branding and a sustainability story. Asia may have been good in production, but it has been poor in meeting the changes in customers' demand. India and Indonesia have prioritised the US market while Vietnam is starting to meet EU market demands. The US market shrunk by nearly 7% in 2022 while the EU and China markets are expanding. It would be prudent to spread our risk and serve all three major markets noting that each market has its own preferences. Millennial and Gen Z consumers believe in healthy seafood and are willing to pay a premium for sustainable seafood. Developed countries which form the major markets for shrimp believe in Environment, Social and Governance issues. Sustainable shrimp will include values such as net zero carbon emissions, traceability, identity preservation, transparency and use of renewable energy.

The business of sustainability relies heavily on traceability and transparency. As most of the Asia's shrimp production comes from non-integrated supply chains, it is critical for all the segments to work together for identity preservation of the shrimp when it reaches the consumer. The roundtable breakout sessions at TARS will help by placing farmers front and centre and linking them with feed companies, hatcheries and processing plants, respectively to ensure this traceability.

A shift to a more resilient supply chain, more efficient business operations and more customer-centric products is the best model to future-proof the industry.

If you have any comments, please email: [zuridah@aquaaasiapac.com](mailto:zuridah@aquaaasiapac.com)

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## Combining the essential, desirable and sustainable

By creatively applying proven science and drawing on data-driven innovation capabilities as well as exceptional standards of operational excellence, dsm-firmenich seeks to tackle the tension between what society needs, what people individually want, and what the planet demands in the areas of nutrition, health, and beauty.

Geraldine Matchett and Dimitri de Vreeze, Co-CEOs of dsm-firmenich, commented, "Today marks a new beginning for us all that is the culmination of more than a century of ground-breaking science from two great companies. dsm-firmenich now stands out as a category of one, uniquely working at the intersection between what people individually want and what we collectively need, without costing the Earth. After all, what is essential has limited impact if it is not desirable, and that impact is not positive if it is not sustainable. And sustainable things that people do not want or need do not help much! We are truly global, built on an incredible foundation of proven world-class science with the broadest portfolio of nutrients, flavours, and fragrances. We are delighted to embark on this journey together as a single force for good as innovators in nutrition, health, and beauty."

## Structured for success

dsm-firmenich is organised in four distinct high-performing businesses, rooted in complementary world-class scientific research and manufacturing excellence. Together they are uniquely positioned to help customers realise their ambitions and address evolving consumer needs and wants.

- Perfumery & Beauty creates superior scents with proven benefits – always with the consumer in mind.

- Taste, Texture & Health helps customers create food and beverage products that are delicious, nutritious, affordable, and sustainable.
- Health, Nutrition & Care provides people a way to look after their health by adding critical nutrients to diet. Driving medical innovation forward, speeding up recovery, and enhancing quality of life.
- Animal Nutrition & Health delivers healthy animal proteins efficiently and sustainably, harnessing power of data to make animal farming practices more sustainable, productive, and transparent.

## Delivering for all stakeholders

dsm-firmenich is a purpose-led company where people and planet as well as financial success are at the core of its strategy. It is determined to keep growing its positive impact and keep raising the bar in helping to tackle climate change, protect nature, and care for people all along the value chain. Working together with customers and partners, the company strives to tackle the challenges of today and tomorrow while making a positive difference for the planet and enhancing the lives of millions.

## A new name and identity

To mark the launch of the new company, dsm-firmenich has revealed a new brand that captures the spirit of bringing two iconic organisations together in a merger of equals. The brand reflects the company's purpose and values and is the expression of a shared identity. The brand symbolises the company's mission to combine what is essential for life, desirable for consumers, and more sustainable for the planet. The purpose of dsm-firmenich is to bring progress to life, together with customers and partners, to achieve positive change and make a difference in the world.

Matchett and de Vreeze, added, "We honour the legacy of DSM and Firmenich by taking the best of both companies in creating a fresh, new identity. It's lively. It's vibrant. It's led by our purpose. Just like dsm-firmenich. This is the beginning of an exciting new time for our employees, our customers, and our partners as we go above and beyond in shaping a positive future for all and as we bring progress to life." [www.dsm-firmenich.com](http://www.dsm-firmenich.com)



At the World Nutrition Forum 2023 (WNF) held in Cancun, Mexico, **Ivo Lansbergen**, BU President Animal Nutrition & Health introduced the merger of two iconic companies which now stands out as a category of one, to an audience of almost 700 participants. This WNF "Where GENIUS Sparks Ideas" brought together leading experts in science, academia, research, veterinary medicine, animal nutrition, genetics, business, and feed manufacturing from around the world.

More on WNF in the next issue.



## VietShrimp 2023: Call to reduce production cost to be competitive

In April, almost all of the leading companies involved in feed and additives manufacturing, farming technologies and other aquaculture activities based in Vietnam converged in the Mekong Delta's Can Tho City for the 4th VietShrimp Aquaculture International Fair (VietShrimp). The event introduced Vietnam's shrimp aquaculture industry to a wider global audience. It featured 200 booths and 150 local and international exhibitors. Visitors numbered 12,000. The last edition was successful but had few visitors from outside of Vietnam, due to the Covid-19 pandemic.

The theme of this year's three-day event from April 12-14 was "Innovative value chain upgrading". A leading activity was the two-day conference program with several industry leaders discussing steps to increase shrimp productivity and produce sustainable shrimp in Vietnam. There were four sessions: Innovative value chain upgrading; Emission reductions in shrimp farming; Value chain digitisation and Branding Vietnamese shrimp. The aim of the organisers, Vietnam Fisheries Magazine and supporters, Vietnam Fisheries Society (VINAFIS) and the Ministry of Agriculture and Rural Development (MARD)- Directorate of Fisheries, was to also introduce the achievements of the shrimp industry, promote Vietnamese shrimp in global markets as well as demonstrate Vietnam's shrimp farming industry as responsible and sustainable. For shrimp aquaculture stakeholders, it was to introduce new products and advanced models and to exchange experiences and transfer technology.

Vietnam's shrimp industry has played a key role in its seafood export sector, which accounts for 45-50% of the total export value; in 2022, shrimp exports totalled USD4.3 billion, up 11% from that in 2021. Vietnam's shrimp exports also account for 13-14% of the global shrimp export value. Vietnamese shrimp products are sold in 108 markets. In 2023, the turnover is expected to reach USD4.5 billion (Vietnamnews.vn).

### Steps to be more competitive

In the session discussing the future orientation for Vietnamese shrimp, Le Van Quang, CEO of Minh Phu, Vietnam's largest and listed shrimp integrator producing both vannamei and black tiger shrimp, called upon industry stakeholders to reduce costs of production so as to remain competitive. He commented that during meetings, customers said that Vietnam's shrimp prices are too high, when compared with offer prices for shrimp from Ecuador and India, citing Ecuador's cost of production at USD2-3/kg for size 50-60/kg shrimp and India's shrimp at USD3-3.8/kg. Vietnam's cost of production is USD4-5/kg, according to Le. Added to this, he said that in India, the stocking density is 60-80 PL/m<sup>2</sup> and the success rate is 60-70% while Vietnam's stocking density is now very high at 250-400 PL/m<sup>2</sup> (although it started stocking at 60-80 PL/m<sup>2</sup>) and the success rate is less than 40%. This makes it difficult to compete with players from these two countries.



Visitors, from left, Wei Che Wen, Uni President Vietnam; Denny Leonardo, Aquaculture Technologist and CEO Pandora Aquatech, Indonesia; Kit Yong, Founder and Quang-Minh (Michael) Nguyen, Co-Founder of Forte Biotech, Singapore-Vietnam.



At the Skretting booth, Ho Gim Chong, BDM Skretting Asia (centre left) with the team from Skretting Vietnam, from left; Van Thuy Nguyen, Head of Marketing Communications & Product Management, Trương Ngọc Trinh, Product Manager and Nguyễn Văn Quân, Sales Representative.

Therefore, the industry has to come together for a more competitive environment, change some approaches on culture models as well as on genetics of broodstock. Industry wants fast growing shrimp for higher productivity, but shrimp succumb to disease. There is a need to develop broodstock to combat disease and adapt to climate change. Minh Phu has targeted R&D to achieve these objectives. His other message for the industry includes transparency in the industry to build trust and quality management systems from broodstock to farming. Le introduced Minh Phu's farming models. If all in the industry are on the same page and if inputs are low, cost of production can be reduced, at least to be equal to that of India.

The message from Dr Loc Tran, Founder of ShrimpVet Laboratory is that diseases such as *Enterocytozoon hepatopenaei* (EHP) and white faeces syndrome will continue to affect shrimp and increase costs of production. For example, via random sampling, the infection rate is 50% but it is not possible to eliminate it as transmission is both vertical and horizontal. Industry must accept that pathogens will always be around. Loc listed ways to limit disease outbreaks to 2-3% as compared to the current 50%, such as through post larvae screening and cleaning up ponds. His take is that reducing stocking density can reduce EHP infestations.



Nguyen Van Trung, General Manager, Genomar Genetics Vietnam. The company has a production base in Tay Ninh province.

Loc discussed some of the factors contributing to the lower cost of shrimp production in Ecuador such as the consolidation of the value chain, low density farming and broodstock with enhanced disease resistance. Vietnam's

shrimp industry cannot follow that of India which is semi-intensive. Loc proposed a model developed by ShrimpVet which included lowering costs with reductions in water exchange, use of probiotics and reduce feed conversion ratio (FCR) to 1.1.

Dr Nguyen Duy Hoa, Global Technical Director - Empyreal and Motiv Products, Cargill Inc discussed some combined solutions to manage diseases and minimise risks. Steps include managing the organic and biological loads and improving water quality. The proposal is also to reduce stocking density and Hoa stressed on a carrying capacity of 2.5 tonnes per 1,000m<sup>3</sup> water in the farming of large sized shrimp which also includes feeding with functional feeds to improve gut health.

On steps for the creation of a sustainable Vietnamese shrimp, Erik de Vaan, General Manager, Nutreco Vietnam described how aquafeed company Skretting is working along the supply chain to have sustainable feeds for the Vietnamese market. This includes working on traceability with suppliers. He iterated that sustainable shrimp requires the collaboration of all in the supply chain, from farmers to processors.

### New shrimp farming models

Aquafeed companies including Charoen Pokphand Vietnam (CP Vietnam), Grobest, Sheng Long Bio Tech International, Uni President Vietnam and Viet Uc, Vietnam's leading aquaculture company have been proposing shrimp farming models for farmers to combat poor success and survival rates. CP Vietnam has a combined model which was introduced to customers 6 years ago. Samart Sawangudomporn, Vice President, Marine Hatchery Business, explained that the models are specifically designed for customers. The model on display starts with a nursery phase growing post larvae over 15-20 days to 1-1.5g. The indoor grow-out is in several phases - phase 1 is grow-out for 20-30 days at 700 PL/m<sup>3</sup> and phase 2 with 300-500 PL/m<sup>3</sup> and then by phase 3 stocking at 300-150 PL/m<sup>3</sup>. The biomass is controlled at 3.5kg/tonne of water with several partial harvests, which yield the average 33 shrimp/kg. Grow-out for large size 15/kg (67g shrimp) is in outdoor ponds.

Skretting Vietnam has created a farming model called SUCCESS, focussed on reducing production cost and incorporating features such as automation in feed management and water quality monitoring. It is now being used by 100 farmers successfully. Simon Sanguin, Global R&D Team Leader - Aqua at Royal De Heus, described some ongoing trials to increase feed efficiency.

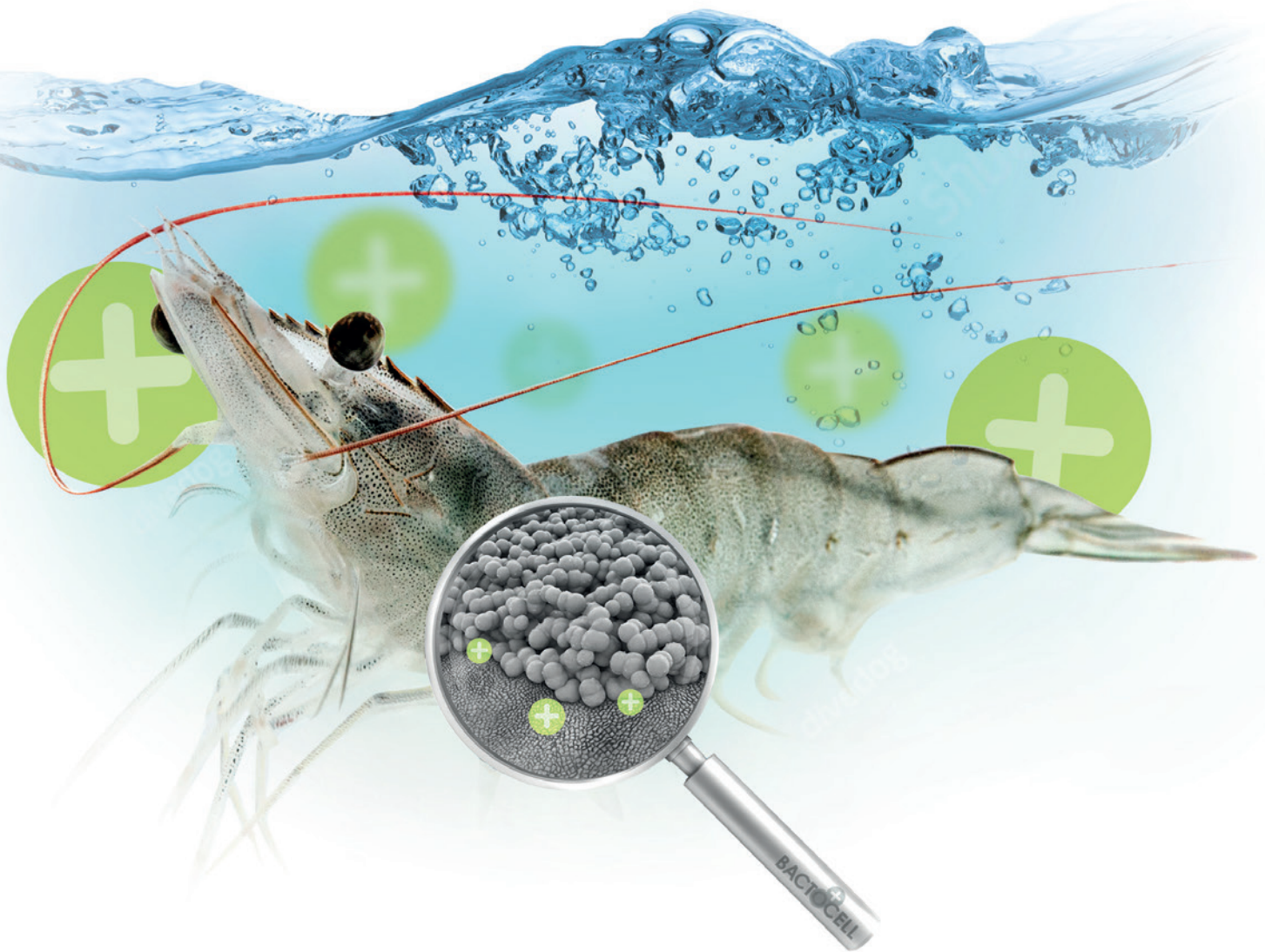


Samart Sawangudomporn and team with CP Vietnam's combine house model

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# Rising costs of production

Shrimp farmers in Southeast Asia and India say that rising costs start at 15% largely due to higher feed prices and costs of energy and manpower

By Zuridah Merican

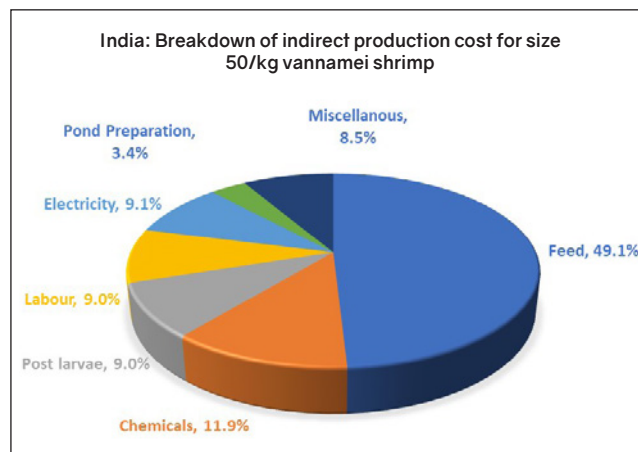
Consequent to the pandemic and the Ukraine invasion, Asian shrimp farmers say that there is no escape from rising costs of production (COP). This is on top of the challenges with frequent outbreaks of diseases which are already reducing survival rates, raising production costs and reducing margins. Several shrimp farmers and stakeholders in Southeast Asia and India cited the average increases in production costs from a low of 15% to as high as 25% depending on shrimp harvest sizes. In the first quarter of 2023, lower shrimp prices in the international market aggravated the farming situation across many countries.

In general, the major contributors to higher production costs include increases in feed prices, as well as energy and manpower costs. Prices of feed ingredients and costs of feed processing have been on the rise since September 2021. As a measure of support for shrimp and fish farmers, most feed millers only began to raise feed prices in the beginning of 2022 (see the industry review on aquafeed production, pages 21–25). Table 1 shows some direct costs of production quoted by some farmers in the region.

## Contributing factors

According to B. Ravikumar at Growel Feeds Pte Ltd, in 2019, the cost of production of vannamei shrimp was very much lower in Andhra Pradesh, India. He estimated an overall increase of 15–20% to around INR265/kg (USD2.54) for size 60/kg shrimp and for size 50/kg shrimp, it was INR278/kg (USD3.28). While higher cost of feeds at 15–20% is a contributing factor, the main cost factor has been electricity charges, which in Andhra Pradesh increased threefold and workers' salaries which rose by 30–40% (Figure 1).

"In the industry, we also hear of higher costs of equipment parts and equipment which bring up maintenance costs by 40–50%. Here in Andhra Pradesh, we are fortunate that our electricity cost is still low, whereas in Gujarat and Tamil Nadu, electricity costs are nearly double of what farms pay in Andhra Pradesh. However, land costs are much lower



**Figure 1.** Breakdown of direct costs for the production for size 50/kg vannamei shrimp in India. Since 80–90% of ponds surveyed have had outbreaks of *Enterocytozoon hepatopenaei* (EHP), /white faeces syndrome, this chart balances production cost of normal ponds and ponds with disease outbreaks. If only normal ponds are considered, feed would contribute 45–49% to the cost of production. Source: Ravikumar, Growel Pte Ltd.

in these states compared to Andhra Pradesh." In a related article in issue March/April 2023, Ravikumar and colleagues had compared % survival, feed conversion ratio (FCR) and cost of production (COP) in low saline (5–12ppt) ponds.

In **Indonesia**, Haris Muhtadi, Shrimp Club Indonesia gave a COP for size 60/kg in 2022 at IDR42,500/kg (USD2.86). This was 6.9% higher than in 2021. Rizky Darmawan, PT Delta Marine Indonesia gave a higher COP at IDR44,000 (USD2.96/kg). A farmer in West Java, who wished to remain anonymous quoted cost of production of size 30/kg at around IDR50,000–60,000/kg (USD3.36–4.04/kg), which he said was 20–25% higher than in 2021.

Country	Direct cost/kg (USD)	Stocking density /m <sup>2</sup>	Survival (%)	Harvest size (shrimp/kg)	Notes
India	2.47 (INR265)	30	85	60	Andhra Pradesh; 5–12ppt; FCR 1.21; B. Ravikumar, 2023.
Indonesia	3.35–4.03 (IDR50,000–60,000)	100–125	80–90	30	Partial harvest; Survival rate can decrease with disease
Indonesia	2.85 (IDR42,500)	140–160	80–85	60	
Malaysia	4.35 (MYR20)	191	81	45	CPF combine system; DOC70 (Hea, pers comm.)
Malaysia	3.77 (MYR 17.00)	80–100	65	60	Lined earthen ponds; 85 DOC
Philippines	3.47 (PHP194)	300	80	50	FCR1.3; 120DOC,
Thailand	3.38	150	75	70	80–90 DOC; FCR, 1.3–1.4; Vinij Tansakul, pers comm.
Thailand	3.69	100	65	60	80–90 DOC; FCR 1.3–1.4; Vinij Tansakul, pers comm.
Vietnam	4.00	150–300	30–40 /50–80	50–60	Loc Tran, pers comm. Survival rates in earthen ponds are lined ponds – 50–80% but only 30–40% in unlined ponds.
Vietnam	2.50	150–300	>85	30	ShrimpVet model; Loc Tran, pers comm.

**Table 1.** Cost of production of vannamei shrimp in Southeast Asia and India.



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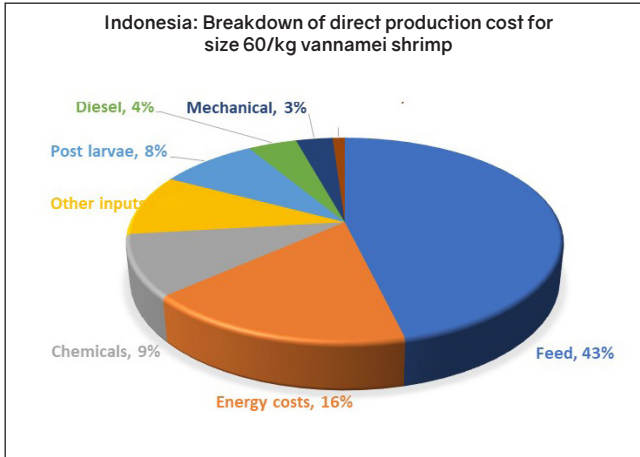
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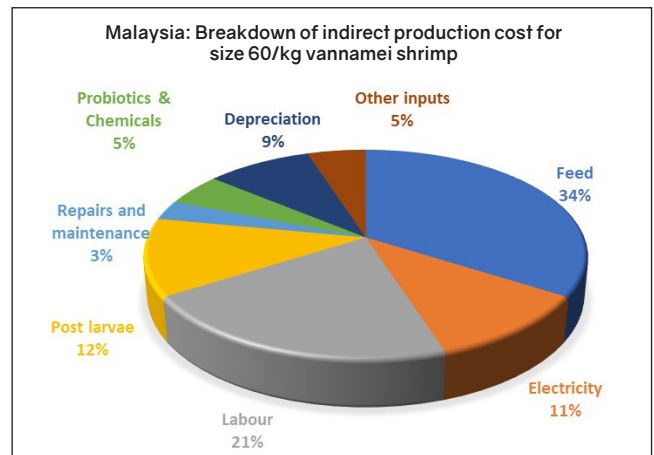
The major cost components are: 8% post larvae, 43% feed and 16% energy (Figure 2). Throughout 2022, the total increase in feed prices was IDR1,200-1,300/kg (~USD0.08) which was 6-7%. Increases were implemented in a staggered manner and in March 2023, another increase of IDR500/kg was introduced. Other increases include a 5% increase in post larvae by IDR2/PL and energy by 15-20%. Energy costs (diesel and electricity) have been on the rise since 2019 at 11% and 12% in 2021.



**Figure 2.** Breakdown of direct cost of production for size 60/kg vannamei shrimp at PT Delta Marine Indonesia.

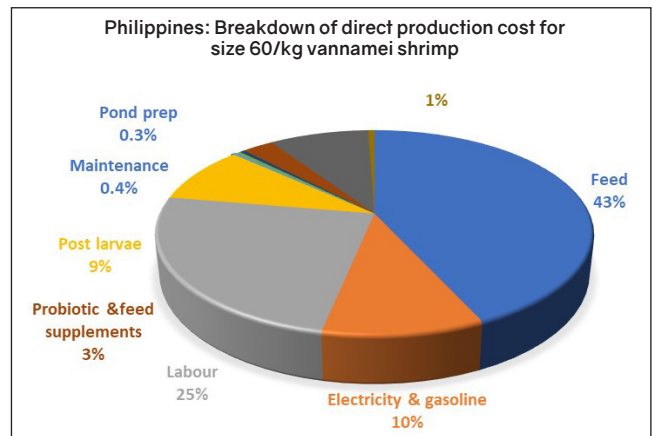
Wan Nadhri Wan Fauzi, CEO at Blue Archipelago Bhd, **Malaysia**, a leading shrimp integrator estimated that in 2022, increases in cost of production totalled MYR1-MYR1.30/kg and were largely due to higher feed prices and costs of labour. Energy costs remained stable. Cost of specific pathogen free (SPF) post larvae increased by almost 15%, in the first quarter of 2023. The increase was higher with specific pathogen resistant (SPR) post larvae at 22%. With disease outbreaks, chemical inputs and probiotics increased by 5%. "The lockdown from Covid-19 and war in the Ukraine really played a pivotal role in these price increases. The Malaysian government imposed a higher minimum salary and this raised our labour costs by 28%," said Wan Nadhri.

In the case of costs in farming the monodon shrimp, increases were also with post larvae which rose 8%. Feed costs also rose. The stocking density was 35-45 PL/m<sup>2</sup> and selling prices were MYR33-34/kg (USD7.17) for size 30/kg.



**Figure 3.** Components of indirect cost of production for size 60/kg vannamei shrimp in Malaysia.

In the **Philippines**, COP was given as PHP224/kg (USD4.00) for size 40/kg. Industry members said that increases were due to feed prices, energy (electricity) rising by 20% and post larvae prices which now cost 35 centavos each. According to CP Philippines, the breakdown in COP is feed at 47%, energy, 15%, post larvae, 8% and labour, 7%. In 2023, relatively high shrimp prices helped industry. The base price was PHP240-280/kg (USD4.29-5.00) in the Visayas and Mindanao. This meant PHP290/kg (USD5.18) for size 50/kg shrimp in the Visayas.



**Figure 4.** Breakdown of indirect cost of production for size 60/kg vannamei shrimp at a farm in the Philippines.

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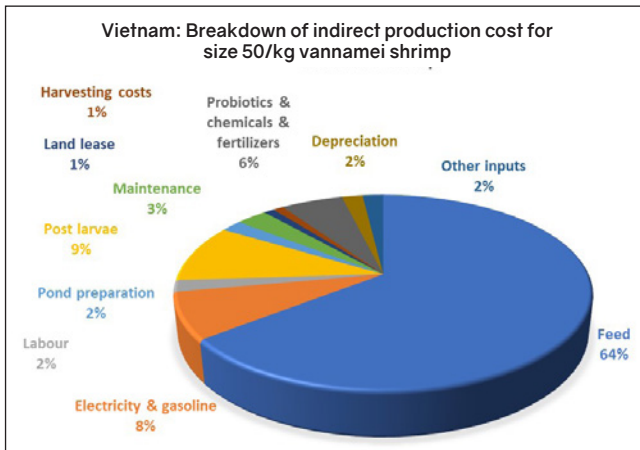
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In **Thailand**, the cost of production rose by 15–18% compared to 2021, according to Shrimp Aquaculture Consultant, Vinij Tansakul. The challenges with COP in 2022 were: higher feed costs and increase in farm input and energy (electricity and gasoline) compared to 2021. Another industry source noted the rise in post larvae prices although post larvae quality has decreased.

Dr Loc Tran, ShrimpVet Laboratory, said that the general COP in **Vietnam** for size 50/kg shrimp is USD4.0/kg farmed in lined ponds. Another industry source cited a COP of USD4.26/kg for size 35/kg. Compared to 2021, the increase has been 15%, attributed mainly to higher feed costs and inputs for water treatment and low survival rates. However, it was noted that if farmers stop farming, it is due to costs equal or below selling prices of shrimp. Post larvae prices have risen to VND125/PL. Vietnam's leaders in shrimp farming often discuss how COP for vannamei shrimp is way above that of India and Ecuador.

During VietShrimp 2023, Loc Tran compared indirect costs of production for size 50/kg shrimp as USD2.4/kg for Ecuador; USD2.9/kg in India and USD4.25/kg in Vietnam. The largest contribution to higher costs is feeds at 64% because of the preference for high quality and high crude protein feeds (at more than 40%). Other large inputs are for water treatments, liners and manpower (Figure 5). "At our farm, we have reduced production cost of size 50/kg to USD2.5/kg, using ShrimpVet's farming model. The stocking density is lower at 150-170 PL/m<sup>2</sup> and survival was good at >85% and the success rate at 95%," said Loc Tran.

At the same event, industry leaders and feed millers proposed models and ways to reduce costs of production at least to USD3.5/kg (see pages 5–6).



**Figure 5.** Breakdown of indirect cost of production for size 50/ kg vannamei shrimp in Vietnam. Adapted from a presentation by Loc Tran, ShrimpVet Laboratory during VietShrimp 2023, April 12-14, Cantho City, Vietnam.



28g shrimp from Anh Tai's farm in Soc Trang. See pages 18-21.

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# Raising productivity

At VietShrimp 2023, the Sheng Long team describes their model to increase shrimp output at a lower cost



At Sheng Long Bio-Tech International, from the right, Justin Su Keng Yi, Manager Animal Product Division; Nguyen Khac Hai, Deputy Manager Technical Department, Chau Bach Anh, Manager Processing Department and Louis Hsu Ling, Manager Global Marketing Division.

During VietShrimp 2023, the Sheng Long Bio-Tech International team comprising Justin Su Keng Yi, Manager Animal Product Division; Louis Hsu Ling, Manager Global Marketing Division and Nguyen Khac Hai, Deputy Manager Technical Department, explained that good quality post larvae is essential for successful farming. The feed company, a leading producer of both shrimp and fish feed in Vietnam has two hatcheries producing 3 billion post larvae/year. It is also strong in the tilapia segment with a tilapia hatchery in Soc Trang.

Sheng Long has four feed mills - two in Long An produce both fish and shrimp feed, the one in Vinh Long produces only fish feed and that in Nha Trang only shrimp feed. The total feed production capacity is 600,000 tonnes of aquafeeds.

"Vietnam needs not only quality post larvae but also those free from pathogens. In our hatcheries, we are careful to prevent pathogens and so we use 100% specific pathogen free (SPF) polychaetes from the Netherlands. Since we started to use only these live feeds, the feedback from farmers from the south and western regions has been very positive. More capacity is needed, and Sheng Long is on the lookout for another hatchery.

"Farmers want strong and fast-growth post larvae. The major source of broodstock is from Shrimp Improvement System (SIS) and we need more options. We are thinking of carrying out our own genetics program," said Justin.

Some 30% of Sheng Long's customers are from the south, where farmers in Camau, Bac Lieu, Soc Trang, Ben Tre and Tien Giang face *Enterocytozoon hepatopenaei* (EHP), white spot syndrome virus (WSSV) and white faeces syndrome (WFS). In the case of WFS, farmers opt for functional feeds. He added that in the central and northern regions, farmers request for disease resistant post larvae as they also face EHP, WSSV, WFS as well as acute hepatopancreatic necrosis disease (AHPND).

The team also explained the features of the Thang Long Smart System (TLSS) introduced in 2019 both for shrimp and tilapia. In one example of the TLSS, water is drawn into a 3,800m<sup>2</sup> pond and goes through three treatment ponds of decreasing sizes, from 2,000m<sup>2</sup> to 1,300m<sup>2</sup>. Nguyen Khac Hai explained that post larvae are stocked in a 200m<sup>2</sup> nursery at 1,500–2,000 PL/m<sup>2</sup> for 20 days. Then post larvae are transferred to grow-out. In the first grow-out pond of 1,000m<sup>2</sup>, stocking is 400–450 PL/m<sup>2</sup> for 30–35 days. They are next transferred into two ponds each of 1,000m<sup>2</sup>. "In the third phase, stocking is at 120–150 PL/m<sup>2</sup> with 35–45 days of culture. Harvest sizes are usually 30–40/kg when farmers practise full harvesting. They carry out partial harvesting to get larger shrimp such as size 25/kg."

He added, "In 2022, we offered a motorbike as incentive for our farmers to reach a harvest of size 25/kg shrimp. This year, we raised this to a shrimp size 20/kg."

Sheng Long now has 180 demonstration farms with the TLSS system all over the country. Jeff Chuang Jie-Cheng, General Manager, Sheng Long, said, "In 2022, we put all our efforts to build up TLSS continuously, with added advantages of our animal health products. The fantastic results from our farmers clearly reflect the advantages of the TLSS model which produces high output with lower costs and risks. In fact, by harvesting larger shrimp such as size 20–40/kg, farmers can enjoy stable profits." In terms of profit, a farmer in Ben Tre growing shrimp to size 19/kg over 136 days at a FCR of 1.40, earned a profit of VND633 million (USD28,772). The lowest FCR achieved for size 25/kg was 1.05 and the highest was 1.40."

Since 2016, Sheng Long has entered the processing segment with a plant in Can Tho. Louis said that markets are in the Middle East for snakehead fish, pangasius in China, gourami in Malaysia and tilapia in Europe and Japan. It is yet to export shrimp.

Chuang said, "We will certainly continue to promote our TLSS model plus "TL" model particularly for vannamei farming in earthen ponds. Even though now shrimp prices are not so attractive, with optimisation these farming models, farmers have better productivity in HDPE-lined ponds."



Display of the Thang Long Smart System (TLSS) during VietShrimp 2023.

# Bioremediation for profitable vannamei shrimp farming

A small investment on probiotics results in lower cost of production

By B. Ravikumar, Loc Tran, Gnana Sri, Uma Maheswararao and Ramesh Arji



Ideal water quality parameters in a bioremediation pond

The use of probiotics is one of the most important developments for sustainable shrimp farming. Probiotics are safe, effective and eco-friendly and act by stimulating shrimp growth and general health by competitive exclusion of pathogenic bacteria.

## Benefits of bioremediation

Microorganisms are very important and have critical roles in a shrimp culture cycle. At pre-grow out and growout stages in earthen or lined ponds, water quality and disease prevention are directly related and closely affected by microbial activity. Microbial populations play very important roles in shrimp ponds, including the recycling of nutrients, maintaining primary productivity and the regulation and remediation of water, pond bottom quality and also working efficiently on sludge area (Jasmin et al., 2020).

A probiotic is defined as a live microbial adjunct which has beneficial effects on the host by modifying the host-associated or ambient microbial community. Probiotics act by ensuring improved use of the feed by enhancing its nutritional value, as well as enhancing the host response towards disease or by improving the quality of its ambient environment (Verschuere et al., 2000).

Water and soil probiotics are regularly applied in shrimp ponds to modify as well as manipulate the microbial communities in the water column and pond bottom sediments. This is either to reduce or eliminate specific pathogenic species of microorganisms (*Vibrio parahaemolyticus* and *Vibrio harveyi*) and therefore improve shrimp survival rates (Toledo et al., 2019). Verschuere et al., (2000) said that most probiotics proposed as biological control agents in aquaculture belong to the lactic acid bacteria (*Lactobacillus*, *Carnobacterium*, etc.) or to the genus *Vibrio* (*Vibrio alginolyticus*, etc.), *Bacillus* or *Pseudomonas* as well as other genera or species.

Bioremediation plays a major role in making available a supply of natural food, as well as enhancing mineral

recycling rates and dissolved oxygen dynamics in shrimp ponds. It also helps in competitive exclusion of pathogenic bacterial population and improves the general health of shrimp throughout the crop cycle.

In this article, we show that bioremediation provides significant benefits with a potential to improve shrimp yields and minimise cost of production. For the past three years, we conducted trials at the R&D farm of Growel Feeds Pvt Ltd, Andhra Pradesh and in customers farms across India. These bioremediation protocols have been part of Growel's SOP, leading to crop success rates of more than 90%. To show crop production economics between treatment and control ponds, we used recent data from July 2022 to March 2023.

## Lower cost of production

Production costs in ponds with bioremediation protocols are typically lower. Improvements in yields increase the overall profitability. Bioremediation is most cost effective compared to other production management procedures.

Bioremediation simply relies on the regular addition of simple, highly digestible carbohydrates (such as molasses, jaggery and rice bran) on which heterotrophic bacteria can thrive. This carbon addition, together with nitrogen wastes from shrimp feed will enhance a bacterial bloom which consumes  $\text{NH}_4^+$  for the synthesis of bacterial proteins, thus leaving less room for photosynthesis in the pond which then results in more stable water quality.

Bioremediation technology (aerobic and anaerobic fermentation) already provides significant benefits to shrimp farmers around the world. Such a system is supposed to ensure more stable dissolved oxygen (DO) levels between day- and night- time and to avoid algal crashes which are associated with low DO and poor water quality events (Ebeling et al., 2006; Samocha et al., 2007). Furthermore, dense bacterial population is suspected to have a controlling effect over pathogenic bacteria for shrimp, such as *V. parahaemolyticus* (Crab et al., 2007).

Water	Equipment required	Carbohydrate sources	Others	Probiotics
100L of water (fresh water is preferred)	<ul style="list-style-type: none"> <li>Two sets of 200L plastic tanks, one set will be used for fermentation and second set will be placed under sunlight for sterilisation after washing</li> <li>1 set of air blower for aerobic fermentation running for 18 to 24 hours</li> </ul>	2kg of molasses or jaggery; 0.5kg rice bran; optional is 0.5-1kg of other sources of starch (corn, sweet potatoes)	Mineral mix; 200g of sodium bicarbonate	100-200g of a reputable water probiotics

**Table 1.** List of materials required for aerobic activation of probiotics.

Water	Carbohydrate sources	Others	Probiotics	Fermentation
100L of water (fresh water is preferred)	5-6kg of molasses/3-4kg of sugar or jaggery; 1-2kg rice bran; optional is 1-2kg of other sources of starch (corn, sweet potatoes)	Mineral mix; two sets of 200L plastic tanks	100-200g of reputable soil probiotics	24 hours of anaerobic fermentation (without aeration)

**Table 2.** List of materials required for anaerobic fermentation of probiotics.

### Importance of bioremediation

After disinfection of pond water, *Vibrio* can quickly re-establish itself in the culture water. With this pace of *Vibrio* growth, water and soil probiotics after fermentation (called bacterial amendments) through bioremediation protocols can compete with *Vibrio* for competitive exclusion in shrimp ponds. Two to three applications of probiotics per week after fermentation will suffice.

Beneficial bacteria can be activated by fermenting small amounts of probiotic powder at 200 to 300g/ha every 3 days from 10 days prior to stocking, in sterile and near zero salinity water with constant aeration and sterile organic carbon sources. Once after the maturation of pond water is completed, post larvae can be stocked.



Healthy shrimp harvested from bioremediation pond.

### Aerobic activation

Materials and method used for aerobic activation are given in Table 1. The recommended application is 100L/ha of pond water once in three days and preferably at 9-10am.

### Anaerobic fermentation

Anaerobic fermentation is the metabolic process by which probiotic strains extract energy from carbohydrates in the absence of oxygen to multiply and produce various bioactive metabolites. The list of materials required is given in Table 2. The recommended application is at 100L/ha daily and preferably carried out at 2-3 am. During pond preparation, the application is at 500L/ha to enrich pond bottom soil.

Cost of bioremediation for a 0.8ha pond size)					
Details	Inputs				
	Reputable probiotics (water & soil)	Molasses	Rice bran	Mineral mix.	NaHCO <sub>3</sub>
Number of applications	25	25	25	25	12.5
Dose in kg/application	0.16	1.6	0.4	0.16	0.16
Total units required (kg)	4	40	10	4	2
Input cost (INR)/kg	4,500	25	20	150	40
Total cost (INR)/input	18,000	1,000	200	600	80
Total input cost (INR) = 19,880					
Cost of bioremediation (INR)/kg of shrimp* = 3.81					
*Exchange rate: INR81.8 = one USD on 16 April 2023					

**Table 3.** Cost of inputs for bioremediation in shrimp farming. The total cost was INR3.81/kg of shrimp.



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A: Treatment ponds									
Pond No	Pond area (ha)	SD PL/m <sup>2</sup>	DOC	ABW (g)	ADG (g)	SR (%)	Biomass (kg)	FCR	COP (INR)
T1	0.8	35	71	18.86	0.27	89	4,700	1.10	226
T2	0.8	36	82	24.40	0.30	84	5,903	1.17	248
T3	0.8	35	74	21.73	0.29	86	5,233	1.13	236
T4	0.8	35	73	20.73	0.28	87	5,050	1.16	242
Average	0.8	35.25	75	21.43	0.29	86.5	5,222	1.14	238

B: Control ponds									
Pond No	Pond area (ha)	SD PL/m <sup>2</sup>	DOC	ABW (g)	ADG (g)	SR (%)	Biomass (kg)	FCR	COP (INR)
C1	0.8	35	77	18.01	0.23	82	4,135	1.23	265
C2	0.8	36	95	24.00	0.25	78	5,391	1.31	288
C3	0.8	35	87	20.03	0.23	80	4,487	1.27	274
C4	0.8	35	86	20.12	0.23	79	4,451	1.29	281
Average	0.8	35.25	86.3	20.54	0.24	79.8	4,616	1.28	277

C: Summary of results									
Pond No	Pond area (ha)	SD/m <sup>2</sup>	DOC	ABW (g)	ADG (g)	SR (%)	Biomass (kg)	FCR	COP (INR)
Treatment	0.8	35.25	75	21.43	0.285	86.5	5222	1.14	238
Control	0.8	35.25	86.3	20.54	0.235	79.8	4616	1.28	277
Difference (+/-)	0	0	(-)11.3	0.89	0.05	6.7	606	(-) 0.14	(-) 39
Difference (+/-) in %	0	0	13.09	4.13	21.28	8.40	13.13	10.93	14.08

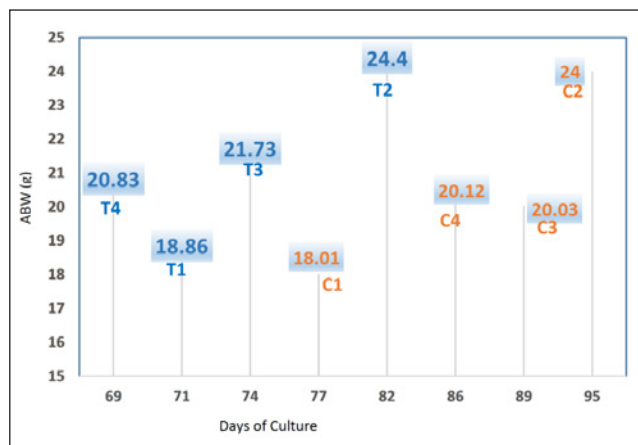
**Table 4.** Results from trials at the Growel R&D Farm as well as 27 customers farms across India conducted from July 2022 to March 2023. SD=stocking density; DOC= days of culture; ABW=average body weight; ADG=average daily growth; SR=survival rate; FCR=feed conversion ratio; COP=cost of production. A: treatment ponds; B: control ponds and C: Summary of results with % differences.

The general observations from these pond trials are that bioremediation plays a vital role in vannamei shrimp growth, survival rate and disease resistance by maintaining beneficial bacterial population and competitive exclusion of pathogenic bacteria in shrimp ponds throughout the crop cycle. In these trials we have shown that with the use of pond probiotics, at an additional cost of INR3.81 (USD0.05) per kg of shrimp, gave improvement in yields.

The average daily growth (ADG) of the harvest shrimp was 0.28g and 0.23g in bioremediation and control ponds, respectively. The difference was significant between two production systems. ADG was 18% higher in bioremediation ponds than in the control pond whereas shrimp production was 13.13% higher in bioremediation than control ponds (Tables 3 and 4 and Figure 4).

The average feed conversion ratio (FCR) and cost of production (COP) were lower in treatment ponds (1.14 and INR238/kg or USD 2.90/kg, respectively) compared to control ponds (1.28 and INR277/kg or USD3.38/kg, respectively). The average survival rate in treatment ponds was 8.4% higher than the control ponds due to good shrimp health condition throughout the crop cycle (Table 4).

Additionally, we observed that daily variation of water quality parameters (dissolved oxygen and pH) was minimal in treatment ponds. This reduced the stress levels for the shrimp (Table 5).



**Figure 4.** Growth performance of vannamei shrimp as average body weight (ABW in g) in treatment ponds T1-T4 (blue) and control ponds C1-C4 (orange). In treatment ponds, the ABW was 21.43g at DOC 75 due to better shrimp growth than in control ponds, where ABW was 20.54g at DOC 86. As most of the farmers prefer to harvest between 20 to 25g due to better farm gate prices and to get more crops per year, the crops in the treatment ponds were harvested earlier.

Water quality parameters		
Parameters	Treatment ponds	Control ponds
Dissolved oxygen (mg/L)		
Morning	4.11 ± 0.54	3.13 ± 0.59
Afternoon	7.2 ± 1.3	8.4 ± 1.1
Salinity (g/L)	12.0 ± 2.0	12.0 ± 3.0
pH	7.90 ± 0.40	8.20 ± 0.40
Temperature (°C)	29.20 ± 2.42	29.4 ± 2.6

**Table 5.** Summary of water quality parameters during the trials.

## Acknowledgement

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# How to achieve successful shrimp crops in Vietnam

With new practices of less water exchange and maintaining water quality with probiotics, Soc Trang farmer Anh Tai says he achieves higher survival rates at target harvest sizes, if he adheres to the pond carrying capacity

By Zuridah Merican



Nursery pond with shading holds 1000PL/m<sup>2</sup> of PL8

In conversations on the performance of the shrimp industry in Vietnam, industry players will give a regional picture of success rates of crop cycles, based on the pond system. In the central and northern region where more of the earthen ponds have HDPE liners, it ranges from 70-80% whereas in the southern region, namely in the Mekong Delta, it has been as low as 15% attributed to farming in unlined earthen ponds.

Additionally, in the south, the poor quality of shared water resources is a very serious concern. This raises the cost of water treatment which now comprises 10% of the cost of production. Success rate is taken as the percentage of crops with good margins. Another woe is the extremely high costs of production as compared to Vietnam's major competitors in the global shrimp market, namely India. In Vietnam the average cost of producing 20-25g shrimp is USD4.00/kg.

Soc Trang and Bạc Liêu in the Mekong Delta are the leading shrimp farming provinces, which produced 200,000 tonnes of vannamei shrimp in 2022. Feed company, Uni President Vietnam (UPV)'s technical team, based in Soc Trang, recently said that the success rate in Soc Trang has gone down to around 25%. Three years before, success rates were much better. Water salinity in the Mekong Delta ranges from 5 to 15ppt and at the lower salinity, farmers face soft shell shrimp. A popular yet costly practice over the last few years is to exchange pond water frequently. Today, an accepted practice is treating water in reservoir ponds, exchanging water as little as possible and using more pond probiotics.

Over the last few years, most of the leading shrimp feed millers in Vietnam have been developing culture models for their farmer clients. They have tackled water quality as the route against disease outbreaks and for more predictable harvests, thus improving success rates for their clients. These systems were on display at the recent VietShrimp 2023 (see pages 5-6).

## Control biomass and water exchange

One example is farmer Anh Tai in Soc Trang, who was exchanging water at 30-40% daily and now is only topping water at 30% over 3-4 days. He applies chlorine to his two water treatment ponds. He also follows protocols on water quality management with probiotics as suggested by UPV which have been selecting farmers facing challenges and grooming them to be successful. In Soc Trang, the strong team of Vu Trong Huy and Nguyen Van Minh Tuyen, two field technical managers, has been nurturing Tai to reach his target production of 50g shrimp at a much lower cost of production. "Here in Soc Trang, many farmers face issues with water quality. With the poor water quality in the Mekong Delta, intake water must go through four levels of water treatment. Despite this, *Vibrio* levels remain high and so we have proposed the use of water probiotics. Even though the probiotic dosage used is higher, in the end it is more cost effective for the farmer. Ultimately, the target is to reduce *Vibrio* loads and outbreaks of *Enterocytozoon hepatopenaeid* (EHP) and white faeces syndrome (WFS)," said Huy, technical advisor at the R&D Centre in Soc Trang.

UPV has been encouraging farmers to follow its pond and water management protocols. "Since 2022, we have conducted seminars weekly; in 300 demonstration ponds (3-4 ponds of 1,000m<sup>2</sup> to 1,500m<sup>2</sup> we have achieved 80% success rates. Of course, it was difficult during the pandemic period. Farmers reported many disease outbreaks, the most serious was WFS where the final result was slow growth. Other diseases are early mortality syndrome (EMS) or acute hepatopancreatic necrosis disease (AHPND) and EHP. In the background is white spot syndrome virus (WSSV)," said Huy.

The model that UPV has been proposing to shrimp farmers in Soc Trang is stocking PL8 at 1,300 -1,500 PL/m<sup>2</sup> in nursery ponds over 30 days to reach 1g. The stocking density in grow-out ponds is 200-220 PL/m<sup>2</sup>.



A 1000m<sup>2</sup> grow out pond where the dissolved oxygen is kept at 7mg/L.



The three ponds are in a row, close to each other so that transfer is a quick process. Harvesting and transferring shrimp. Anticlockwise from top left, harvesting 28g shrimp, weighing to get the biomass and then transfer to the next grow-out pond.

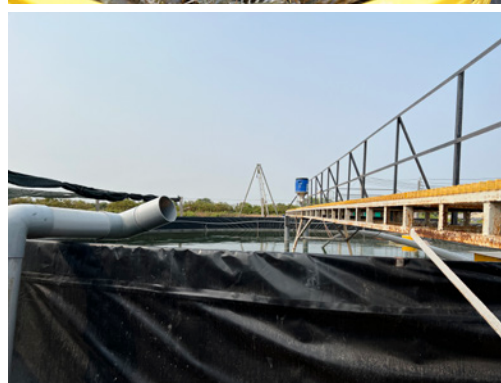
UPV Director Wu Sheng Wei who is the major force in this development of the UPV model, said, "Using the nursery phase and with our technical support, farmers can overcome the disease challenge during the first 30 days of culture (DOC), and look ahead to a higher survival rate. We have set '8 Protect Lines' to guide farmers on how to increase their success rates. These include feed nutrition, sludge removal, feed management, biomass control, water disinfection, probiotic bacteria system, health products and confidence."

Tai started shrimp farming, initially with the black tiger shrimp, when he was only 21 years. Today, at 34 years Tai has four ponds at his farm in Soc Trang in the Mekong Delta. "Disease is my worst nightmare. When I exchanged water, it not only was time consuming, but the survival rate was only 50%. Today with this new practice, I can achieve 90% survival rate. I remove the sludge three times daily and the

protein scum four times daily. I keep the dissolved oxygen level at 7 mg/L." Today, Tai is an exemplary farmer for UPV.

### A model with many phases

In Vietnam, the three main pond models are earthen ponds, lined earthen ponds and round tanks. Wei Che Wen, Asia Sales Manager said that UPV is suggesting two carrying capacity limits per tonne of water. "Depending on the pond system design, we specify from 2 to 2.2kg/tonne water for round tank systems and lined earthen ponds, and one kg/tonne water for earthen ponds. In round tanks and lined earthen ponds, the stocking density is 200 PL/m<sup>2</sup>. Partial harvesting is essential to achieve these carrying capacities. In final harvests the total production capacity can be 5kg shrimp per tonne of water. Our strategy is also to bring down the cost of production of 20-25g shrimp to under USD3.5/kg."



Main picture. Anh Tai with a new delivery of feeds, via motorcycle. Top right, 28g shrimp and a roundtank system at the R&D centre in Soc Trang.



At the pondside, Farmer Anh Tai (centre) with UPV's team in Soc Trang.

In the case of Tai, his pond now fits into the lined earthen pond model since they were lined with 0.5mm HPDE liners a year ago. His culture starts with a shaded nursery pond of 1,000m<sup>2</sup> stocking 1,000/m<sup>2</sup> post larvae (PL8) which come from the nearby Viet Uc hatchery. The nursery phase is over 30 days until shrimp reach 1g. Tai added, "I use as nursery feed, UPV's starter feed TOPONE, the premium grade feed with 45% crude protein." According to Wei, it is usual for farmers in the Mekong Delta to use this premium feed for the first DOC 40. Tai himself is convinced that using this feed helps him secure a steady crop. "I have achieved a feed conversion ratio (FCR) of 1.25 for a harvest size 43g with this feed," he said.

In the grow-out phase, Tai uses two 1,000m<sup>2</sup> ponds and transfers shrimp interchangeably as he fulfils the pond carrying capacity of 2kg/tonne of water. Ponds are aligned in a row, close to each other so that transfer is a quick process. Initially, 1g post larvae from the nursery pond are transferred into two parts of the first grow-out pond, one at a stocking density of 350 PL/m<sup>2</sup> and the other stocking at 175/m<sup>2</sup>. Shrimp from the pond portion with higher density are then moved to another pond to match the stocking density of 175 PL/m<sup>2</sup>.

Tai continues to spread out his shrimp over the three ponds as they grow. Such a practice is not unique to Tai's ponds but is a common practice all over Vietnam. What is unique here is using the premium feed to achieve 50g vannamei shrimp over a culture period of 4 months and 4 days.

According to Tai, "So far, for this season (stocking early December 2022), he has had two partial harvests which started when the crop reached size 55/kg (18g) at DOC 70. The volume was around 2 tonnes and next was another harvest of 4.5 tonnes of size 35/kg (28.6g) shrimp at DOC 105. The third harvest is 1.5 tonnes of size 25/kg (40g) at DOC 134 and the final harvest at DOC 142 for size 23/kg (43.5g) at 3.5 tonnes. After each partial harvest, Tai moves the shrimp in his three ponds to balance back the carrying capacity.

## R&D on the best water treatment and farming protocols

In general, shrimp culture is in earthen ponds and only 20% are in round tanks. The trend to line ponds with HDPE liner is catching up; in 2023, it was estimated that in Vietnam, only 30% of earthen ponds are lined and most of them are in the central region. The deterrent is the cost of liners. Nevertheless, when conducting research into developing management strategies at its R&D centre, UPV is taking into consideration the needs of all these three farmer groups, i.e., those operating earthen and lined ponds and round tanks.



Farmer Anh Tai, second left, with the UPV team during the visit. First row: from right, Tran Phuoc, Nguyen Van Le, Nguyen Ha My Xuan, Vo Thuy To Quyen and Nguyen Thi Nhat. Second row: from the right, Wei Che Wen, Ma Chin Tien (Director of Aquatic R&D Division) and Vu Trong Huy.

In Vietnam, genetics-wise, the preference is for fast growth and robustness, with the balanced line genetics proposed by three broodstock suppliers - Shrimp Improvement Systems (SIS), Kona and SyAqua. Charoen Pokphand has the turbo range of fast growth shrimp. "Farmers focus on fast growth of 30g shrimp in DOC 100. Working with feed conversion ratios, we calculate the feeding rate for each scenario and each farm. The average FCR is 1.4 but we work with farmers who strive for better success to achieve an FCR of at least 1.2-1.3. We want them to bring down their cost of production to under USD3.5/kg for size 50/kg shrimp. Considering partial harvesting we can also push for the harvest capacity to be at 5kg/tonne of water," said Wei.

The round tank production model is the central feature at the R&D centre in Soc Trang. UPV collaborated with Canadian startup, Wittaya Aqua on an innovative water treatment technology for the nursery and grow-out tanks. Each round tank for grow-out or nursery is associated with two treatment tanks for water settlement and treatment. "During the grow-out cycle, we exchange water every 4 days at 30% and for the nursery cycle we exchange water every 5 days at 20%. After each cycle, wastewater is channelled out if the water is not used for recycling. These practices depend on the ammonia, nitrate and nitrite levels in the water. There are six round tanks for grow-out and two for nursery culture," said Wei. "Our round tanks are 500 tonnes in capacity. However, in some farms, the capacities range from 800-1,000 tonnes.

"Ultimately, the aim at this centre is to develop the appropriate technology to increase productivity and reduce cost of production and bring up the success rate in Vietnam's shrimp farming," concluded Wei.



Uni-President Vietnam's team at VietShrimp 2023.

# Aquafeeds in 2022: Margins under pressure

For the feed miller, there is uncertainty with instability on costs of feed ingredients and feed demand as farmers encounter challenges in farming and lower ex-farm prices

In his presentation during TARS 2022 which was on Aquafeeds, Piet Verstraete, 4Sea Consulting Ltd showed three scenarios in Asia's aquafeed sector - margins under pressure, liquidity under pressure and solvency under pressure. With an example of vannamei shrimp feed in India, Verstraete showed that costs for the ingredients have increased by more than 40%, while feed price increases have been lagging behind. The situation in 2022 mirrored the title of our 2021 report "Asia's aquafeed players battle with rising costs," in issue May/June 2022.

Since mid-2020, it has been a never-ending battle - rising costs of feed production starting with high freight cost, followed by high prices of the major raw material prices namely soybean meal and corn. In 2022, wheat prices consequent to the Ukraine war began to rise. Feed millers initially resisted passing costs down to the farming segment; however, coming out of the pandemic they started to increase prices, albeit slowly and in stages. After almost two years of bearing low returns, where are feed millers with regards to margins i.e., can they see a full recovery soon? In this article some industry players discuss how they cope with the increase in ingredient prices, the effects of rising feed prices on their farmers' ability to continue farming, changes in market share and the resulting competitive landscape.



Pelleted shrimp feed for grow-out.

## Rising prices of feed ingredients

At the global level, the increase in prices of soybean meal, corn and wheat continues to escalate. Between Jan 2021 and May 2022, soybean and corn prices have climbed 60% and 74%, respectively. In Indonesia, at the local level in March, rice bran prices remained at IDR5,200/kg (USD0.34) and the effect was large as it comprised 12-30% of the total feed. "The difficulty in procuring ingredients also triggers competition with other feed-producing countries," said Deny Mulyono, Chairman of the Indonesian Feedmills Association or GPMT (kompas.id).



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Indonesia exports corn to Vietnam and the Philippines and GPMT hopes the Indonesian Ministry of Trade will limit the export of feed ingredients. “Although, local corn has lower energy values when compared to US corn, it is cheaper and can be an option by adjusting the formulation,” said Dr Budi Tangendjaja, USGC regional technical consultant in Indonesia, at a seminar in January 2023. Indian, feed millers struggled with high prices of soybean meal until the government allowed a certain quota of imports in May 2022.



“If a shrimp feed contains 20% fish meal, 20% soybean meal, and 2% fish oil, the cost increase for these three items alone is close to CNY1,000/tonne (USD141.9),” said Yufan Zhang.

### Higher feed prices and effects on the farmer

#### China

Dr Yufan Zhang, Alltech Aqua Development Manager China and Technical Manager for Southeast Asia, said that in 2022, China’s aqua feed companies may have initiated five to six price increases. In the end, the total increase of fish feed is about CNY800/tonne (USD113.2) and for shrimp feed, it was more than CNY1,000/tonne (USD 141.5).

The main reason for the price increases has been the sharp rise in the costs of ingredients: fishmeal increased from CNY12,000/tonne (USD1,698.5) to CNY14,000/tonne (USD1,981.7), soybean meal increased from CNY3,500/tonne (USD495.4) to CNY4,700/tonne (USD665.3) and fish oil increased from CNY14,000/tonne (USD1,981.6) to nearly CNY30,000/tonne (USD4,246.3). “If a shrimp feed contains 20% fish meal, 20% soybean meal, and 2% fish oil, the cost increase for these three items alone is close to CNY1,000/tonne (USD 141.9),” said Zhang.

High feed prices in China will translate to a higher dependence on financial support. There was no significant effect until the end of 2022 and early 2023. “What we saw was large shrimp sold at low prices, and farmers suffering huge losses. Then, feed distributors could not collect credit payment and could not support farmers, dampening their enthusiasm to farm.”

#### India

The price increase for shrimp feed was small at only 5% from INR80/kg (USD0.96) to INR84/kg (USD1.01). There has been increases of 8-10% for several feed ingredients while it was from 6-8% for fishmeal, Hipro soy at 7-9% and wheat flour at 20-25%. These are feed ingredients for shrimp feed. Fish feed prices increased at 8.5% from INR35.5/kg (USD0.42) to INR38.5/kg (USD0.46). The cost of feed production was affected by increases in costs for energy at 7-8% and labour at 5-6%.

“Most of the farmers suffered losses. This meant that the new stocking was slow for this year, due to cash flow issues and minimal credit support from distributors. The fish sector was good compared to previous years due to consistent market prices,” explained Seshu Akkina, COO Deepak Nexgen Feeds.



“Shrimp farming was down but mainly because of low prices and disease outbreaks rather than an effect of higher feed prices,” said Haris Muhtadi.

#### Indonesia

Indonesian feed millers increased prices slowly. “On average, increases were 10% i.e., IDR1,500/kg (USD0.10) for shrimp feeds and for fish feeds, it was around IDR1,100/kg (USD0.07) which was an 11% increase,” said Sales Director of CJ Feed and Care Indonesia Haris Muhtadi. The increases were for soybean meal at 30%, labour at 4% and other feed ingredients at 20%. “Shrimp farming was down but mainly because of low prices and disease outbreaks rather than an effect of higher feed prices.”

#### Thailand

Since 2020, Thai feed companies have increased prices of shrimp feed three times and by about 9-12%. “The last time we saw an increase was in October 2022. But the costs of all ingredients have increased at no less than 20-30%. For example, fishmeal increased by 40%, from THB33/kg (USD0.95) to THB51/kg (USD1.47). Therefore, it has been difficult for all sectors. In 2023, we have not seen any price increases yet,” said Vinij Tansakul, Aquaculture Consultant. (Figure 1). In Thailand, feed millers need the authorisation of the government to raise prices.

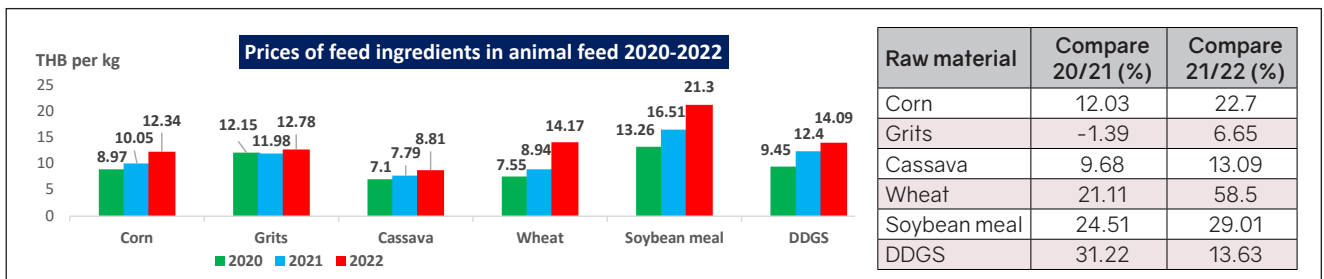


Figure 1. Three-year prices of raw materials used in animal feed 2020-2022. Courtesy of Vinij Tansakul. Source: Thai Feedmill Association.



“Although we estimate that the overall aquaculture feed market was reduced by 15-20%, we continued to increase our share of the feed market.”  
said Jeff Chuang Jie-Cheng.

**Vietnam**

There have been price increases totalling 10-10.5% for shrimp feeds. In the case of snakehead and tilapia feeds, the increases were 11.3 and 12%, respectively. The justification was increasing costs of feed ingredients - fish meal (+32%), soybean meal (+16%); wheat flour (+31%), fish oil by (+12.7%) and others at 10-16% as well as the increasing cost of feed production itself. “Feed prices are higher than in 2019 but unfortunately, the margins of feed companies are declining,” said Jeff Chuang Jie-Cheng, General Manager at Sheng Long Bio-Tech International, Vietnam.

“Over the past two years, 2021 to 2022, prices of shrimp and fish feeds in Vietnam have increased by around USD200/tonne due to soaring costs. At the same time, the ex-farm price of fish and shrimp were low. Shrimp farmers were also suffering from huge losses from disease. There was panic and loss of confidence to restock. Feed distributors controlled their investment in feed and in giving out credit,” added Chuang.

“Although we estimate that the overall aquaculture feed market was reduced by 15-20%, we continued to increase our share of the feed market. We believe that we are benefitting from our technological transformation and advancement in feed formulation to drive our competitiveness.”

**Production trends and challenges in 2022**

Table 1 gives some estimations on aquafeed production. In India, the fish feed production of 1.1 million tonnes in 2022 was mainly for the pangasius fish at 0.7-0.8 million tonnes, 0.2 million tonnes for roopchand or pacu and the rest, feeds for the carps. Malaysia’s shrimp feed usage was estimated to be at the same level as in 2021, since shrimp disease outbreaks and slow growth have been serious, particularly, in southern Peninsular Malaysia and in Sabah in 2022 and into 2023. An industry source said that farms are considered successful even if they harvest 15g shrimp.



Kusuma Dewi Tjahyono, Vice President, PT Japfa Comfeed Indonesia (third right) and some feed players at the USGC seminar in Jakarta in January 2023.

Country	Estimates on aquafeed production (tonnes)			
	2022		2021*	
	Shrimp feeds	Fish feeds	Shrimp feeds	Fish feeds
China	2,500,000* (incl crab feeds)	19,500,000	1,100,000 -1,500,000	18,000,000
India	1,000,000	1,100,000	1,350,000	650,000 -1,000,000
Indonesia	405,000	1,310,000	423,500	1,230,000
Malaysia	90,000 -100,000	110,000	NA	NA
Philippines	120,000	867,000 (incl 520,000 milkfish and 347,000 tilapia feeds)	NA	NA
Thailand	481,000	664,000	464,000	540,000
Vietnam	750,000 -760,000	2,370,000 (incl 1,300,000 for the pangasius and 70,000 marine fish feeds)	930,000	2,450,000 (1,400,000 pangasius feeds)

\* Source: 2021, see AAP 2022; Data for Indonesia - GPMT; Thailand-Thai Feed Mill Association; All data for Malaysia, Philippines and India include local and imported feeds.

**Table 1.** Some industry estimates on aquafeed production (tonnes) in selected countries in 2022 and compared with published estimates for 2021.

**Feed production capacity and competition**

In India, the production capacity for fish feed is around 2.2 million tonnes per year (tpy) and only 45% has been utilised. The shrimp feed production capacity is around 3-3.2 million tpy and the utilisation is lower at 31%. Recently, more capacity was added with Skretting India’s new feed plant in Gujarat to produce both shrimp and fish feeds. Given the small market for shrimp feed in India’s west coast, industry players expect a tough competitive environment among three aquafeed companies. They said that demand can be created by providing credit facilities, but farmers have a choice of shifting to a new feed brand when the credit dries up.

According to Romi Novriadi, Ministry of Marine Affairs and Fisheries, Indonesia had 44 feed mills in 2022 and total production capacity was 3.4 million tpy (Novriadi, 2022). In addition, there are 11 small scale government aquafeed plants supplying an annual 4,224 tonnes/year fish feed.

**Margins and market share**

Regional industry players said that margins have been greatly squeezed as the increases in costs (ingredients and production) have been higher than the feed price increases. Some say that with more competition in the industry, not every price increase can be put in place. Often there is net zero increase when discounts are applied. In the very challenging shrimp feed segment, it may be years before they can see the returns of good margins. An approach is to retain dedicated customers who believe that “if the feed quality is good, they will not change their feed”. A feed miller lamented on difficulties of having margins when encountering soaring prices of super prime fishmeal and of cholesterol for their premium feed brands.



"We are happy that we can retain our shrimp feed market share. In fact, we became the second largest feed company in 2022." said Seshu Akkina.



"... some middle-sized and small businesses may have increased sales, because they sell feed at lower prices and their cost of marketing is a lot less," said Vinij Tansakul.

Haris added, "So far, we have managed to secure our market but we work hard by assigning technical teams to farms to support shrimp farmers. We provide more lab services and most importantly, maintain feed quality, despite rising costs."

"In India, most feed companies are suffering heavy losses. We are happy that we can retain our shrimp feed market share. We expanded our dealership network in many new areas and our ifeed brand grew stronger in the market adding volumes YoY. Most of the small and marginal feed companies also lost their markets as farmers are showing more interest in high performance feeds," said Seshu. "In fact, we became the second largest feed company in 2022."

In Thailand, the increasing market share of a company was attributed to forward purchases of ingredients. Otherwise Tansakul said that in Thailand, it is very challenging to determine whether market share is shrinking. "Competition is fierce among the large feed millers. It is possible that the overall sales volume of large feed companies could have decreased by 5-10% while some middle-sized and small businesses may have increased sales, because they sell feed at lower prices and their cost of marketing is a lot less."

Zhang said that the market for functional additives is shrinking amid soaring feed costs and increased competition in the industry. "In China, Alltech aqua business is transitioning towards aqua animal health product development. We have developed a series of small packaging products to be used at the farm level. We enhanced the cooperation with local aqua animal health companies. In this segment, we have had more than 100% growth in the past year."

### Competitive landscape

Tansakul commented, "Diversifying feed formulations is a marketing strategy that most businesses adopt. There are formulations for preventing disease and producing attractive colours; mixed functional feeds including those tailored to the requirements of the users, particularly large farms. Some popular marketing strategies also include lower prices for cash payments, extension of credit terms and providing academic training at clients' farms and in farming areas."

However, to maintain performance and efficiency, aquafeed feed miller have been diversifying to early-stage feeds, petfood and even to animal feed. In Thailand, the emphasis is on production of healthy pet food to compete in the highly competitive animal feed industry. Some feed mills have invested in solar energy to reduce global warming and save energy costs.

It is getting to be very crowded in Indonesia's shrimp feed segment. The latest addition is the Thai Union Feed Mill and Avanti JV's plant in Surabaya, completed at the end of 2021. This will add another 36,000 tpy to national production capacity.

Haris said that with the full throttle of investors mainly from China, the market is very competitive, in terms of prices and services. Some offer attractive credit terms. Therefore, there is push to improve technical services such as lab services for disease and water quality monitoring. Providing post larvae is almost mandatory. As a comparison, the total shrimp feed manufacturing capacity in Ecuador is estimated to be around 2.1 million tpy with actual demand around 2 million tonnes in 2022 (Shrimp Insights, 2022).

### Low protein versus high protein shrimp feeds

Particularly in Vietnam, Thailand and Malaysia, most farmers prefer the highest quality grow-out feed, with more than 40% crude protein for fast growth of shrimp, albeit at higher costs. Wei Che Wen, Sales and Marketing Manager, Uni President Vietnam, said that its farmers in Vietnam and those in East Malaysia usually opt for starter feeds with at least 42% crude protein (%CP).

In Vietnam, Chuang presented two scenarios. With the high risk of disease, price hikes coupled with unprofitable shrimp prices, traditional farmers with earthen ponds have switched to low-protein shrimp feeds. "The success rate is low. For us, it is difficult to judge the cost-effectiveness of these feeds. The demand for low-protein feeds will still be there. On the other hand, those practising high-density farming in lined earthen ponds, will not consider using low-protein feeds at all, because the FCR will be lower and culture period longer."

Haris countered that in Indonesia, the trend is that farmers choose 30%CP feed pellets and 32%CP crumbles. The feed standard in Thailand specifies that vannamei feed must contain at least 32%CP. Tansakul said that the use of low-protein shrimp feed is not a popular trend. "Most Thai shrimp farmers now widely believe that shrimp can only thrive on high-protein feed and that they can only get successful yields by using such feeds."

Zhang said, "Chinese farmers still pay more attention to yield per unit area and FCR which means that there is a high demand for high protein feeds. Of course, this also brings certain risks to the success rate of farming. In general, there is no obvious trend towards low protein feeds in the Chinese market."

## What to expect in 2023

On whether he expects more price increases in 2023, Seshu said that there are no plans, but this will depend on feed production costs in the coming months. "In India, I expect a lower demand at only 0.9-1.0 million tonnes of shrimp feed but more for fish feeds at 1.2-1.3 million tonnes for 2023. This is because around 15-20% of shrimp farmers have switched to fish farming."

Haris expects the Indonesian feed demand to be better at 1.38 million tonnes for fish feed and 415,000 tonnes for shrimp feed. Contrastingly, Zhang expects a more than 10% reduction in the aquafeed market in China, since its decline is already seen, in the first quarter of 2023. Chuang is more optimistic.

"There are the negative impacts including serious outbreaks of shrimp diseases, unstable global situation and the sharp decline in market demand. Therefore, we estimated that the demand for aquafeeds in Vietnam will remain similar as in 2022."

### Will there be another price increase?

Chuang said yes, "The fish and shrimp feed prices have increased by 1.5-2.0% in the first half of 2023. In the second half of this year, we expect an upward trend in prices for animal and plant proteins, starch and fish oil. So the feed price is estimated to increase by another 2-3% range."

Haris said that although the prices are relatively stable, perhaps an increase of 4% is forthcoming.

"At the beginning of this year, prices of ingredients were already high, and that of fish meal is still bullish. However, I expect that in the end, the price of fish and shrimp will restrain the demand of fish meal to some extent. So, I do not think that feed prices will rise more than 5% this year," said Zhang.

Lastly Zhang had this to say, "The most worrying issue this year is the financial supply chain of feed production and distribution. Chinese farmers are dependent on the credit support of distributors, and the distributors also partly rely on the financial (credit) support of feed mills. If it is difficult for farmers to be profitable, the financial situation of the whole industry is affected. If the economy does not pick up as expected in the second half of this year, some companies with aggressive selling strategies last year may be under great financial pressure."

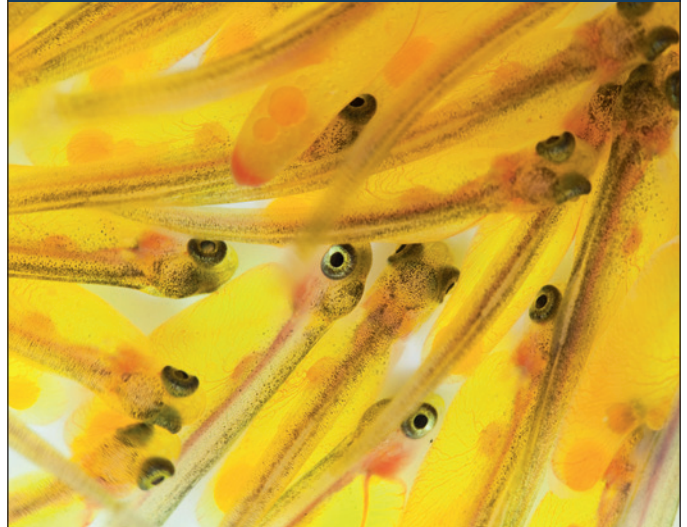
### Acknowledgements

*This is a review on the aquafeed industry in Asia published annually. We would like to express our sincere gratitude to those mentioned in this article and other industry stakeholders who have willingly provided information but have requested to remain anonymous.*

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# Nucleotides, a tool to enhance performance, profitability and disease resistance in Pacific white shrimp

In commercial trials in Indonesia, nucleotides were added to shrimp diets where fishmeal was partially replaced with soybean meal.

By Samuel Correa

Nucleotides have many important physiological and biochemical functions. Despite being synthesised by the body itself, exogenous nucleotide-supplementation is indispensable under certain physiological conditions, such as growth, immuno-compromised animals or starvation as well as in diseased animals (Ding et al., 2021)

Nucleotide supplementation has been extensively studied in animal nutrition. During the weaning period of lactating mammals, nucleotide intake is significantly reduced as milk has a higher content of nucleotides (Mateo and Stein) compared to the relatively low concentration of nucleotides used in the feed ingredients (Yu, 1998). In shrimp, a similar situation occurs during the transition from egg to larva, as embryonic development relies on the nutrients (proteins, lipids and nucleotides) accumulated in oocytes during vitellogenesis (Li et al., 2022). Nucleotide availability will therefore be reduced post hatching.

Availability of nucleotides may be limited in rapidly proliferating tissues, such as immune and gastrointestinal system. In juvenile animals, an exogenous supply of nucleotides might become very important since *de novo* synthesis is insufficient to meet their requirements (Yu, 1998).

## Dietary nucleotides

Dietary nucleotides are typically derived from the cytoplasm of yeast cells from nucleic acids that reside in the cells

core. Nucleotides and their derivatives are multifunctional in nature; they are used for short-term energy storage, for intra- and extra-cellular signalling, as enzyme cofactors and for the synthesis of DNA and RNA (Yu, 1998).

When considering a source of exogenous nucleotides for dietary supplementation, it is important to consider products with a high concentration of free nucleotides, as they are more easily absorbed by the intestine, as opposed to products reporting only total nucleotide content, which consider the nucleotides intrinsic in nucleoproteins or nucleic acid chains. The availability of total nucleotides is reduced in young animals, due to their limited secretion of proteolytic enzymes and nucleases.

## Nucleotide supplementation in the Pacific white shrimp

To demonstrate the positive effects of nucleotide supplementation in the Pacific white shrimp *Litopenaeus vannamei*, two trials were conducted, namely under research conditions (Trial 1) and commercial farm conditions (Trial 2). Both trials had the same objective, which was to evaluate the effects of nucleotides in shrimp performance, immunity, disease resistance and profitability. In both trials, there was a partial replacement of fishmeal (FM) by soybean meal (SBM) and shrimp were challenged with *Vibrio harveyi*. The experimental conditions of both trials are summarised in Table 1.

	No of shrimp	Study Groups	Length of trial
Trial 1	900 in 60 98L tanks with 6 replicates per treatment	<b>10 study groups (90 shrimp/group)</b>	70 days. After the 70-day performance challenge, a 7-day disease challenge was conducted with <i>Vibrio harveyi</i> at $1 \times 10^5$ CFU/mL administered intramuscularly.
		Control (10% FM)	
		Diet 1 (5% FM)	
		Diet 2 (10% FM; 0.05% NT)	
		Diet 3 (10% FM; 0.1% NT)	
		Diet 4 (8% FM; 0.05% NT)	
		Diet 5 (8% FM; 0.1% NT)	
		Diet 6 (6% FM; 0.05% NT)	
		Diet 7 (6% FM; 0.1% NT)	
		Diet 8 (3% FM; 0.05% NT)	
Diet 9 (3% FM; 0.1% NT)			
Trial 2	22,500 in two commercial ponds (20 x 30 m) in 10 replicates per treatment	<b>5 study groups (4,500 shrimp/group)</b>	110 days. From day 30, shrimp were challenged over 5 days with <i>Vibrio harveyi</i> at $1 \times 10^5$ CFU/mL administered intramuscularly.
		Control (10% FM)	
		Low FM (6% FM)	
		10 FMN (10% FM; 0.1% NT)	
		8 FMN (8% FM; 0.1% NT)	
6 FMN (6% FM; 0.1% NT)			

**Table 1.** Experimental conditions of both trials. NT=Nucleotides; FM= Fishmeal

Ingredient (%)	Treatment Diets									
	Control	D1	D2	D3	D4	D5	D6	D7	D8	D9
FM	10	5	10	10	8	8	6	6	3	3
SBM	43	50	45.85	45.85	44.80	44.80	47.5	47.5	51.85	51.85
Nucleotides	0	0	0.05	0.1	0.05	0.1	0.05	0.1	0.05	0.1
Corn starch	8.06	6.06	5.16	5.16	8.21	8.21	7.51	7.51	6.16	6.16
Crude protein	35.72	34.91	35.84	35.81	35.42	35.77	35.48	35.77	35.39	35.24

**Table 2.** Diets were formulated to be isonitrogenous and isolipidic (35% protein and 8% lipid) and contained two inclusion levels of nucleotide and fed to Pacific white shrimp for 70 days.

Ingredient (%)	Treatment Diets				
	10 FM	6 FM	10 FMN	8 FMN	6 FMN
FM	10	6	10	8	6
SBM	43	49.5	43	44.80	49.5
Nucleotides	0	0	0.1	0.1	0.1
Corn starch	8.06	5.56	7.96	8.16	5.46
Formulation cost (USD/kg) in June 2021.	0.9178	0.8892	0.9553	0.9414	0.9267

**Table 3.** Composition of variable ingredients of diets used in the study. Diets were fed to the shrimp for 110 days and were formulated using different levels of fishmeal (FM) and with or without adding dietary nucleotides.

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## Fish meal replacement by soybean meal

Asian feed millers are facing the challenge of using alternative ingredients to replace FM and fish oil in shrimp feed to reduce reliance on wild-caught fish (Quan, 1992). Besides, higher costs of FM when compared to SBM have led to an increased practice of replacing FM by SBM.

Nucleotide supplementation in shrimp diets with reduced content of FM and higher inclusion of SBM has proved to be an effective mechanism to counter the negative effects of SBM on protein digestibility and the alteration of the structure of intestinal cells and intestinal microbiota. This can be explained because nucleotides play an important role as physiological mediators, coenzyme components and contributors to cell growth and division, being crucial to the rapid proliferation of such cells as the intestinal mucosa. Moreover, several clinical studies reported beneficial effects of nucleotides on gut microflora (Reantaso et al., 2013).

## Growth performance

Positive effects of nucleotides were observed in both trials. It could be observed that groups including nucleotide supplementation with the same percentage of FM had better performance when compared to those without nucleotide inclusion. Furthermore, groups with low percentage of FM and nucleotide supplementation, were not inferior in terms of growth performance when compared to control groups. Results obtained from Trials 1 and 2 are shown in Table 4 and Table 5 respectively.

Diet	Final biomass (g)	FMW (g)	FCR	WG (%)	Survival (%)
Control	217.43	16.50	2.80	290.99	87.78
Diet 1	222.97	15.74	2.95	272.78	96.67
Diet 2	219.02	16.21	2.85	283.59	90.00
Diet 3	215.41	16.65	2.79	294.89	86.67
Diet 4	232.42	16.58	2.80	292.00	93.33
Diet 5	235.40	16.76	2.78	298.48	93.33
Diet 6	231.73	16.55	2.79	291.52	93.33
Diet 7	215.37	16.38	2.83	286.60	87.78
Diet 8	230.98	16.33	2.83	286.09	94.43
Diet 9	225.55	16.86	2.75	300.38	88.89

FMW = final mean weight; FCR = feed conversion ratio; WG = weight gain

**Table 4.** Growth performance of Pacific white shrimp fed experimental diets for 70 days. Values represent the mean of six replicates.

Diet	Final biomass (g)	FMW (g)	FCR	ADG (g/d)	Survival pre-challenge (%)
10 FM	7,604	20.05 <sup>a</sup>	1.36 <sup>a</sup>	0.173 <sup>a</sup>	83.31
6 FM	7,405.5	19.44 <sup>b</sup>	1.40 <sup>b</sup>	0.167 <sup>b</sup>	83.91
10 FMN	7,652.5	20.28 <sup>a</sup>	1.34 <sup>a</sup>	0.175 <sup>a</sup>	83.84
8 FMN	7,521	19.98 <sup>a</sup>	1.37 <sup>a</sup>	0.173 <sup>a</sup>	84.67
6 FMN	7,534	19.95 <sup>a</sup>	1.37 <sup>a</sup>	0.172 <sup>a</sup>	83.93

FBW = final body weight; FCR = feed conversion ratio; ADG = average daily gain

**Table 5.** Growth performance of Pacific white shrimp fed experimental diets supplemented with nucleotide for 110 days. Results in the same columns with different superscript letters are significantly different ( $p < 0.05$ ).

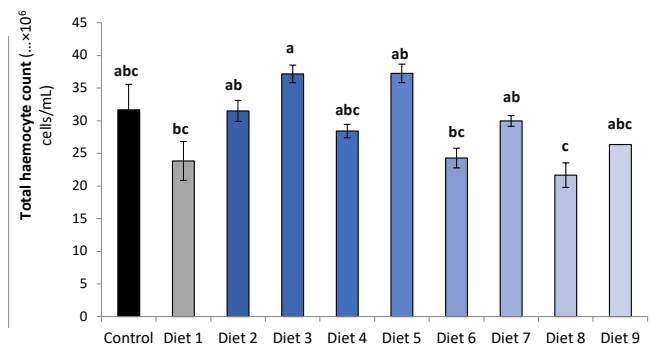
## Shrimp immune system and resistance to disease

Many studies have demonstrated the effects of nucleotides as immunomodulators in vertebrates. However, there is a lack of understanding on how nucleotides may affect the immune system of shrimp as they lack an adaptive immune system. Shrimp rely on their innate immunity, which is activated by the recognition of different microbial cellular components. Cellular defense is directly mediated by haemocytes and involves various processes (phagocytosis, encapsulation, nodule formation, coagulation, apoptosis, etc.). Humoral components include the activation of different cascade systems and release of molecules accumulated within the haemocytes (prophenoloxidase activating system, antioxidant system, agglutinins, protease-inhibitors, anti-microbial peptides, lysozyme, etc.) according to Aquaneo.

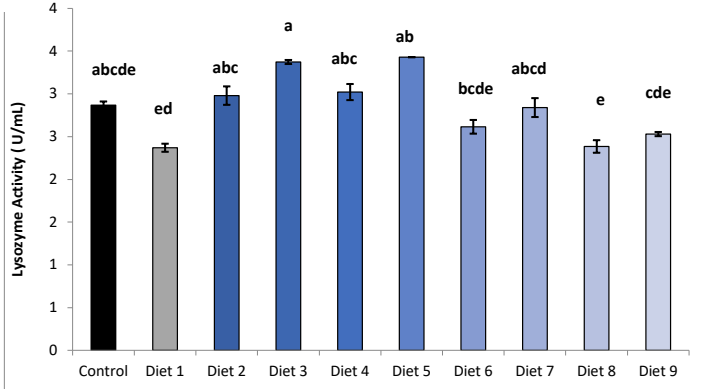
The study conducted by Wu et al. (2008), showed that haemocyte count dramatically decreases during infections or environmental stress. Ancieta-Probstl et al. (2005) demonstrated that the haemocyte counts increased by more than 100% in juvenile shrimp and by 30% in larger shrimp after nucleotide supplementation.

Nucleotide's function may be explained by their participation on the intracellular signalling cascades leading to the activation of cellular and humoral immune responses. Their function may be enhanced during cellular stressful situations, where nucleotides may provide substrate for RNA and DNA synthesis for haemocyte production and humoral response activation.

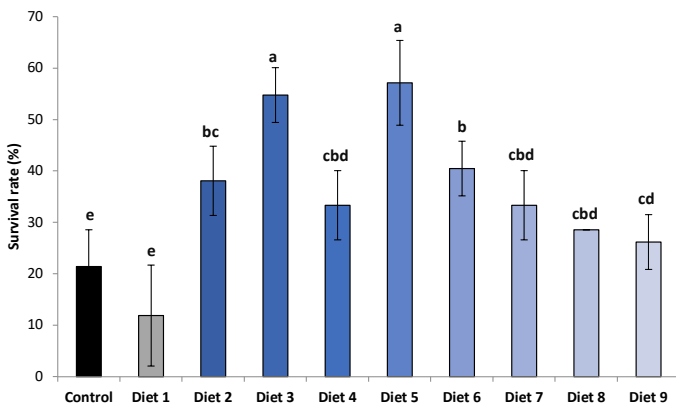
In both trials, numerically higher values of total haemocyte count (THC) and lysozyme activity were found in nucleotide supplemented groups. Results of Trial 1 showed a significant increase of THC and lysozyme activity in groups containing nucleotides. Moreover, a dose effect was observed for nucleotides, with 0.1% achieving better results than 0.05%. (Figures 1 and 2). This may be associated with the higher survival rates seen in both trials when shrimp was challenged with *V. harveyi*. Figure 3 showed the survival rates from Trial 1 and Figure 4 that of Trial 2.



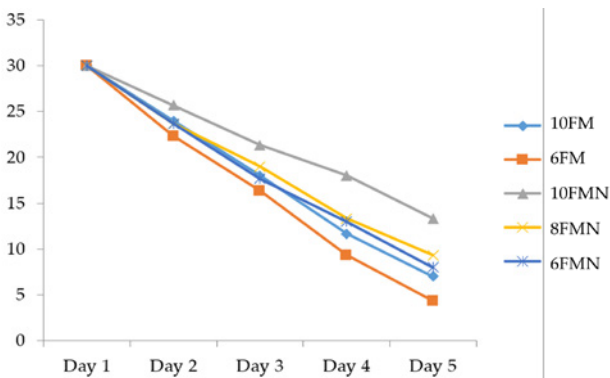
**Figure 1.** Total haemocyte count (THC) of Pacific white shrimp ( $10^6$  cell/mL) at the end of the growth in Trial 1. Different letters indicate statistically significant differences ( $p < 0.05$ ). Values represent the mean of six replicates. All diets containing the same initial letters, show no statistically significant differences between each other. For example, control, diet 2, 3, 4, 5, 7 and 9 showed no statistically significant differences between each other.



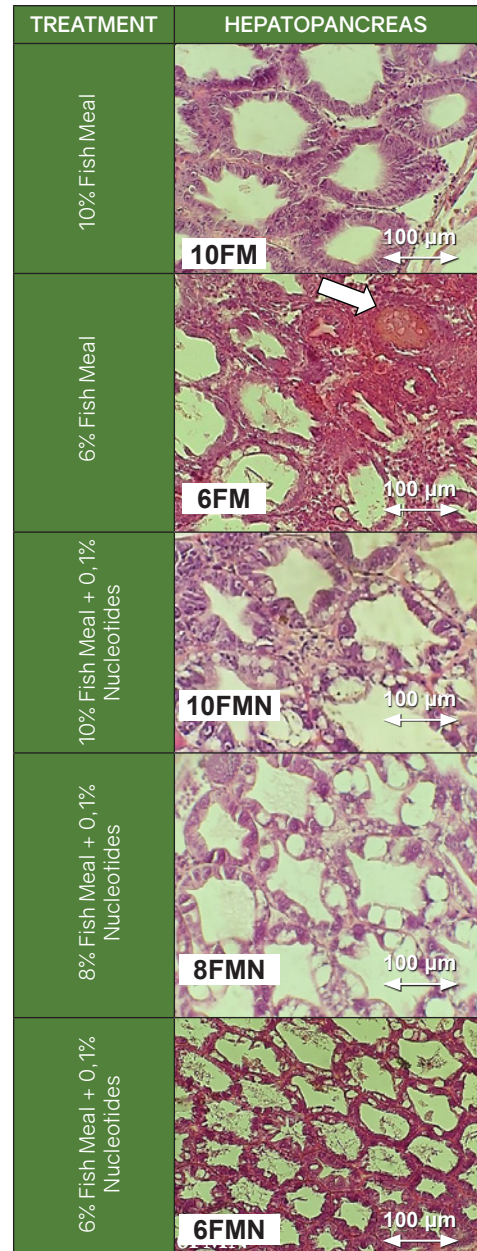
**Figure 2.** Lysozyme activity of Pacific white shrimp (U/mL) at the end of the growth in Trial 1. Different letters indicate statistically significant differences ( $p < 0.05$ ). Values represent the mean of six replicates.



**Figure 3. Trial 1:** Survival rates of white shrimp over 7 day- period after the challenge test with *Vibrio harveyi* ( $10^5$  CFU/mL). Results in the same columns with different superscript letters are significantly different ( $p < 0.05$ ). Values represent the mean of six replicates.



**Figure 4. Trial 2:** Mean survival rate in Pacific white shrimp over 5 days after the challenge test with *Vibrio harveyi* ( $10^5$  CFU/mL). Values represent the mean of ten replicates.



**Figure 5.** Representative histopathological images of the hepatopancreas from Pacific white shrimp belonging to different study groups. The white arrow points to vacuolation observed in the 6FM group, the result of replacing fish meal with vegetable protein sources.

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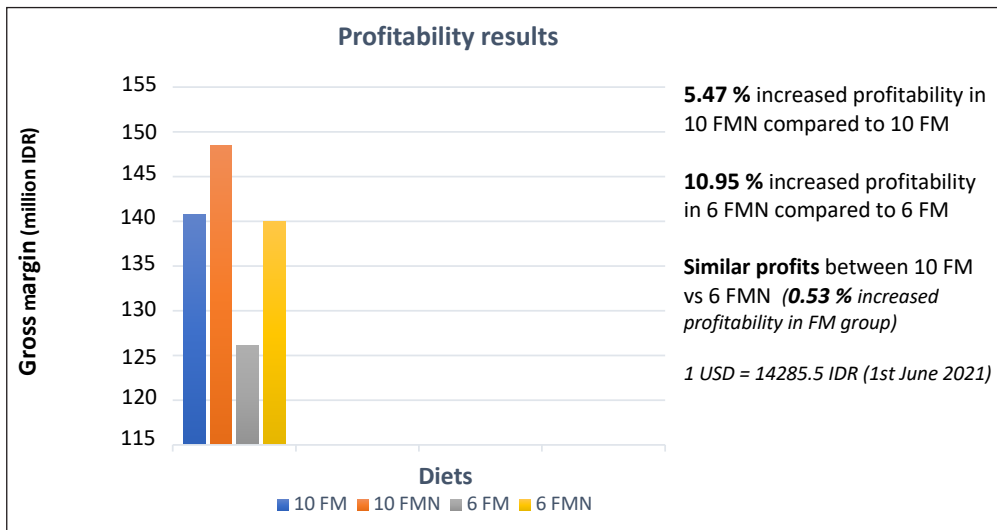


Figure 6. Profitability results.

### Nucleotides increase profitability

In Trial 2, an economic evaluation regarding the inclusion of nucleotides was performed. The results are shown in Figure 6. With 10FMN diets, the gross margin was IDR148,461,501 (USD9,041.3) as compared to gross margin of IDR140,757,291 (USD9,425.6) for 10FM diets. With 6FMN diets, the gross margin was IDR140,010,741 (USD9,374.5), compared to 6FM diets at IDR126,197,614 (USD8,452.2). On the other hand, similar profits were achieved with 6FMN and 10FM diets at gross margins of IDR140,010,741 (USD9,374.5) and IDR140,757,291 (USD 9,425.6), respectively.

### Conclusions

Both studies confirmed that nucleotide supplementation in Pacific white shrimp improved performance, as well as enhanced the immune system, which may be linked to higher survival rates when challenged with *V. harveyi*. These beneficial effects of nucleotides were more significant when FM was partially replaced by SBM. Besides, the inclusion of nucleotides increased profitability outcomes. Based on the results, the 0.1% nucleotide supplementation could be considered as a complementary tool to enhance shrimp production.

### References

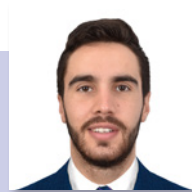
The main references for these trials are as below. Other references are available on request.

#### Trial 1:

Novriadi, R., Ilham, I., Roigé, O., Segarra, S. 2021. Effects of dietary nucleotides supplementation on growth, total haemocyte count, lysozyme activity and survival upon challenge with *Vibrio harveyi* in Pacific white shrimp, *Litopenaeus vannamei*. Aquaculture Reports, 21, 100840. <https://doi.org/10.1016/j.aqrep.2021.100840>

#### Trial 2:

Novriadi, R., Ilham, I., Roigé, O., Segarra, S. 2022. Effects of dietary nucleotide supplementation on performance, profitability and disease resistance of *Litopenaeus vannamei* cultured in Indonesia under intensive outdoor pond conditions. Animals 2022, 12, 2036. <https://doi.org/10.3390/ani12162036>



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# NEXT ISSUES

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**Issue focus:** Aquaculture Innovations

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**Feed/Production Technology:** Larval & Nursery Feeds; Feed Management

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# Efficacy of a phytobiotic-based additive to reduce the severity of EHP-WFS outbreaks in field conditions

A series of field trials in Indonesia, Malaysia, India and China, over a six-year period assessed the effectiveness of the additive in reducing the severity of WFS and EHP infections.

By I-Tung Chen, Martha Mamora, Maria Mercè Isern-Subich and Waldo G. Nuez-Ortín

**W**hite faeces syndrome (WFS) is a multifactorial syndrome affecting farmed shrimp. It results from the interaction of various factors, including poor-quality nutritional sources, environmental stressors and multiple infectious agents. WFS is characterised by the white discolouration in the shrimp gastrointestinal tract and the appearance of floating white faecal strings on the pond water. Other clinical signs include loss of appetite, slow growth, high size variation, and softshell. WFS has become a significant challenge to aquaculture, especially in major shrimp-producing regions across Asia.

Recent studies indicate a unique combination of pathogenic *Vibrio* spp. and *Enterocytozoon hepatopenaei* (EHP), an intracellular microsporidian parasite infecting shrimp hepatopancreas, is required to induce WFS in the whiteleg shrimp, *Penaeus vannamei* (Aranguren Caro et al., 2021). EHP plays a critical role as a primary pathogen that intensifies the impact of opportunistic bacteria like *Vibrio* spp. resulting in WFS.

Disease prevention strategies are mainly focused on implementing pond management and strict biosecurity measures to minimise the introduction of diseases. Also, an important preventive approach is functional nutrition aimed to reduce the load of EHP and *Vibrio* in the digestive tract of shrimp.

Sanacore®GM (Adisseo) is a functional additive based on a synergetic blend of phytobiotic extracts with broad spectrum inhibitory activity against bacteria and parasites. The mode of action of the additive also includes the modulation of the dysbiosis generated by infection and anti-inflammatory action. Sanacore®GM can be administered via feed to reduce the severity of infection of EHP-WFS.

## Fields trials on preventive and corrective strategies

The present article describes various field tests demonstrating the efficacy of Sanacore®GM against EHP and WFS under different farming conditions e.g., climates,

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Ponds at the test farm in Lampung, Indonesia

pond designs, stocking densities and disease history. Over a period of six years (2016-2022), a series of field trials were conducted in Indonesia, Malaysia, India and China to assess the effectiveness of the additive in reducing the severity of WFS and EHP infections. Disease outbreaks were associated with the presence of other pathogens, including white spot disease (WSD) and acute hepatopancreatic necrosis disease (AHPND, Table 1).

Location		Disease History	
Indonesia	Subang-West Java	WFS, EHP, WSSV, IMNV	Failure for the last 2 crops
Indonesia	Bratasena-Lampung	WFS, EHP, Vibriosis	Outbreak at DOC 30-40, SR max 50% with FCR 1.7 for last 4 crops
Malaysia	Penang	WFS, AHPND, WSSV	Outbreak at DOC 40-60
India	Balasore-Odisha	WFS, WSSV	Outbreak at DOC 30-60; SR 30-40%
China	Guangdong	Vibriosis	Failure for the last 2 crops, SR 10-20%

**Table 1.** History of disease outbreaks (white faeces syndrome (WFS), *Enterocytozoon hepatopenaei* (EHP), white spot syndrome virus (WSSV), infectious myonecrosis virus (IMNV) in the selected test farms. DOC=days of culture; SR=survival rate; FCR=feed conversion ratios.

Three strategies, namely preventive, corrective, and preventive plus corrective, were evaluated (Table 2). The preventive strategy involved adding a preventive continuous dose of the additive in feed through the production cycle, while the corrective dosage was supplemented for a short period at the appearance of disease symptoms.

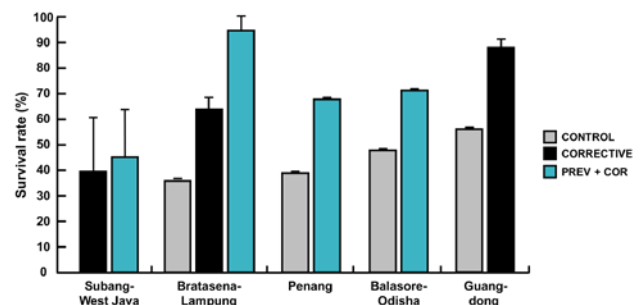
We summarised the effects of Sanacore®GM supplementation under farming conditions across various locations in Southeast Asia and India in Figures 1-3. Under infection, shrimp fed diets not supplemented with the functional additive exhibited poor performance, including low survival rates, high feed conversion ratios (FCR), and frequent emergency harvests due to growth retardation.

On the contrary, the dietary supplementation Sanacore®GM under preventive and corrective strategies led to improved survival, feed conversion ratios (FCRs), and recovery in

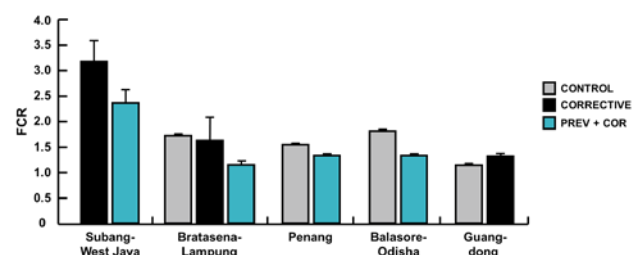
growth rates. The survival rate of shrimp in the control ponds ranged from 35% to 55%. However, shrimp that received additive supplementation exhibited delayed disease outbreaks, despite showing gross signs of infection. Notably, the preventive plus corrective supplementation led to a significant recovery of daily growth from infection, with survival rates reaching up to 66% to 99%. Moreover, the additive supplement reduced the FCR by 25% to 33% and increased total crop yields by an average of three times compared to the ponds without functional additives supplementation. It was observed that the corrective dosage at the start of the outbreak helped to eliminate WFS symptoms and stabilise growth, while the preventive dosage supports growth recovery to pre-outbreak rates. These findings are explained by the capacity of the additive to disrupt the cycle of EHP and to inhibit *Vibrio* proliferation, reducing hepatopancreatic damage and the impact of infection.

Several *in vitro* and *in vivo* studies have corroborated the capacity of the additive to inhibit EHP germination, a critical step to invade host cells, and reduce EHP copies after a period of supplementation. By reducing the viability of EHP spores in the shrimp gastrointestinal tract, it is possible to prevent the parasite from entering the hepatopancreas, where it can multiply rapidly and cause hepatopancreatic microsporidiosis (HPM). This condition leads to the destruction of tubule epithelial cells and the development of lesions. Likewise, Sanacore®GM was proven to interrupt the quorum sensing regulation of *V. parahaemolyticus* through a depressive effect on the signaling pathways determining the bacterial density and toxin production.

## Conclusion



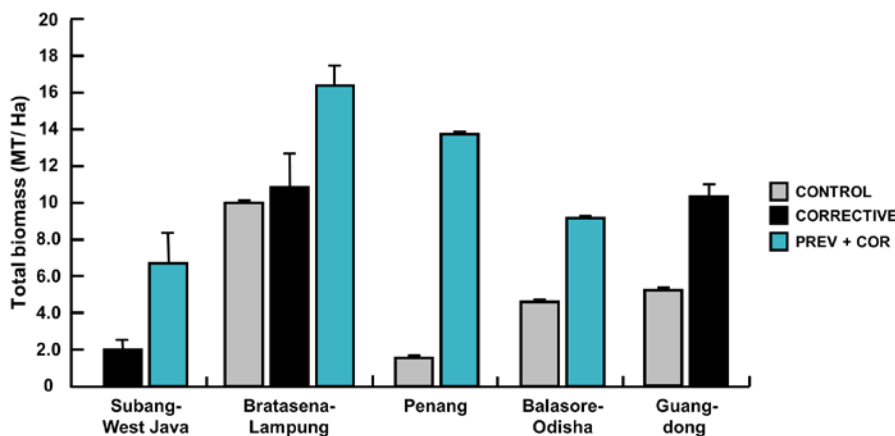
**Figure 1.** The effects on survival rate (%) with the dietary supplementation of Sanacore®GM to support farmed shrimp in dealing with EHP-WFS across regions. The shrimp that were not supplemented with functional additives had lower survival rates and experienced recurrent disease outbreaks, as well as growth retardation, which required more frequent emergency harvesting.



**Figure 2.** The effects on feed conversion ratio (FCR) with the dietary supplementation of Sanacore®GM to support farmed shrimp in dealing with EHP-WFS across regions. Shrimp that received additive supplementation exhibited a delayed onset of disease outbreaks, despite displaying gross signs of infection, which resulted in a rebound in growth and a decrease in FCR.

Location		Pond size	Stocking density	Application strategies
Indonesia	Subang-West Java	3000 m <sup>2</sup>	100 PL/m <sup>2</sup>	Corrective dose during disease outbreak
				Preventive + Corrective during disease outbreak
Indonesia	Bratasena-Lampung	1000 m <sup>2</sup>	100 PL/m <sup>2</sup>	Control
				Corrective dose during disease outbreak
				Preventive + Corrective during disease outbreak
Malaysia	Penang	4000 m <sup>2</sup>	110 PL/m <sup>2</sup>	Control
				Preventive + Corrective during disease outbreak
India	Balasore-Odisha	7500 m <sup>2</sup>	65 PL/m <sup>2</sup>	Control
				Preventive + Corrective during disease outbreak
China	Guangdong	3000-4000 m <sup>2</sup>	67 PL/m <sup>2</sup>	Control
				Corrective dose during disease outbreak

**Table 2.** Application strategies of Sanacore® GM to support shrimp growth and survival across trials.



**Figure 3.** The effects on total biomass (tonnes/ha) with the dietary supplementation of Sanacore®GM to support farmed shrimp in dealing with EHP-WFS across regions. Applying the preventive plus corrective strategy eliminated disease symptoms while facilitating growth recovery to pre-outbreak levels. This, in turn, led to a significant increase in total crop yield during the production cycle.

Shrimp diseases are caused by multifactorial interactions. Field trials contemplate all production variables and are essential in determining the efficacy of functional additives to promote shrimp health under farm conditions.

Sanacore®GM has shown efficacy under different application strategies and production conditions. Clearly, it supports shrimp health and reduces the severity of EHP-WFS. The preventive use of the additive can be a strategy to recover growth rates to pre-outbreak levels and optimise farm profitability. Pond management measures must go hand in hand with feed supplementation of Sanacore®GM.

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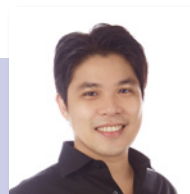
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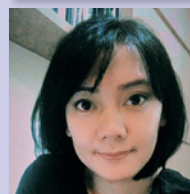
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All authors are with Adisseo Asia Pacific Pte Ltd, Singapore.

# The future of aquaculture: Achieving sustainability through innovation and collaboration

By Henry Wong



Sustainability is the practice of meeting the present needs while preserving future generations' ability to meet their own needs. It entails making informed decisions and taking environmentally, socially, and economically responsible actions. The significance of sustainability has surged in recent years, mainly due to the escalating global environmental challenges that we face, including climate change, habitat destruction, and pollution. As such, we must prioritise sustainable practices to safeguard our planet's and future generations' well-being.

Despite being one of the most sustainable animal protein-producing industries, sustainability remains a crucial topic in aquaculture. With the global population growing at an unprecedented rate, the mission of aquaculture to fill the gap in demand for aquatic protein is more vital than ever. However, we can take this mission to new heights by improving system efficiency and reducing our environmental footprint. It is inspiring to see many people recognising the importance of preserving our natural resources, ensuring the aquaculture industry's long-term viability, and taking action to promote its sustainability.

Consumers increasingly seek sustainably sourced seafood, leading many retailers and restaurants to offer certified sustainable seafood products. However, there is still much more work to be done. We need better research to understand aquaculture's environmental and social impacts and to develop even more sustainable farming practices. Talking about sustainability in the aquaculture industry is just the beginning – we must act to ensure that the industry is truly sustainable.

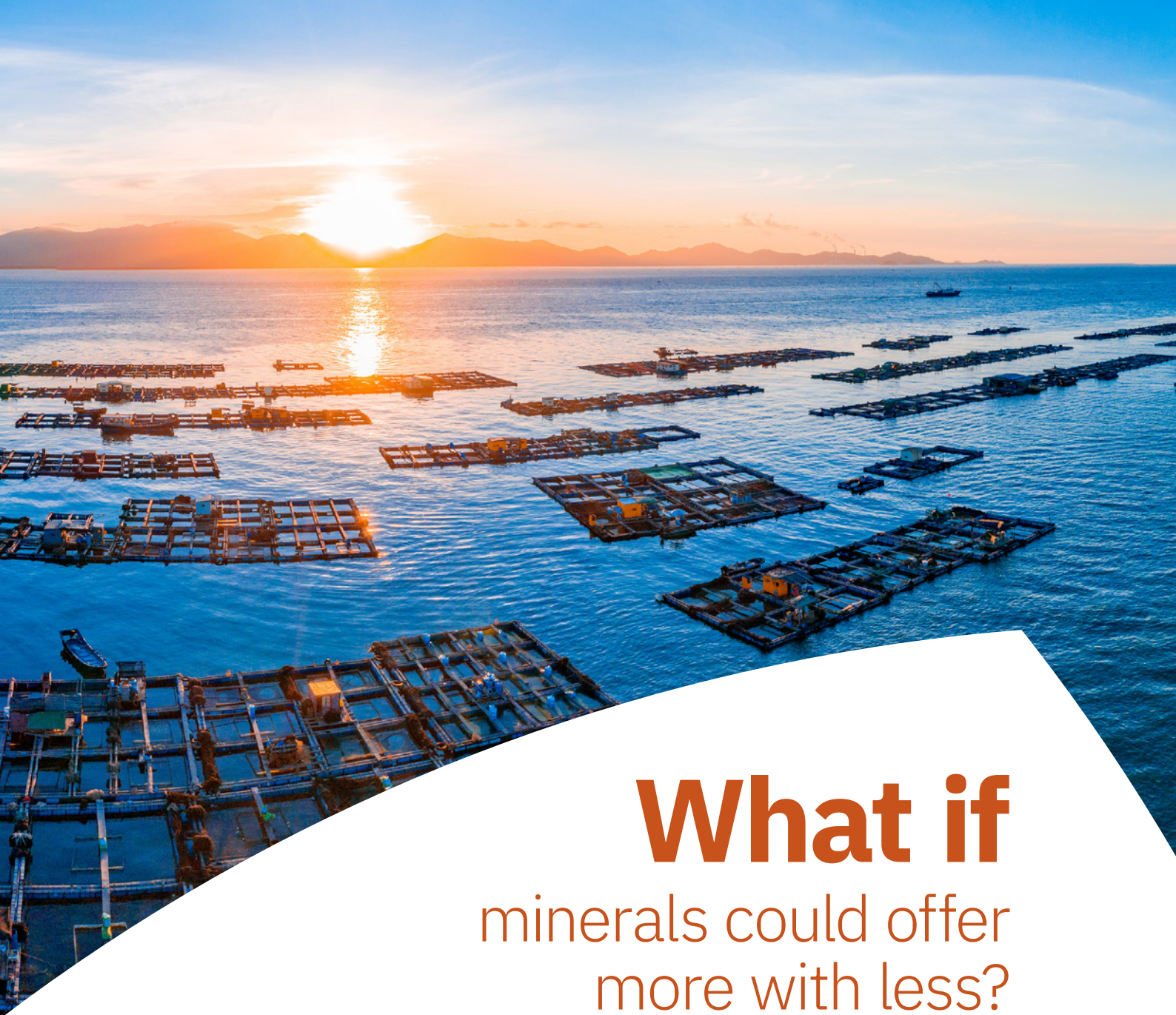
Alltech's Planet of Plenty vision is a bold and inspiring initiative to create a world of abundance through science,

sustainability, and storytelling. This vision is particularly relevant to the aquaculture industry, where sustainability is a crucial topic. The company recognises that the aquaculture industry has a vital role in meeting the growing demand for protein sustainably and responsibly. Through the Planet of Plenty vision, it is committed to working with farmers, researchers, regulators, and consumers to achieve sustainable aquaculture that supports the long-term health of the planet and its inhabitants.

## Sustainable aquafeed

This is a hot topic being discussed in the aquaculture industry. While compound aquafeed is necessary for many intensive farming systems to promote efficiency, concerns have been raised about the sustainability of marine ingredients such as fishmeal and fish oil used in aquafeed. Nevertheless, the role of sustainable aquafeeds in meeting the increasing demand for seafood through sustainable aquaculture production is vital.

According to FAO's report in 2022, fish and crustaceans, as fed species, constituted 51.5% (equivalent to 63.2 million tonnes) of the world's aquaculture production in 2020. Additionally, to fulfill the anticipated production levels of fed species in 2025, an approximate amount of 73.15 million tonnes of aquafeed will be needed as projected by Boyd et al. Therefore, it is crucial to develop sustainable aquafeeds based on the choice of ingredient composition. Sustainable aquafeeds should also take into account the economic and socio-cultural dimensions, in addition to nutrition and environment, to achieve a holistic approach to sustainability. In this regard, the aquafeed sector must recognise the trade-offs associated with different feed ingredients and feed formulations to ensure sustainable aquafeeds are sufficiently available to realise the opportunities offered by aquaculture.



# What if minerals could offer more with less?

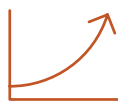
Alltech Mineral Management program provides natural nutritional solutions to meet the challenges of aquaculture and achieve the best animal production, health, performance, and profitability.



A highly efficient  
mineral diet



The ability to  
feed minerals at  
lower rates



Opportunity to  
better health and  
performance



Quality and  
traceability



Mineral excretion  
reduction

Contact your local Alltech representative or email [knowyourminerals@alltech.com](mailto:knowyourminerals@alltech.com) to learn more about Alltech Mineral Management and TRT.





### Sustainability scoring system

Our leading aquaculture feed division, Alltech Coppens, has been spearheading the sustainability drive in the industry. Recognising the critical role of feed sourcing and sustainability in the aquaculture sector, the company has developed a sustainability scoring system that assesses the environmental impact of each ingredient used in the feed. The score ranking is established by a life cycle assessment (LCA) using several databases, such as the Global Feed LCA Institute (GLFI) and other information sources.

The scoring system evaluates various factors such as greenhouse gas emission, water usage, and land use, ensuring that feed is sourced responsibly and produced sustainably. Alltech Coppens uses a well-known method called ReCiPe 2016, which was developed with the collaboration of RIVM, Radboud University Nijmegen, Leiden University, and Pré Consultants. The method considers the environmental impact of each stage of the feed production process and is compliant with the EU's Product Environmental Footprint Category Rules for Feed (PEFCR). The ReCiPe 2016 method along with the database from the GLFI is used to assess the impact of all their industrial feeds based on factors such as raw materials, supplier location, and feed performance (in terms of feed conversion ratios - FCRs).

### Marine resources sustainability

However, to fully account for the sustainability of marine-sourced fishmeal and oil, an additional indicator was added: Marine resources sustainability. This indicator was also normalised and weighted into the company's sustainability score. This scoring system categorises diets based on their total impact score, with feeds with the lowest impact score placed in category A. This ranking is based on an A-B-C principle, where all feeds in category C form the baseline for the scoring. By utilising this methodology, Farmers are provided with transparent and accurate information about the sustainability of their feed. This helps farmers make informed decisions on the impact of the feed they use on the environment.

Internally, this sustainability scoring system has enabled the company to accurately quantify its environmental impacts. Through this system, the company has reduced the carbon footprint of its feed by 7.2% compared to 2020. In 2020, the company proudly reported that 56% of its marine materials were produced out of trimmings. In 2021, the company further increased this percentage to a total of 81% of its marine ingredients. These impressive results reflect its commitment to sustainability and dedication to improve its practices continuously.

$$\left( \text{ReCiPe 2016} + \text{gfl i} + \text{Marine resources sustainability} \right) \times \text{FCR} = \text{A/B/C}$$

### Organic trace mineral technology

Additionally, Alltech supports the aquaculture feed with its organic trace mineral technology. Trace minerals are a vital component of aquaculture feed, as they are required in small quantities and are essential for normal life processes and cellular metabolism. These minerals, including copper (Cu), iron (Fe), manganese (Mn), zinc (Zn) and selenium (Se), form components of body fluids, hormones, and biological compounds such as haemoglobin. Supplementing the right amount of trace minerals is crucial to maintaining the health, fertility, hatchability, immunity, and performance parameters of aquatic animals, including growth rate, feed efficiency, and flesh quality.

Traditionally, aquaculture feed has relied on inorganic trace minerals, which are poorly absorbed by aquatic animals and can also have a negative environmental impact when excreted. Different sources of trace elements assume different molecular forms and ligands, and subsequent compounds formed in the gastrointestinal tract of aquatic species may prevent mineral absorption and metabolism. Inorganic sources of trace minerals often dissociate, releasing charged mineral ions before reaching absorption sites in the intestine, which often form insoluble and indigestible compounds that are excreted as waste.

To address these challenges, Alltech has developed a wide range of organic trace minerals using chelation technology, which offers a more sustainable and effective solution. Chelates are produced through the reaction of mineral salts with an enzymatically prepared mixture of amino acids and peptides, resulting in a highly stable trace mineral source. The chelated structure of these minerals, specifically, copper, iron, manganese and zinc protect the elements from forming insoluble complexes within the digestive tract, thus facilitating transport across the intestinal mucosa. This process enhances the bioavailability of trace minerals, making them more easily absorbed by fish and reducing the amount of minerals that are excreted into the environment. Incorporating these minerals into feed at reduced levels can enhance the overall health condition of aquatic organisms, lower the amount of mineral waste excretion, and decrease the negative impact of aquaculture practices on the environment.

Alltech's organic trace minerals have been extensively researched and have demonstrated significant benefits in various species, including salmon, seabream, tilapia, and white shrimp. For example, studies have shown that post-smolt Atlantic salmon reared in conditions with suboptimal oxygen and supplemented with Bioplex zinc and Sel-Plex selenium-enriched yeast showed improved FCR and growth rate compared to those supplemented with inorganic trace minerals (Kousoulaki et al., 2019).

In Pacific white shrimp, *Penaeus vannamei*, Bioplex supplementation increased total haemocytes, plasma protein, phenoloxidase enzyme levels, and tissue mineral concentration (Reyes et al., 2018). Fukada and Kitagima (2019) attributed lower levels of Bioplex and Sel-Plex to improved weight gain, FCR, and final weight in yellowtail *Seriola quinqueradiata* fingerlings when dietary fishmeal was reduced. The reduction in the excretion of trace minerals into the environment contributed to more sustainable aquaculture production. Their studies demonstrated that the bioavailability of organic trace minerals provided a suitable solution to meet the trace mineral requirements of aquatic animals while reducing the discharge of minerals into the external water resources.

In conclusion, Alltech's Planet of Plenty vision is a call to action for all stakeholders in the aquaculture industry to come together and work towards a more sustainable future. The focus on sustainable feed scoring and the use of organic trace minerals in aquafeed are just two examples of how the company is leading the way in responsible aquaculture production. By working together and applying science and technology, and adopting best practices, we can create a larger impact and contribute significantly towards a sustainable future. Let us take this invitation seriously and work towards building a better planet for ourselves and generations to come.



**Henry Wong** is Alltech's Regional Commercial Development Director – Asia Aquaculture, based in Malaysia. Email: [hwong@alltech.com](mailto:hwong@alltech.com)



Fish farm in Cebu, Philippines

## Navigating the challenges of responsible aquaculture in 2023

The challenges are complex and require awareness and support from companies, operations and stakeholders aspiring to grow in a safe and sustainable way

By **Xaviere Lagadec**

The aquaculture industry has seen significant growth in recent years, driven in part by the need to meet the growing demand for seafood to feed the planet. There are growing concerns about the environmental and social impacts from aquaculture activities. For aquaculture companies, it is crucial to understand the challenges they must overcome to act responsibly in 2023 and beyond.

### Trends and challenges in aquaculture

#### *Feed and the environment*

Feed costs and sourcing sustainable ingredients are significant environmental challenges. Commercial feed production used to rely heavily on wild fish for fishmeal and fish oil production. This quickly became unsustainable as production from capture fisheries reached its limits. Alternatives to marine sources of protein and oils, such as plant-based and land animal-based ingredients were introduced, reducing the industry's dependence on non-renewable resources from capture fisheries.

Fishmeal and fish oil still comprise 70–80% of the total feed supply (GFI, 2020). This percentage is decreasing as alternative feed ingredients are being used, such as insect meals, plant protein meals, algae meals and oils, soybean meals and oils, as well as fishmeal and fish oil from fish processing by-products.

#### *Welfare*

There are growing consumer concerns over animal welfare including fish and crustacean welfare and health.

Whether for ethical considerations or improved quality of the products, the importance of animal welfare is growing due to the direct implication on fish production and on the sustainability of the aquaculture industry. A less stressed animal is healthier and requires fewer treatments to maintain health. It has a better growth rate, feed conversion and superior meat quality.

#### *Biodiversity*

Maintaining biodiversity is an important goal in this sector's strategy. Each aquaculture stakeholder can play a role and focus on reducing the biodiversity loss and even demonstrate positive impacts.

Aquaculture activities negatively impact natural habitats and wild species are well studied. Farmed escapes in marine waters is a major concern as the likelihood of interbreeding with wild stocks could have ecological and genetic consequences. Escapees may also invade areas that are non-indigenous to them. Open fish farm cages can attract wild fish, raising the risk of infectious diseases and parasites spreading to the surrounding wildlife.

Another aspect is the intensive use of pharmaceuticals including antibiotics. This accelerates resistance of pathogens, such as bacteria and parasites. Residues from oral administration through fish feed or immersion treatments often end up in the surrounding environment. This alters the normal bacterial flora of farmed and wild species, endangering local biodiversity.

### Spatial

Access to space at sea and on the land is increasingly challenging. Numerous activities from aquaculture farms, fishing areas, wind farms and transportation routes, are competing for space.

In Asia, mangrove deforestation is a major concern as shrimp production puts pressure on this habitat, which hosts a unique biodiversity, prevents coastal erosion, and contributes to carbon sequestration. Nearly a third of the mangroves in Southeast Asia were lost between 2000 and 2012 and traced to aquaculture (Richards and Friess, 2016). With the annual aquaculture production forecast set to increase by 250% by mid-century, the fight for space and the challenge to reduce environmental impacts are very real.



### Security

A rising topic on most corporate agendas is data and cyber security. The aquaculture industry is undergoing significant operational changes. Fish farms are equipped with new technologies and sophisticated sensors. These generate data and connect farms and the rest of the value chain to an expanding, interconnected network. Data security risks and technical issues, data quality and cyber security are becoming increasingly major challenges, although somewhat unfamiliar for many.

### Is there more?

The above challenges apply to the aquaculture industry globally. However, different geographies may face additional local challenges in striving for sustainable and responsible aquaculture production. In Southeast Asia, the need to respond to consumer and market concerns is increasing. Moreover, the industry must balance domestic consumption and exports. The upside is that geographies with a combination of good climate, feed supply, large local market and access to water are favoured for development and growth of immature markets.

Moreover, the evolution of requirements and geopolitical uncertainties led countries to gravitate towards local production for the domestic market. Thus, aquaculture production is focused on self-sufficiency and the reduction of dependency on the global supply chain. However, the fact remains that local production must also tackle global challenges to ensure sustainable growth.



## Supporting you in your commitment to sustainable seafood

DNV is an accredited certification body for Aquaculture Stewardship Council (ASC) and other seafood certification services such as Marine Stewardship Council (MSC). Our experts are among the most experienced auditors in the industry.



Read more

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sngseq@dnv.com





### How can the aquaculture industry respond?

The challenges at hand and ahead are complex. Addressing them requires direct investments as well as collaboration, within the industry and with outside partners and counterparts.

But what is the ideal response? There is no easy solution. However, DNV, an independent assurance and risk management provider, operating in more than 100 countries, believes that new technologies, innovations and certifications for aquaculture schemes, such as Aquaculture Stewardship Council (ASC) and Global G.A.P can go a long way in supporting the industry response. That is if companies are committed and determined to grow more sustainably.

For example, the circular economy together with increased use of novel ingredients, such as insect meal and algal oils, are necessary to further reduce the dependence on wild caught production and pressure on our land-based ecosystems and wild fish stocks. Investing in vaccine development to target common diseases will reduce the discharge of medicinal residues and the use of chemical treatments for lice.

Innovation goes together with traceability schemes and third-party certification as they provide transparency, supply chain and consumer confidence in products from feed to fork.

With increasing digitisation, the aquaculture industry is more vulnerable to new threats. The ability to trust data collected for decision making, to secure data and production systems from cyber-attacks means setting up new systems and protection mechanisms in place that were not required before.

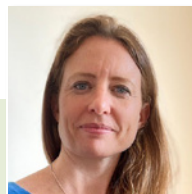
From very specific aquaculture challenges to new threats including information security, the industry faces many challenges in their quest for growth. The ability to understand and address both new and established risks is quintessential to increase production in sustainable ways.

DNV is committed to bring knowledge and expertise to the aquaculture industry. A webinar in Vietnam and seminars hosted in Singapore and Indonesia in late 2022 deep dived into trends, challenges, and roles of businesses in building a more sustainable future for aquaculture. Many local government agencies in Southeast Asia are taking actions towards building a more sustainable aquaculture industry. In November 2022, the Singapore Food Agency (SFA) launched an aquaculture research development programme to support Singapore in becoming a leading research and innovation hub for sustainable tropical aquaculture.

From sharing analyses such as “Marine Aquaculture Forecast to 2050” to hosting seminars, and forming meaningful collaborations around the world, DNV wants to create awareness and impactful aspirations on sustainability, by supporting companies, operations and aquaculture projects to grow in a safe, sustainable way as well as to navigate the challenges of responsible aquaculture in 2023 and beyond. This is through its assurance of operations, risk management and sustainable programmes for fish and fish well-being.

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# The Shrimp Improvement Project in Banyuwangi secures support for road map delivery

This vision of responsible and sustainable shrimp farming in Indonesia includes community action on wastewater and disease management, certification and access to finance and technology.

By Anton Immink, Dane Klinger, Shantika Sastraprawira, Garrett Goto, Kenidas Luckman, Deddy Poerba and Fani Faisol



Field training on opportunities and considerations for IPAL design and build, was carried out on an operating shrimp farm in southern Banyuwangi. Students from a local university joined the farmers.

Over the last several years, industry and government stakeholders in Banyuwangi, East Java, Indonesia, have developed an improvement plan (road map) to help fulfill a shared vision for a more sustainable, profitable, and resilient shrimp aquaculture sector. The time-bound road map to achieve that vision addresses environmental quality, disease management, and certification requirements, amongst other things, and was developed with the encouragement of a group of NGOs. Of course, Covid protracted the timeline, but things are right on track after the Regent of Banyuwangi formally kicked off the road map's delivery phase in a signing ceremony in December. The timing aligns with grant support from the Walmart Foundation to Conservation International, enabling Konservasi Indonesia, Yayasan Sinergi Akuakultur Indonesia, and ThinkAqua to support local business and government stakeholders to deliver the Sustainable Shrimp Development Road Map over the next two years.

Banyuwangi is a leading production area for shrimp in Indonesia, growing more than 20,000 tonnes. The producers here are known to be pioneers - including being among the first with international certifications, creating novel innovations in feed and farm management, and working with startup companies to test emerging technologies.

The Shrimp Improvement Project or SIP has a jurisdictional or landscape or zonal approach towards understanding and managing the risks and impacts associated with the industry. The process is inherently multi-stakeholder (involving producers, supply chain companies, government, and NGOs) and was initially developed to reduce deforestation and

negative environmental impacts across the agricultural production areas for crops such as palm oil and soy. SIP is the first time this model has been applied more broadly in shrimp farming and aquaculture. It builds off guidelines created a few years ago for regional management of the aquaculture sector and now includes biodiversity and financing goals.

The official signing ceremony and the road map delivery kick-off meeting was held on 13 December 2022. Progress review meetings are planned at intervals throughout the coming years, with the road map and improvement process expected to take four years to be completed.



Farmers and students drawing out their IPAL (wastewater treatment pond) plans following theoretical and field training on the major considerations.

## Objectives of the road map

### Ecosystem Protection

1. Communal water bodies and ecosystems are conserved and protected through community-based water quality management, carrying capacity measurement and monitoring, and limiting the discharge of pond wastewater to a level that allows for maintaining the balance of the ecosystem.
2. Individual shrimp farms manage the nutrient loads in their effluent to enable the health of the surrounding ecosystem to be maintained through measurement, monitoring and treatment of the quality of inlet water, production ponds and wastewater according to appropriate levels; and,
3. Mangrove forests are maintained in good health with the support of shrimp industry players.

### Standard of Living for Farmers

1. Farmers are able to meet a decent standard of living for themselves and their families through a decent and stable income level and without debt.
2. Farmers can maintain their farming operations in a prosperous state in the long term through access to high quality feed and seeds, capacity building assistance for tambak production and financial management and business legality support; and,
3. Farmers can upgrade their operations to a more profitable and reliable state in the long term through access to appropriate financing, application of innovative technology and best-in-class management practices.

### Community Collaboration and Capacity Building

1. All relevant stakeholders collaborate and coordinate to improve communication and educational capacity to implement an area-based approach to aquaculture, based on the Food and Agriculture Organization's Ecosystem Approach for Aquaculture and as directed by the Conclusions in this document.
2. All farmers collaborate and coordinate to control the spread of disease, improve communication and education among farmers and seek collective bargaining positions to increase product competitiveness.
3. Stakeholders along the supply chain collaborate and integrate vertically to control the spread of disease and increase price transparency in the supply chain, product traceability and opportunities for risk sharing; and,
4. Public and private sector stakeholders collaborate and coordinate to encourage investment into the sector through regulatory amendments; support and enhance internationally recognized certification programs and accompanying verification processes; and developing an infrastructure that provides a platform for multi-stakeholder dialogue.

## Wastewater treatment ponds

A key component of the road map is increasing the number, and use of, wastewater treatment ponds (locally known as IPAL, Instalasi Pengolahan Air Limbah). These facilities are essential components on certified farms and require farmers to designate specific areas of the farm for the settling of suspended solids and removing dissolved wastes before discharging water into the environment. Leading members of the local Shrimp Club of Indonesia (SCI) branch have been exploring different designs and promoting the general need for all farmers to have an IPAL. They are also required for farms to comply to CBIB certification (Cara Budidaya Ikan Yang Baik) which in the Indonesian language stands for the good aquaculture practice standard). However, there are still debates with the government about exactly how to size and build them – and how to enforce their use. The aim is for solutions to these debates to be resolved within the SIP process, creating a pathway to the adoption and utilisation of IPAL.



*Shrimp ponds do not operate in isolation. The jurisdictional approach of SIP aims to address challenges and opportunities at scale. Progress in Banyuwangi may be mirrored elsewhere in the future. Photo credit: Garrett Goto from Conservation International.*

Alongside this focused work on wastewater treatment, the plan is to monitor coastal water quality. This may be done through conventional water sampling protocols or modern technology like drones, which would enable more rapid sampling across larger areas.

## Coordinating disease management

Shrimp farmers are no strangers to disease issues – disease leads to billions of dollars in yearly losses. Another area of engagement in SIP is to increase the adoption of innovations in health and disease management. Discussions with the industry are underway to determine how lessons from a previous pilot diagnostics service, delivered with local tech innovator JALA, can be scaled to enable farmers to access timely diagnostics and how the industry – or government – could use those data to provide an early warning system for neighbouring farmers.



JALA's Christine Kombong preparing shrimp for rapid analysis on-farm and at the opening of the shrimp health laboratory in Banyuwangi.



SIP will also develop new collaboration models amongst smallholder farmers to address multiple challenges, from health and environmental management to access to inputs and markets. Specifically, smallholder farmers want to increase their access to technology and utilise data more readily to support farm management improvements. Greater coordination and technology amongst all farmers will help to strengthen traceability.

### Access to finance

New farming equipment, inputs and management protocols are constantly emerging to reduce disease risk and improve farm productivity and efficiency. Farmers want to keep up, but that takes money. SIP is supporting the development of the Asia Aquaculture Facility, a fund to invest in farmers in Banyuwangi to reconfigure their ponds following the latest guidance to meet international market needs and biodiversity demands. Not everyone will be able to access this funding because of farm location and management information systems, but for a select few, this offers an opportunity to fast-track modernisation.



Some of the authors at a pond-side location following the recent IPAL training. From left to right: Deddy Poerba, Garrett Goto, Fani Faisol, Shantika Sastraprawira and Anton Immink. Follow the project on the AIP Directory <https://aipdirectory.org/aip/shrimp-east-java/>

Overall, the ambition is to support the industry and government to address challenges and risks through a series of facilitated multi-stakeholder processes that can be replicated in other areas of Indonesia and the region in general. The shrimp aquaculture industry in Banyuwangi has strong ambitions to continue its leadership in responsible farmed shrimp production at the regional level – and the road map will help realise that vision.

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**Kenidas Luckman** is CEO, Yayasan Sinergi Akuakultur Indonesia and has extensive experience in Indonesian aquaculture.

**Deddy Poerba** is Industry Engagement Officer, Yayasan Sinergi Akuakultur Indonesia and has several years of direct experience on shrimp farms in Banyuwangi.

**Fani Faisol** is Aquaculture Program Field Officer, Konservasi Indonesia, with local finance and governance experience.

# A practical approach to aquatic animal welfare

Collecting outcome measures for better welfare

By Marius Nicolini, Oistein Thorsen, Pau Badia Grimalt, Murilo Quintiliano and Ralf Onken



*Tilapia feeding in a pond in Hainan (China). Studies have suggested that fish are capable of experiencing pain and fear, similar to other vertebrates.*

The work on aquatic animal welfare started in 2018. The leading UK food retailer, Marks and Spencer (M&S), received the 2019 Aquaculture Award for animal welfare in recognition of their Welfare Outcome Measure Programme, developed and delivered by FAI.

This Welfare Outcome Measure Programme gathers welfare outcome data such as mortality rates, disease prevalence, injuries and fish body condition across different growth stages and production units in their supply chain. This data provides insights into how fish experience and are impacted by various farming systems. By adopting an outcome measure approach, M&S can collaborate with suppliers to identify risk areas and implement improvement initiatives where necessary. This approach helps integrate welfare management into daily business operations through data-driven decision-making. Additionally, this approach enables greater transparency and brand integrity amidst growing scrutiny from citizens, regulatory bodies and NGOs on animal production practices.

Alongside the collaboration with M&S, FAI Farms has also been working on a highly practical approach to animal welfare in aquaculture. This approach centres around placing farmers at the heart of a comprehensive welfare framework, empowering them with the knowledge and tools necessary to ensure the highest possible animal welfare standards in their operations.

## Looking differently at aquatic animal welfare

The status of aquatic animal welfare is generally considered to be less advanced compared to land-based farm welfare. This is primarily because aquatic animals like fish and crustaceans are often considered less sentient or less capable of experiencing pain and suffering compared to land animals like cows, pigs and chickens.

However, over the past two decades, numerous studies have demonstrated that fish possess anatomical, physiological, behavioural, and pharmacological mechanisms that suggest they are capable of experiencing feelings such as pain and fear, similar to other vertebrates.

This evidence has been summarised in Braithwaite's book, "Do Fish Feel Pain?" (Oxford: Oxford University Press, 2010). Recently, there has been a growing recognition of the importance of improving the welfare of aquatic

animals. This has been driven by concerns around the environmental sustainability of current aquaculture practices and the ethical and moral obligations of treating all animals with respect and compassion.

There are several challenges to improving the welfare of aquatic animals, including the difficulties in assessing and monitoring their welfare due to their unique physiology, living environment and behaviours. There is a needed effort to develop and implement appropriate standards and guidelines adapted to the many aquatic species farmed around the world.

Over the past four years, FAI Farms has been working to develop a welfare approach specifically tailored to the aquaculture industry. As part of this effort, we have created species-specific operational welfare indicators and tools, making it easier to integrate welfare considerations into the industry's everyday practices. Our goal is to make animal welfare a mainstream concern in aquaculture and promote the adoption of best practices throughout the industry.

## Welfare framework for aquatic species

The aquaculture industry must consider various welfare critical points, which require the assessment of several indicators to ensure farmed animal welfare. Routine management practices, such as physical manipulation, can lead to physical and psychological stress. Water quality and associated environmental factors, such as dissolved oxygen, carbon, pH, temperature, and light regimes, are essential for maintaining fish and shrimp homeostasis. Indicators may be a direct observation or measurement from the animal, or an indirect information related to the environment and farm management.



# OUR APPROACH



**Develop species specific operational Welfare Indicators, for health, behaviour, nutrition and environment**



**Develop welfare assessment Protocol and App to help farmers monitor and implement welfare improvements**



**Create interactive, free, multi-language online training to implement welfare in aquaculture, from hatchery to slaughter**

A welfare protocol's validity, reliability and feasibility are crucial to its effectiveness. It must be validated by expert judgment, produce consistent results and be practical in terms of required time and farm conditions. Protocols for salmon and trout have been established for decades, but it is only recently that FAI Farms, in partnership with the Animal Welfare Laboratory at Paraná State University (LABEA) and Wai Ora, have developed protocols for tilapia, carp and shrimp, some of the most commonly farmed aquatic species worldwide.

The welfare assessment protocols for tilapia, carp and shrimp were established to address four out of the five domains of animal welfare: nutrition, environment, health, and behaviour. Indicators related to the psychology domain were not explicitly categorised but were indirectly evaluated through other proposed indicators. For each indicator, the reference values were determined based on literature and field experience. We have made a concerted effort to acknowledge that the degree of tolerance or ideal level of a given factor or indicator is not solely dependent on the animal's life stage. Rather, it is also influenced by the production system used and the environmental conditions in which the animals are raised.

Our approach considers these factors, recognising their critical role in promoting optimal welfare outcomes for farmed aquatic animals. Each indicator is scored to reflect the continuum of animal experience, ranging from positive (score 1) to very negative (score 3). We believe that non-invasive methods, such as those proposed by FAI farms, for assessing farmed fish and shrimp welfare will become a standard tool for farms. In the future, it will become increasingly challenging to produce seafood without considering their welfare throughout the production cycle.

Assessment is a powerful tool for improving animal welfare in aquaculture. Evaluating the physical, physiological, and behavioural indicators of animal welfare allows for identifying areas of improvement and implementing strategies to address them. For example, regular welfare



Sampling for on-site water quality measurements in a tilapia farm in Hainan province, China.

assessments can help identify potential sources of stress or harm, such as poor water quality or overcrowding, and allow for interventions to be put in place to address these issues. Assessments can help ensure that best practices are followed throughout the production process, from hatchery to slaughter, to promote optimal welfare outcomes. They can also facilitate communication and collaboration among stakeholders within the aquaculture industry, including producers, researchers and regulators.

By establishing shared standards and protocols for welfare assessment, stakeholders can work together to develop and promote sustainable and responsible aquaculture practices. This can ultimately lead to improved animal welfare and increased efficiency, profitability and public trust in the industry. These assessments trigger a virtuous cycle of enhancements by appealing



Is there anything to suggest harvest methods which are in line with animal welfare guidelines for shrimp? Yes, electrical stunning has been tested in order to accelerate the stunning time, reduce crowding and handling time by pumping the animal directly into the electrical stunner. It shows a better consistency on stun delivery: source [tesco-and-hilton-seafood-case-study-improving-the-welfare-of-whiteleg-shrimp-at-harvest.pdf](#) ([compassioninfoodbusiness.com](#))

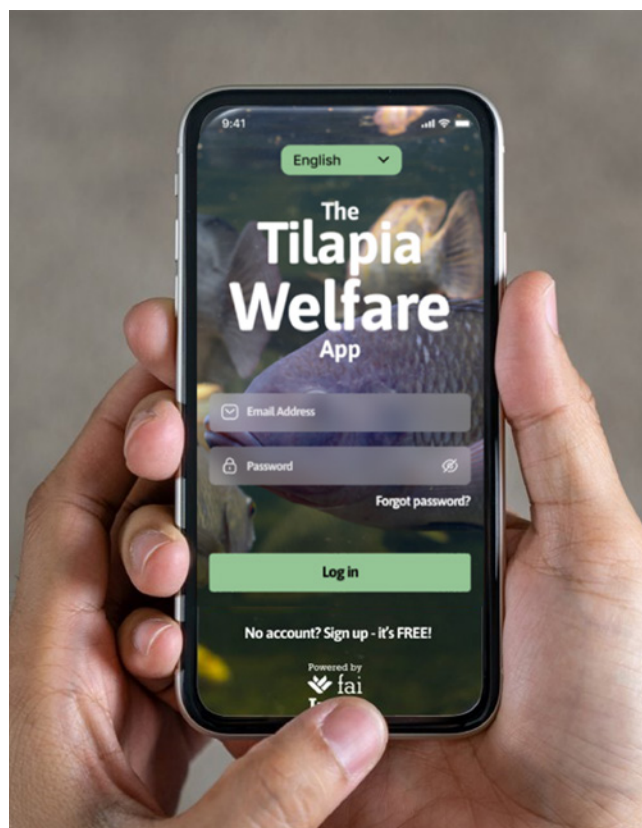
to the farmers' intrinsic desire to excel and improve. If a problem is detected during the assessment, measures will likely be taken to rectify or enhance it, ultimately leading to improved welfare.

### Communicating welfare to the aquaculture industry

An industry-wide adoption of welfare indicators and assessment protocols is necessary to ensure consistent and effective animal welfare monitoring. At all levels of the aquaculture industry, education and training are vital to promoting animal welfare. To that end, we offer free online training on welfare and we are currently developing mobile applications that farmers can use to perform welfare evaluations easily.

Mobile applications offer many benefits for performing welfare assessments of aquatic species. By providing real-time data collection, easy data access, a user-friendly interface, improved accuracy and cost-effectiveness, mobile apps are an effective tool for assessing the health and well-being of aquatic animals. The app can be used as a farmer self-assessment or as a second- or third-party assessment tool. The assessment results can be easily shared with various stakeholders, including customers and certification bodies, to ensure compliance with good production practices and promote positive outcomes.

"Who cares the most about tilapia welfare? We believe farmers are the most important factor in driving welfare improvements in aquaculture. We believe they are an untapped force for good whose power can be unleashed through practical farm assessments that align business and welfare objectives," said Øistein Thorsen, CEO of FAI.



The FAI Tilapia Welfare App gives producers an opportunity to conduct on-site welfare assessments of their fish using a mobile application. This tool helps them evaluate the well-being of their fish and identify any necessary improvements to enhance their living conditions.

The FAI Academy offers a free online training program focused on tilapia welfare. This course is specifically designed for individuals working in tilapia aquaculture production, such as farm managers and technicians. Its primary objective is to equip learners with the knowledge and skills necessary to implement effective welfare practices in their daily routines, from hatchery to slaughter. As part of our ongoing commitment to animal welfare, additional courses on welfare for other aquatic species, including shrimp and carp, will be made available soon.

“FAI’s online training suite on tilapia welfare is the first of its kind focused on implementing welfare practices in tilapia aquaculture daily routines, from hatchery to slaughter. The courses can be accessed on a smartphone, tablet or computer and were created for everyone working in tilapia aquaculture,” said Thorsen.

### Building a community around welfare in aquaculture

The establishment of welfare indicators for aquatic animal species has presented several challenges. One significant obstacle is the limited amount of information available on the biology of certain animals. To address this, we have utilised the most reliable and current news from the technical and scientific literature to develop our indicators.

However, we recognise that these indicators and associated reference values require ongoing evaluation and updating to ensure their accuracy and relevance. To this end, we aim to foster a community focused on aquatic animal welfare, creating a platform to share knowledge on welfare and revised protocols, based on the latest research and developments in the field. Our goal is to continually improve our approach on welfare assessment and promote the adoption of best practices across the aquaculture industry.

We invite all individuals and organisations involved in aquaculture to join us in our mission to enhance the lives of farmed aquatic animals worldwide. Together, we can create a brighter future for these animals and promote sustainable and responsible practices within the aquaculture industry.



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# A focus on aquaculture technology reflects Hawaii's long tradition in aquaculture

The second Ag Tech conference - **THRIVE Hawaii Agrifood Summit** will focus on developing sustainable food, agriculture and aquaculture solutions for the Asia Pacific region with global corporate leaders. It will be held on September 26-27, 2023 in Honolulu, Hawaii. The two-day event on industry trends and innovation will consist of keynote speeches, panel conversations, start-up pitches and more.

The Asia Pacific region faces a range of food security challenges, including population growth, climate change, poverty, water scarcity, urbanisation, conflicts, natural disasters, and pests and diseases, which disrupt food production and supply chains. Addressing these challenges will require a combination of approaches, including investing in agricultural research and development, promoting sustainable farming practices, improving infrastructure and logistics, and strengthening social safety nets to support vulnerable communities. Climate-smart innovative technologies will play a crucial role.

"The first Tropical AgTech Conference was held on June 22-23, 2022, at the University of Hawaii-Hilo. The focus on tropical agriculture differentiated the conference from other AgTech conferences around the world. This event was considered a great success by the 250 participants. Building on that success, we will convene our second AgTech Conference at the Hawaii Convention Center in Honolulu," said Dr Jim Wyban, Summit Co-Organiser.

"To reflect Hawaii's world class expertise and long tradition in aquaculture, we are adding aquaculture technology as a key theme of this event. On September 26, the program will focus on AgTech and on September 27, on aquaculture technology. Aquaculture can benefit from adopting technology that is already deployed in agriculture (ie AgTech). This why we are putting the two together."

For the aquaculture section, organisers have announced confirmed keynote speakers including Dean Jerry (James Cook University, Australia), Ross Houston (Benchmark Genetics, UK), and Robin Pearl (American Penaeid, USA). They will sit with Jim Wyban for a deep dive panel discussion on shrimp and salmon breeding and genetics. Dick Jones, CEO of Blue Ocean Mariculture

will speak on the potential of offshore aquaculture and Toru Mitsuboshi of Nissui from Japan will cover Nissui's work with yellowtail, salmon and indoor shrimp farming. In algae technology, there will be keynotes by Hawaii based Neil Sims (Ocean Era), Alexia Akbay (Symbrosia) and Heidi Kuehnle (Kuehnle AgroSystems) plus a panel on opportunities with algae, moderated by Rebecca White (Pebble Labs).

Wyban said, "We are delighted to announce the signing of an agreement with SVG Ventures | THRIVE as a partner for this 2023 conference. SVG is a leading global AgriFood Innovation and Investment platform headquartered in Silicon Valley and comprises top agriculture, food and technology corporations, universities and investors. Crunchbase & Pitchbook recognises SVG as the most active agtech investor with 80+ investments in the sector."

"We are thrilled to partner with SVG and have rebranded our conference to THRIVE Hawaii Agrifood Summit to reflect our partnership."

Reflecting on the focus of building the Agrifood tech innovation ecosystem, throughout both days of the program will be entrepreneur pitches. Wyban summarised that the program will include keynote speeches, panel discussions, deep dive breakout sessions plus entrepreneur pitches throughout. The Summit will kick off with an opening reception at the Entrepreneurs Sandbox on September 25. More information: [www.hawaiiagrifood.com](http://www.hawaiiagrifood.com)



THRIVE Hawaii Partners, from left, Jim Wyban, John Hartnett, Helen Hartnett and Jason Ueki.

## THRIVE Hawaii Agrifood Summit

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# Observations on grading associated operculum deformity in Asian seabass fingerlings

By R. Dinesh



An Asian seabass with operculum malformation (top) swimming amongst others with normal operculum.

## Mechanical grading of fingerlings showed some operculum malformations

Deformities are frequent in both wild and farmed fish populations, and are more common in the hatchery phase. The occurrence of malformations in fish has been linked to a number of factors.

This article reports for the first time, the presence of operculum malformation in hatchery-reared seabass fingerlings *Lates calcarifer* due to mechanical grading in India. Hatchery-reared seabass fingerlings were sampled to describe and quantify the occurrence of this irregularity. The development of the opercular malformations was tracked and photographed under stereomicroscopy.

In the current observation, 131 individuals (11.29%) were discovered to have semi-operculum deformities out of 1,160 fingerlings. The growth of malformed fish ( $4.5 \pm 0.2\text{cm}/1.9 \pm 0.1\text{g}$ ) was moderate compared to normal fish ( $5.6 \pm 0.5\text{cm}/2.5 \pm 0.2\text{g}$ ) during the current investigation period but was not significantly different in the later stages after 100 days (unpublished data). The physical damage caused by size grading was the specific source of the abnormality in this observation; this may have been an overlooked component despite the fact that numerous researchers evaluated other possible causes.

The current record, on the other hand, is noteworthy and provides a basic explanation of the anomaly as well as a caution to do proper grading to decrease the occurrence of grading associated deformity in hatchery-reared Asian seabass fingerlings.

Morphological abnormalities of the skeleton, fins and scales occur in both wild and farmed fish during the larval and juvenile phases of development; however, the prevalence of malformations in wild fish is usually relatively low (Diggles, 2013). These anomalies demand special attention since they are more common in farmed fish at the larval and fingerling phases (Beraldo et al., 2003). These are linked to a variety of physiological, environmental, genetic, xenobiotic, and dietary variables (Blogione et al., 2001; Cahu et al., 2003; Lall and Lewis-McCrea, 2007; Ma et al., 2016).

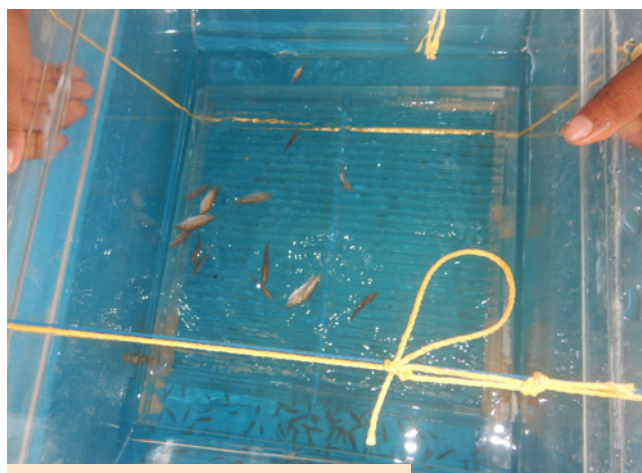
Deformities can also be caused by non-inherited congenital abnormalities (Handwerker and Tave, 1994; Tave and Handwerker, 1994). Nagano et al. (2007) noted that such deformities

have a direct impact on commercial aquaculture, as they reduce the market value of fish products and require manual sorting. Furthermore, skeletal malformations reduce swimming ability, conversion index, growth and survival (Gavaia et al., 2009) and can result in functional disability (Noble et al., 2012).

## The grading process

In seabass farming, it is not common for farmers to conduct nursery rearing. Due to the cannibalistic nature of the fish as well as differential growth, specific care is required during the nursery phase. Farmers who do nursery rearing often grade their fish every 5-7 days or anytime when there is a size difference among the fish.

Mechanical graders are used to quickly sort large numbers of fish into specific size groups. Hand grading is used if



A mechanical grader used in this study

fewer fish need to be sorted. Farmers fix hapas in ponds for nursery rearing as it is a low-cost method that can be practised in closed ponds or open water bodies. During grading, all fingerlings are removed from each hapa and placed in grading containers, where the fast growers are sorted and transferred to different hapa/tank based on fish size. Grading using sieves or mesh nets is common among farmers rather than mechanical graders.

Determining the causes of abnormalities during larval and juvenile fish production is challenging (Haga et al., 2011). Grading may sometimes do more harm than good. However, for some cannibalistic species, frequent size grading is necessary to achieve good survival and productivity while eliminating runts. When kept in tanks at high density, fish may require periodic grading. For efficient grading, fish may need to be crowded in the grader, but this can cause physical harm and make grading more difficult (Kelly and Heikes, 2013).

### Opercular shortening

The operculum is one of the first craniofacial bones to grow embryologically and is susceptible to a variety of developmental and acquired disorders. Opercular shortening is a common abnormality in larval and juvenile salmonids (and other species), affecting up to 80% of fish within a population (Ferguson and Sandoval, 2020). Since 2004, occurrences of deformities of opercula and dorsal fin have been observed in Asian seabass hatcheries (Yue et al., 2022).

Seabass fry aged 22 days ( $1.1 \pm 0.2$ cm) were obtained from the Asian seabass hatchery of Rajiv Gandhi Centre for Aquaculture, Sirkali, Tamil Nadu, India. The animals were stocked at  $1,000/m^3$  and were fed highly unsaturated fatty acids (HUFA) enriched *Artemia nauplii* (OSI, USA) at 1-2 nauplii to 4-6 nauplii/mL followed by *Artemia* biomass (1-1.5 *Artemia*/mL) before being weaned to a commercially manufactured diet (Marubeni Nisshin Feed Co., Ltd) which contained 50% crude protein, 5% crude fat, 3% crude fibre, 15% ash and 11% moisture.

Fish were fed four times a day *ad libitum* and the uneaten feeds and faeces were removed by siphoning them out of the fiberglass-reinforced plastic (FRP) tanks. Before the next feeding, a third of the water in each tank was replaced. Complete replacement of tank water was done with fresh filtered seawater every morning.



Zoom out picture of Asian seabass with a deformed operculum

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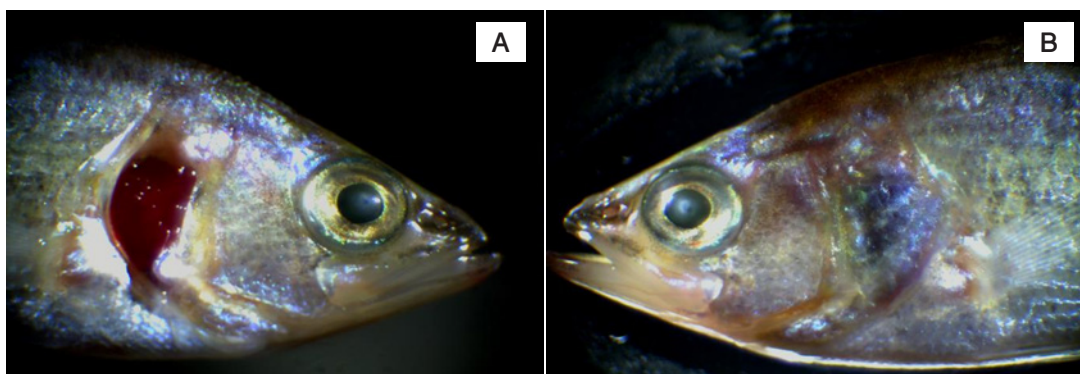
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**Figure 1.** Asian seabass *Lates calcarifer* (4.5 cm length and 1.9g) with unilateral semi-operculum (covering less than 70% of gills) (A) and developed operculum (B)

Seabass are highly cannibalistic which is more pronounced during the early stages (first two months). Regular grading is an accepted culture practice which removes shooters and results in better survival. In this study, grading was done once a week using an acrylic grader. The grader size was 57 (L) x 36 (W) x 24 (H) cm while grading slide was 32 (L) x 32 (W) x 1 (H) cm with different inserts/slides of bar space of 2.5, 3, 3.5 and 4mm, respectively. As the harvested fish were placed into the grader, small fish swam through the spaces and larger fish were retained. The space between the bars in the grate determined the size of fish staying in the grader. Water quality parameters such as temperature, dissolved oxygen, pH and ammonia were monitored by following standard procedures (APHA, 1992).

The tanks were sampled after 9 weeks of rearing and all fish (1,160 fingerlings) were captured, counted and weighed. The deformed fish were separated, inspected and photographed with a stereomicroscope (Carl Zeiss, Germany).

### Semi-operculum deformity

Out of a total of 1,160 surviving juvenile fish, at 85 days old ( $5.3 \pm 0.8$  cm length and  $2.3 \pm 0.4$  g weight), 131 (11.29%) showed deformities. These were externally apparent and identified as semi-operculum deformity (Figure 1). It was caused by abnormal development of either the sub-opercle or both the sub-opercle and the opercle, resulting in a shortened operculum (Al-Harbi, 2001). This abnormality was also observed in gilthead seabream (Beraldo et al., 2003), European seabass (Abdel, 2004), Atlantic salmon (Kazlauskien et al., 2006), cobia and dusky grouper (Engrácia Filho et al., 2018) and freshwater fishes including common carp (Dabrowski et al., 1988; Al-Harbi, 2001), Nile tilapia (Tave and Handwerker, 1994), Mozambique tilapia (Handwerker and Tave, 1994), rainbow trout (Frischknecht et al., 1994) and redline torpedo fish (Sajeevan and Mercy, 2016) due to nutritional deficiencies, unfavourable abiotic factors, rearing conditions and genetic factors.

### Opercular malformations

While the gill covers of the fry were initially intact, opercular malformations became visible after 60 day post hatch (DPH). The changes became more noticeable as the operculum developed and grew, and at 85 days after hatching, the gill covers were severely damaged (uneven operculum edges) and covered less than 70% of the gills.

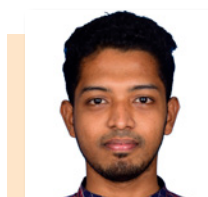
These findings showed that left-sided opercular malformations were more common in seabass fingerlings (85.6%), which were consistent with the findings of Abdel (2004), who found that left-sided opercular anomalies were also more common in European seabass *Dicentrarchus labrax*. Several studies have also found the presence of unilateral and bilateral semi-operculum in various fish species (Al-Harbi, 2001; Kazlauskien et al., 2006). The bilateral anomalies, contrary to their observations, were not recorded in the current investigation. Fish with this deformity swam normally, but their growth was moderate compared to normal fish.

Malformations in fish can have a variety of causes, which are frequently associated with nutritional deficiencies, unfavourable abiotic factors, rearing conditions as well as genetic factors (Wang and Tsai, 2000; Fagbuaro, 2009; Amitabh and Firoz, 2010; Arbuatti et al., 2013). The water quality parameters [temperature ( $28.0 \pm 0.50^\circ\text{C}$ ), pH ( $8.0 \pm 0.2$ ), dissolved oxygen ( $6.51 \pm 0.24$  ppm), and ammonia ( $< 0.02$  ppm)] were at optimal levels in the current study.

However, in this current study, it was concluded that faulty grading had a negative influence on the fish when compared to hand grading fish from the same lot. There was no mortality in the malformed fish.

The purpose of this study is to draw attention to the fact that deformity due to grading is observed in hatchery-reared Asian seabass. As a result, extreme caution should be taken when grading with mechanical graders. Grading may cause injuries leading to mortality. Hence proper care should be taken in handling the fingerlings. Crowding fish in the grader can cause physical damage and make grading more difficult because smaller fish cannot easily swim out of a crowded grader.

References are available on request.



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## The start of home-grown shrimp in the USA



In March, Homegrown Shrimp USA (HGS), the first shrimp farming facility in the US for Thailand-based Charoen Pokphand Foods (CPF) Public Limited, hosted its opening ceremony. Located in a rural, cattle and citrus community in the heart of Martin County, Florida, HGS produces Pacific white shrimp *Litopenaeus vannamei*.

Guests at the opening ceremony included Thailand's Ambassador to the US, His Excellency Tanee Sangrat and spouse, Cholatip Kambhu Sangrat; Thitiwat Sukhasvasti Na Ayudhaya, Economic Counsellor, Royal Thai Embassy; and Maria D. Sariol, Honorary Consul-General in Coral Gables. CPF executives present included Dr Sujint Thamasart and Anat Julintron. HGS clients, friends of the company and prominent members of the local community attended the opening.

In his welcome address, Dr Robins McIntosh, HGS CEO and CPF Senior Vice President said, "We are especially proud of the advances in shrimp genetics and culture systems that we have pioneered. It was disease-free fast-growing shrimp that we thought could provide the difference in making the RAS facilities that have been emerging in the US and Europe, and which are commercially successful and economically viable. Here, we have to just overcome the challenge of working in a temperate country, to develop a system that could create a tropical marine environment for the efficient culture of warm water shrimp – here, or anywhere else in the world."

The story on HGS began in 2018, when the leadership of CPF decided the time was right to create shrimp culture technologies that would make shrimp culture a reality in the US. Understanding that food trends were moving towards more local production of foods, and that consumers wish for more transparency in the way food is produced, the company decided it was time to develop and invest in shrimp production in the US.

The concept is fresh local shrimp, anywhere, anytime and with minimum impact on the environment. Shrimp are grown inland away from coastal environments in climatically controlled buildings and water is recycled for repeated reuse. Solid wastes are responsibly disposed of through a combination of oxidation, anaerobic digestion and compaction/dewatering. With high efficiency, only a small footprint of land is required to annually produce over 2 million pounds (907 tonnes) of America's favourite seafood.

"HGS now creates in the US a much-desired, premium, wholesome and sustainable shrimp that consumers can enjoy and also feel good about consuming," said McIntosh. "The US represents the largest shrimp market in the world. In 2018 there were no large successful year-round shrimp culture operations in the US, but CPF felt we should change that – the US having made shrimp the number one seafood and CPF being one of the world's most influential shrimp producers."



External view of the newly dedicated shrimp grow-out facility at Homegrown Shrimp USA.



### Grow-out and hatchery

The facilities at HGS include a new 180,000 square feet (16,722m<sup>2</sup>) indoor, metal building to grow the post larvae to market size. The building has 40 circular 100m<sup>2</sup> production tanks and 8 tanks to recycle water and collect solid wastes. There is the state-of-the-art water recirculation system (RAS) and the ability to control and keep water temperatures at slightly over 30°C, ideal for shrimp growth, survival and well-being. Cycles are 80 days or the time it takes to reach 25g (26 count headless and 18 count head on). Harvesting is all year round.

The HGS hatchery was commissioned in 2020 and is one of the few commercial hatcheries in the world that is inland and completely uses recycled water. The water system is quite complex - it turns water that has cultured the larvae and post larvae shrimp to nearly coral reef quality seawater required for hatchery operations. Included in the system is a denitrification step, followed by a "riverbed" step, finished by several protein skimming and oxygenation steps.

Genetics and health are extremely important for the success of both this and other USA and European shrimp farms. CPF the parent company started developing a shrimp line specific for these systems five years ago. This line known as the Bolt Line, is noted for the fast growth rates that are possible when culture conditions are optimised as is possible with indoor culture. All CPF

broodstock are specific pathogen free (SPF). This makes disease free culture possible, which is essential for these systems to succeed. HGS has captured significant post larvae market share in both the US and Europe. The hatchery has the capacity to produce over 60 million post larvae annually.

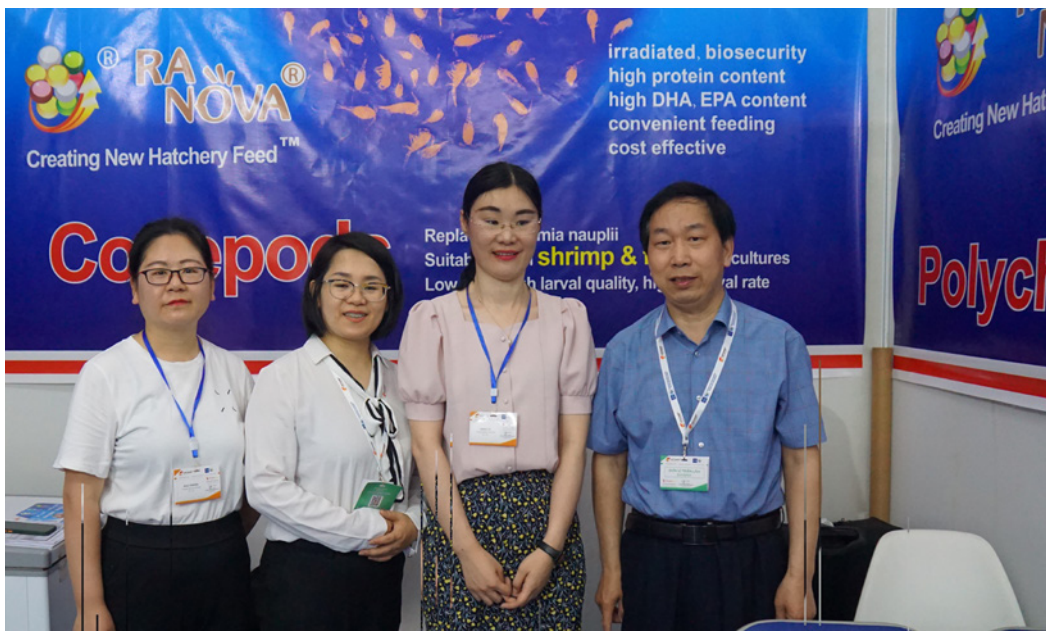
Currently shrimp feed from an American manufacturer is used in the culture of shrimp. The balanced formulation optimises growth, increases feed utilisation efficiency, and reduces wastes. However, in the future, the HGS team will work towards developing a shrimp feed free of all marine meals and oils. The absolute goal would be to develop a feed that uses only methanogenic bacteria as a protein source, thereby eliminating not just marine meals but also soy meal, which is increasingly responsible for the deforestation of tropical countries.

McIntosh's final comments addressed the relevance of the innovative, industry-changing pioneering efforts embodied by HGS. "It is disruptive technology developed and optimised here that makes aquaculture one of the solutions for our deteriorating oceans. Our mantra is 'saving the oceans and helping feed people through aquaculture.' Ultimately, as more knowledge is gained and efficiency improved in this facility, we envision these projects to be able to locally produce shrimp sustainably year-round anywhere in the world." [www.homegrownshrimp-usa.com](http://www.homegrownshrimp-usa.com)



Homegrown Shrimp USA officially opens its Florida shrimp operation in the presence of several VIPs (From left to right; Tanee Sangrat, Sujint Thammasart, Robins McIntosh, Angel Robinson, Susan Thomas, Ted Yoho and Anat Julintron). All photos credit:HGS.

## Frozen copepods for shrimp hatcheries



At VietShrimp, Dr Liu Fengqi (right) and his team displayed the reactivation of the freeze dried copepods.

China's **Tianjin Ranova Petfood Co Ltd** has a newly constructed factory with a large and advanced freeze-drying technology. Its subsidiary company, **Tianjin Intra Technologies Co Ltd** specialises in the production of aquarium and larviculture feeds. The location near Bohai Bay gives the company access to raw materials for processing. The product range includes irradiated copepods in three lengths, which the company focused at its booth during VietShrimp. This is the first time the company is exhibiting at this event.

It was Dr Liu Fengqi from the College of Life Sciences at Nankai University, now its CEO, who selected the copepods for higher content of protein and lipid and higher content of EPA and DHA. These were then cultured in a natural lake, harvested in spring each year and rinsed in tap water and totally frozen at minus 30°C for 5 hours.

Tianjin Intra, established in 2000, started to export frozen copepods to Japan, Korea and Malaysia since 2002. These irradiated with gamma rays copepods are used in larviculture of red seabream, halibut and vannamei

shrimp. Liu, said, "Our frozen copepods are the best quality worldwide. They replace 50% Artemia nauplii in fish, shrimp and crab larviculture. They are widely used in larval production for the vannamei, monodon shrimp, *Macrobrachium* and groupers etc.

"Copepods are bigger than Artemia nauplii and small copepods are of the same size as Artemia nauplii. At Tianjin Intra, the copepods are separated into 3 lengths; 0.5-0.8mm; 0.7-1.4mm and 1.30-2.0mm. Some nutritional values are higher fatty acids than Artemia nauplii and when disinfected by irradiation, there are no pathogens and lastly, the price is lower than for Artemia," added Liu.

With regards to using the copepods in shrimp hatchery, Liu advised to use them for larger post larvae (PL5) and feed more copepods when post larvae are molting. According to the team, the benefits of using copepods are that, aside from lower production costs, post larvae grow faster by 10-20%, such that PL5 has the size of PL6. Post larvae quality is better with more fat content.

[www.intra-feed.com/www.ranova-pettreats.com](http://www.intra-feed.com/www.ranova-pettreats.com)

## New feeds for vannamei shrimp in Vietnam

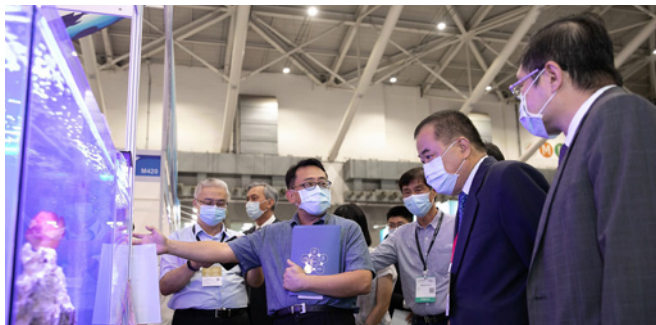
These are VARCO and VINTA which Gold Coin, Pilmico introduced for the Vietnamese market during VietShrimp 2023. Their recommended use is linked to the farming systems. In Vietnam, farmers prefer high crude protein feeds and in winter, with lower temperatures, shrimp will not grow when fed on feeds with lower crude protein.

VARCO is a premium, complete, and nutrient-dense feed with functional properties and 43% crude protein. It is designed for high performing systems and where the stocking density is at more than 200PL/m<sup>2</sup>. The water exchange in such systems is around 10-15%. VINTA feeds contain less crude protein at 40% and have been designed for traditional farming systems, i.e., farms stocking 50-150PL/m<sup>2</sup> with simple water management systems. [www.goldcoin-group.com](http://www.goldcoin-group.com)



On the left, Serge Corneillie PhD, Head of Aquaculture Division, at Gold Coin, Pilmico during Vietshrimp 2023.

# Featuring smart aquaculture to increase production and stabilise product quality, TIOFIS 2023 opens in August



The **9th Taiwan International Ocean and Fisheries Industry Show (TIOFIS)**, organised by MY Exhibition Co. Ltd., will be held on August 31 to September 2 at Hall 1, Taipei Nangang Exhibition Center. The exhibition covers five major areas:

- Marine Fisheries
- Fish Farming
- Eco-Friendly Ocean
- Aquatic Products Processing and Technology
- Sustainable Seafood

TIOFIS will integrate equipment and solutions for marine industry, aquaculture, aquatic product processing, packaging, cold chain logistics, etc. Taiwan is a supply base for fishery industry equipment and products in the Asia Pacific region.

## Taiwan's advantage in smart fishing technology for sustainable aquaculture

As supply from marine fisheries has been declining year by year due to the impact of climate change and overfishing, the country has gradually come to rely on aquaculture to provide seafood products. However, aquaculture also faces limited land and water resources, resulting in competition with other industries.

Therefore, the development of smart fishing equipment that can increase production and stabilise quality has become a focus of the industry. Taiwan, benefiting from its technology island advantage, combines advanced technologies such as ICT, AI, IoT, big data analysis and blockchain to introduce them into the fishing industry, which can significantly reduce the burden of fishing operations and provide fishermen with a more efficient management model.

## TIOFIS: Advancing a sustainable fishing industry

TIOFIS is a major exhibition showcasing Taiwan's experience, technological advantages, and innovative

applications in the fishing industry. It also provides tailor-made innovative solutions for tropical and subtropical fisheries and creates a platform for knowledge and technology exchange in the Asian fishery industry.

This year's exhibition focuses on "Balancing Profitability and Sustainability" and strives to develop a new type of industry model focussing on both industry profitability and environmental sustainability. The exhibition provides domestic and foreign exhibitors with opportunities to find partners and international exposure, making it the best channel to enter the Taiwanese market and market globally.

In 2022, the show held in Taipei, had the 3rd Marine Aquaculture Technology Forum which focussed among others on Taiwan's threadfin industry (see issue January/February 2023, pp53 <https://bit.ly/3nxs7LH>). There were 464 booths and 13,000 visitors from 55 countries. Some 273 matchmaking meetings were completed online and offline. As a global market hybrid event, it drew 26,386 total content views from 40 countries.

The 4th Marine Aquaculture Technology Forum organised by the National Taiwan Ocean University will be held on August 31. There will also be other seminars and forums. Organisers invite domestic and foreign buyers and professionals to exchange and match business opportunities. It is estimated that exhibitors from dozens of countries will gather, and nearly 300 online and offline procurement matching meetings will be held.

Interested companies are welcome to register for the exhibition and seize the opportunity to upgrade their industries after the epidemic. More information: <https://reurl.cc/NqvxAn>; Email: [info@taiwanagriweek.com](mailto:info@taiwanagriweek.com)



# Taiwan Int'l Ocean and Fisheries Industry Show 2023

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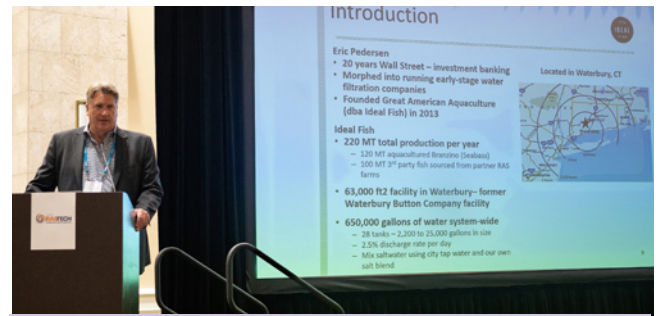
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# RASTech 2023: Cashing in on collaboration



Geno Evans is CEO, Evan Fish Farm in Florida, farming sturgeon for caviar



Eric Pedersen, President & Founder of Ideal Fish which produces the branzino fish (also called European bass) in a formerly abandoned factory in Connecticut, USA.

Collaboration and the ability to pivot rapidly are key survival tools in today's ever changing aquaculture landscape. This was a point frequently stressed by industry experts who spoke at the recently concluded RASTech 2023 Conference and Trade Fair in Orlando, Florida.

The two-day, sold-out event was held at the JW Marriott Orlando in Grand Lakes. It was attended by more than 400 people from 16 countries who shared their experiences and knowledge in aquaculture and the recirculating aquaculture system (RAS) industry.

During the first keynote session titled "Lessons Learned" speakers discussed their strategies for dealing with crucial challenges their businesses faced. Among the panelist in this session were Damien Claire, Chief Sales and Marketing Officer at Atlantic Sapphire; Justin Henry, owner of Henry Aquaculture Consult and Aquaculture Business Director at University of British Columbia; Per Heggelund, founder of AquaSeed, Sweet Spring Salmon and now, Andfjord Salmon; and Sylvia Wulf, President and Chief Executive of AquaBounty Technologies.

## Establishing partnerships

They agreed that from dealing with supply chain challenges in a post COVID business environment to getting a handle on perennial technical issues and production problems, the flexibility to quickly shift tactics and employ strategic alliances can spell the difference between foundering and thriving.

"Really establishing those partnerships, and working with your collaborators is critical," according to Wulf. For instance, in the months following to the COVID outbreak shipping issues disrupted the delivery of electrical equipment and components needed by aquaculture companies. Prices of materials skyrocketed.



In response, AquaBounty conducted weekly and monthly consultations with its contractors and suppliers. "We were in constant collaboration with our partners to make sure we understood what the critical supplies were, when did we need them, and what was going to happen with pricing," said Wulf.

At one time the cost of copper was shooting up. AquaBounty needed to make decision on whether to buy the material at a high price or wait a bit but run the risk of supply disappearing.

"Sometimes, we need to buy at a higher price than what we had planned for because we will need the product at some point in time. You got to have a plan, but you need to be flexible," Wulf explained. "...We have really been closely working with our engineers and our subcontractors to make sure we consider every efficiency we can find."

Collaboration also means connecting with academia, research organizations, and industry knowledge centres that can provide your business with vital research information according to Heggelund.

"The Freshwater Institute has been the nucleus for all of us...the University of Maryland has been in the same position," he noted. "They may not have seen the same growth issues we seen, but they still keep on working on and solving these issues. We are fortunate that we have so many institutions that can support us as we learn and move forward."

Later on in the conference, while speaking at a business tract titled "Creating a RAS Business Model", Henry drilled down on the areas where a RAS business might need to find collaborators.

"You should ask yourself who should be involved in creating your business RAS model," said Henry.

By doing this exercise, businesses can develop a list of areas where expertise is needed.

"You will need finance expertise, you will need expertise in regulatory framework for the location you want to operate on, you will need RAS technology expertise, you will need operational expertise, RAS design expertise, sales and marketing expertise," Henry said.

This could require "several people, several groups of people, or just one person" but it will mean collaborating.



From left: John Keeler, CEO of Blue Star Foods Corp.; Eric Pedersen, President of Ideal Fish; Martin Gardner, President of Blue Ridge Aquaculture; Geno Evans, CEO of Evans Fish Farm; and David Kuhn, Associate Professor at Virginia Tech.

### Collaboration powers design

“We are still working on fixing some of those issue a couple of years later,” according to Claire. “Our biggest lesson was we decided to move with a new construction team.” Instead of an integrated RAS designer, Atlantic Sapphire chose to partner with a local engineering firm that specializes in water treatment.

“What we learned in Miami is that very strong local partnership with water treatment experts is what we need for Phase 2,” according to Claire. “Water treatment is very similar to RAS. Ultimately, we are a very big water treatment plant with fish in it.”

AquoBounty also sought outside help in deciding the design for its three North American facilities.

Wulf said the water filtration system of her company’s Indiana facility was designed by the Freshwater Institute while the technology used at the Prince Edward Island location came from Innovasea.

“We are using the Indiana facility and technology to train, improve and retain out talent pool and the PEI technology we are designing into our Ohia facility,” she said.

Jamie Stein, Co-Founder of international land-based aquaculture investment firm Devonian Capital, summed up the importance need for collaboration and sharing of knowledge in the RAS industry.

During the Investor’s Forum he said the RAS industry is a fingerling that has just hatched “but it’s not a zero-sum game.”

“Every project we invested in, we worked with talent, experience and hard work from a whole bunch of people,” he said. “...We can provide capital but there’s only so much we can do. Collaboration is critical. Every failure hurts us all, and every time we share experience, we grow the pie.”

This report was contributed by Jean Ko Din, Editor, Hatchery International and RAStech

### Rapid reaction

Asked for his advice on what companies can do when met with a challenge such as a pandemic, Henry said you can either fall back temporarily or meet the hurdle head on.

“For a lot of the projects in the last one or two years, the answer was maybe a bit of a slowdown. Scaling down was the solutions of some people who were forced into a decision,” he explained. “What we’ve done was to take this opportunity to focus on design. We worked together with Pure Aqua to drive cost down through design.”

He said they looked at things such as minimizing the use of high-cost materials and reducing footprint.

Like most aquaculture operations, the Miami RAS arm of the Norwegian company Atlantic Sapphire suffered supply delays and rising materials cost, according to Claire.

“Pre-COVID we had a budget of \$225 million which we had to revise to \$270 to \$300 million, which is quite significant,” said Claire.

To cut cost, Atlantic Sapphire shifted strategies by changing the design of its RAS tanks.

“In our Phase II construction, we actually moved the fish from steel tanks to concrete tanks,” he said. “Cost is the main reason for the change.”

Following some “setbacks” with its Phase I Miami facility, Atlantic Sapphire also decided to change RAS partners.



The Innovasea team at RASTECH 2023 in Orlando, Florida. From left: Juan Pablo Barrales, Constance Beaulaton, Marc Turano, George Nardi and Chris Manley.

## APAC's insect meal players at VIV Asia 2023



The Asian Food and Feed Insect Association (AFFIA) and its members had a successful event at VIV Asia 2023. The AFFIA booth in the association's pavilion attracted hundreds of visitors from different sectors and countries. VIV Asia 2023 was held from March 8-10 in Bangkok, Thailand.

Hundreds of visitors from different sectors and countries visited the AFFIA booth, manned by members; Protenga, Nutrition Technologies, Insect Engineers, Entofood, Veolia, Better Insect Solutions and Global Bugs throughout the three-day exhibition with their smiles, samples, and leaflets. The promotion of insects as food and feed was well received by the other exhibitors and visitors. AFFIA members: Veolia, Insect Engineers and Insect Better Solution, also had their own booth and reported a high visitor rate.

On Thursday, March 9, AFFIA held a conference "Insect-based Ingredients, Applications, Challenges & Perspectives in APAC". The conference attracted over a hundred curious participants. Presentations by AFFIA members engaged the audience with relevant questions and discussions. The strong interest in the insect industry expressed during the whole event from all the participants and visitors is encouraging. AFFIA is proud to represent its members and provide them with highly positive feedback following the participation of such events.

During this session, Nathan Preteseille presented on the AFFIA - FAO project. Other presentations included; The benefits of insect meal and insect oil on growth, digestibility and the immune system of *Litopenaeus vannamei* by Cameron Richards, Veolia; Developing insect products barriers to market entry by Maricar De La Vega, Nutrition Technologies and Practical advances in technology-enabled production systems for cost-efficient and scalable insect production by Leo Wein, Protenga.

This was also an opportunity for AFFIA to invite new members to join the association in order to support the industry forward. AFFIA is also pleased to collaborate with VNU Asia Pacific, the organisers of VIV Asia, as they continue to offer quality events and content to a global and regional audience.

AFFIA will be organising the first Asian Insect Industry & Research Forum (AII&RF) from July 12-14, 2023, at Kasetsart University, Bangkok, Thailand. The event will bring together a wide range of participants and speakers from the ento-industry and beyond for a five-theme conference and exciting networking opportunities. For more information on AFFIA: [event@affia.org/contact@affia.org](mailto:event@affia.org/contact@affia.org)

# VIV ASIA 2023 : A resounding success



In its March press release, the VIV Asia team said that the event delivered a dynamic, expansive marketplace to 47,527 attendees which featured feed to food products and services from more than 1,186 global manufacturers and suppliers representing over 57 countries.

VIV Asia 2023 concluded successfully, as a robust platform for B2B international business. Over three days, the show facilitated face-to-face interactions, networking, knowledge-sharing, and a lively marketplace at Bangkok, Thailand. The event maintained its stable attendance and even slightly exceeded the previous edition. Despite the global circumstances and the past three long years of Covid 19 restrictions, the show's international appeal for the feed to food industry remained evident, confirming its significance as a World Expo.

In addition, the co-location with Meat Pro Asia, the premier trade platform for processing and packaging solution in the meat industry consolidated the feed to food industry under one roof. The animal protein sector responded positively to this powerful co-location, resulting in high attendance. This achievement represents another significant milestone in the VIV global series of events. "VIV Asia is the first VIV show in 2023 and it represents – and rightfully so – our goal to connect the markets, and enhance industry trade both locally and globally," stated Birgit Horn, Managing Director of VIV Worldwide, during the event.

VIV Asia serves as the primary platform for sector leaders in Asia to showcase their latest developments. "We need to reimagine the food system using the new technology. The industry needs to think about this issue as they are in the business of supplying food. VIV Asia and Meat Pro Asia is a really great place to gather new information on this new and important topic. I am very impressed with the show", commented Hunter.

## Technical sessions

There were more than 120 sessions spread over four days and allowed attendees an all-round understanding on industry insights, technologies and best practices. Aquaculture was well represented throughout VIV Asia

2023 with booths clustered within the Aquatic section and technical presentations throughout the three days. On March 7, there was the Aquatic Asia conference: Evolving Aquafeed Towards Meeting a Sustainability Agenda, organised by International Aquafeed and VIV Asia and an Aquafeed Extrusion conference organised by International Aquafeed.

Dr Kallaya Sritunyalucksana-Dangtip, Principal Researcher, BIOTEC & NSTDA, Thailand gave an interesting update on the shrimp microsporidian, *Enterocytozoon hepatopenaei* (EHP) as a component cause of white faeces syndrome (WFS). This presentation was hosted by Kemin Aqua Science. The research team at Biotec have been studying the molecular characterisation and mechanism of virulence of this microsporidian since 2009. They have applied these results

to develop mitigation solutions for EHP outbreaks at the farm level.

Kallaya said that recently, they have found EHP as a component cause of WFS and called this type of WFS as EHP-WFS. This has been found to be associated with chronic AHPND. A laboratory model for EHP-WFS has been established and can be used to test for the inhibitors or management practice for WFS. Her key message was that the post larvae stage is most susceptible. The recommendations included a lower stocking density to reduce the load; when EHP is detected, water exchange will reduce the load; use AP4 primers for bacterial checks.



Kallaya Sritunyalucksana-Dangtip (centre) with the Kemin AquaScience of Grin Swangdacharuk and Dr Rajalekshmi M, R&D Director (right).

**BCF Life Sciences**, France has developed Kera-Aqua, a range of free amino acids mixes dedicated for aquaculture. Extracted from a sustainable protein source, these amino acids mixes strongly improve shrimp and fish farming performances when applied into the feed formulations. Pierrick Kersante, R&D Aquaculture Manager underlined the benefits of the product, Kera-Stim®50 and Kera-Start®88.

Kersante showed that in trials in Ecuador, the supplementation of Kera-Stim®50 in feeds improved post larvae survival rate after 21 days in the pond. In Peru, the trial was on how the amino acids improve survival of shrimp under natural WSSV infection. There was also a trial in a farm in Suratthani to test the product in challenging farming conditions during a white faeces outbreak.



At BCF Life Sciences, Pierrick Kersante (second left) and Luxsanawadee Soonngam, Business Developer, Aquaculture SEA (right).

Dr Orapint Jintasatoporn, Associate Professor at the Faculty of Fisheries, Kasetsart University presented “An innovation in *Vibrio* protection for shrimp” and covered aspects of shrimp growth and gut health. The company Global Nutrition International, France, has a multifunctional feed additive (Globamax AQ Pro™) launched in Thailand. The additive comprises a proprietary combination of protected calcium butyrate, hydrolysable natural polyphenols, organic selenium and yeast-polysaccharides rich in bio-available selenium, beta-glucans and mannans. These support gut health inhibiting *Vibrio in vivo*, antioxidant activity, stronger stress-coping capacity and modulating immune response, respectively. Orapint discussed the effects of the product on growth performance, immunity, digestive enzyme, intestinal morphology and gut vibriosis in vannamei shrimp. There were also results from a disease challenge with *Vibrio parahaemolyticus*.



Sandip Ahirrao, Growel Feeds, India (second left); S. Muthukaruppan, Poseidon Biotech (fourth right) and visitors from India.

### Some highlights in the trade show

Chilean based **Atacama Bio Natural Products S.A.** produces an all-natural astaxanthin from the microalgae *Haematococcus pluvialis* which like other microalgae, contains proteins, carbohydrates, essential fatty acids, vitamins, nucleotides and minerals. The product, Red Meal, gives significantly better pigmentation with lower inclusion rate compared to synthetic or biosynthetic sources. In shrimp aquaculture, inclusion in broodstock diets gives active mating, better egg quality and robust nauplii. Post larvae fed enriched microalgae, rotifer, artemia and pellets gave dark colour heads, vigorous activity and positive rheotaxis. At grow-out, shrimp colour was 27+ colour on the salmon fan.



José Luis Arenas, CEO (right) and Patricio Hidalgo, Technical Sales Specialist at the booth of Atacama Bio Natural Products S.A.

**Chemoforma**, based in Switzerland has Vannagen®, a unique formulation of purified yeast extract enriched in nucleotides. Supplementation in diets showed the following; in Thailand, improved performance, survival and growth of Asian seabass under additional stress, when there was a sudden temperature change from 30 to 24°C; in Egypt, there was a higher immune response post immunisation of tilapia against *Aeromonas hydrophilia*; in India, monodon shrimp under extreme salinity stress, showed improved growth performance and in the Philippines, vannamei shrimp showed higher gain in bodyweight and high survival.



Klaus Hoffmann, CEO, Chemoforma AG (centre) and his team.

# GLOBAL MEET ON GIANT PRAWN 2023

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## GIANT PRAWN 2023 EDITION

The GIANT Prawn conferences were founded by Michael New, OBE. The first was held in Bangkok in 1980, followed by two other conferences in India (2003 and 2011). The Asian Institute of Technology (AIT) organized the 2017 edition in Bangkok, Thailand, and the GIANT PRAWN 2019 at Shanghai Ocean University (SHOU), China.

GIANT PRAWN 2023 is the 6<sup>th</sup> conference in the series, jointly organized by AIT, Thailand, and SHOU, China.

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**Huang XuXiong**

Shanghai Ocean University (SHOU), China

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At the Aker BioMarine booth. From left, Bawanta Suta, Atul Barmann, Lena Burri, with guests; Dr Chen Ming Dang, CPF; Nguyen Duy Hoa, Cargill Vietnam; Suphol Phantumaphas, CPF and Norman Lim, Corbion. Second right is Chaiyot Rawekchom and fourth right, Panukorn Totubtim, Sales Manager Krill Sales Manager.

**Aker BioMarine** has Krill Aqua and aside from several presentations at their booth, the team comprising Dr Lena Burri, Director R&D Animal Nutrition and Health, Atul Barmann, General Manager, Aker BioMarine India and Chaiyot Rawekchom, Regional Sales Director Krill SEA also discussed some recent developments. Atul said that imports of krill meal into India have increased in the last three years, helped with a reduction in duty. Chaiyot said that they have made major inroads with the top 5 feedmills in Indonesia, Thailand and Vietnam. Industry is aware, understand and can differentiate its benefits with regards to attractability, robustness and nutritional value. As a science-based company, the Aker BioMarine team depends on extensive research to understand the full potential of this tiny crustacean, and to ensure the well-being of the krill biomass.

There have been several review papers in scientific journals. In the latest review, the team at Labomar in Brazil evaluated the impact and cost effectiveness of krill meal in vannamei shrimp formulations. The conclusion was that krill meal is an effective functional ingredient, mitigating some challenges and is cost effective as well. Another study by the same group looked at krill meal in developing sustainable feed and said it is a viable supplement to fishmeal in shrimp diets. Aside from India, Indonesia is a key strategic market for Aker BioMarine, and it has appointed Bawanta Widya Suta as Aquaculture Sales Manager in the Animal Health and Nutrition department. In late-2021, the company announced a strategic partnership with Seven Stones Indonesia to support its market entry.



Shellen Ng Clark (left) and Ronnie Tan (centre), US Grain Council, with Gesang Katmoko, Cargill.



G. Ramesh, Wenger India (right) with the Wenger Asia in Taiwan, from second right, Paul Chen, Julius Lin (Service Engineer); Jason Ho (Senior Engineer) and Mark Lewis (Senior Engineer).



From left, Robert Redman, Veramaris; Bunluesak Sorajjakit, Thai Union Feedmill; Zuridah Merican, Aqua Culture Asia Pacific; Jose Maria Hernandez, dsm-firmenich and Ramakanta Nayak, EW Nutrition.



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After a hugely successful debut, the Global Shrimp Forum is back and this year it will be even bigger and better, said the organisers. Once again it will take place in Utrecht, the Netherlands, from September 5-7, 2023. Established by the Aquaculture Stewardship Council, Shrimp Insights and Contango, the Global Shrimp Forum Foundation (GSFF) is an independent non-profit and mission-oriented organisation based in Utrecht.

In this edition, GSFF has announced More than 100 speakers and panellists have been confirmed and this year, to set the scene, the Forum will open with a leadership panel, including President of Cargill Aqua Nutrition, Helene Ziv-Douki, General Manager of Omarsa, Sandro Coglitore and Chairman of Devi Fisheries, Rajagopal Choudary Chitturi.

There is a star line-up for the breakout sessions featuring industry leaders such as, General Manager of Skretting Ecuador, Carlos Miranda, CEO of Marinasol, Roberto Ferron, Shrimp Buyers Maruha Nichiro and Hidetami Haruta, and Managing Director of MU Seafood, Shyamal Das. The programme as announced in May will include:

- Trade Statistics: The Latest Import and Export Trends
- Feed Manufacturing and Feed Ingredients
- Production: Strategies to Sustain Shrimp Production in Challenging Times
- Finance and Investment: CEO Visions and Investor Reflections
- Animal Welfare and Decarbonisation
- Technology and Innovation
- Retail and Consumption

GSFF is also funding a study to inspire discussion about how to promote global shrimp consumption. The preliminary results of the research will be presented and debated as part of the meeting. During an invitation only lunch, the world's top producers will also discuss the status of establishing a global shrimp council.

The Global Shrimp Forum is the place where industry leaders can come together to discuss the most pressing issues their businesses face, and to develop a long-term strategy towards the creation of a resilient and sustainable industry. The GSF aims to facilitate discussion and encourage collaboration.

"In 2022, at the inaugural event, GSF gathered over 430 people, representing over 225 companies and 33 countries. It delivered 2.5 days of content, with plenty of networking opportunities and celebration. The feedback we received was overwhelmingly positive and it was clear that the warm water shrimp industry had been waiting for a dedicated event. With support from our partners, we are certain that the Global Shrimp Forum will grow to the next level," said Willem van der Pijl, Owner, Shrimp Insights and GSFF Board Member and Managing Director.  
[www.shrimp-forum.com](http://www.shrimp-forum.com)



## EDITORIAL CALENDAR 2023

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

Volume 19	July/August	September/ October	November/ December
Deadlines - Technical articles	May 16	July 18	September 19
Deadlines - Advert Bookings	May 23	July 25	September 26
Innovations/ Startups	Experiences and opinions covering role models; clear and present needs of industry; innovations and digitalisation in aquaculture		
Interviews with industry leaders	Focus in 2023 will be leaders pushing for sustainable aquaculture		
Issue focus Emerging trends and challenges	Demand & Supply Equilibrium	Aquaculture Innovations	Health & Disease Management
Industry Review	Tilapia	Marine Fish	Coffish & Freshwater Fish
Feeds & Processing Technology	Novel Ingredients	Larval & Nursery Feeds	Feed Enzymes
Production Technology	Real Time Monitoring/Big Data	Feed management	Post-Harvest Processing
Marketing activities	Market and product developments, generic marketing, certifications, branding, food safety etc		
Company/Product News	News on activities at international, regional and local conferences and trade shows		
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Reservations are accepted on a first-come basis. For more information, programs and application forms, contact: Mian N. Riaz, Ph.D, Director, Extrusion Technology Program, Professional & Continuing Education- TEES Edge, Texas A&M University, USA. Email: [mnriaz@tamu.edu](mailto:mnriaz@tamu.edu) <https://foodscience.tamu.edu> /<https://teesedge.tamu.edu/online/extrusion>

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[www.responsibleseafood.org](http://www.responsibleseafood.org)

**August 16-17**  
TARS 2023 - Shrimp Aquaculture,  
Bali, Indonesia  
[www.farsaquaculture.com](http://www.farsaquaculture.com)



**August 25-27**  
VIETFISH 2023  
Ho Chi Minh City  
[www.vieffish.com.vn/en](http://www.vieffish.com.vn/en)

**August 31- September 2**  
Taiwan International Ocean and Fisheries  
Show (TIOFIS 2023)  
Taipei  
[www.taiwanfishery.com.tw](http://www.taiwanfishery.com.tw)

**September 5-7**  
Global Shrimp Forum  
Utrecht, The Netherlands  
[www.shrimp-forum.com/](http://www.shrimp-forum.com/)

**September 18-20**  
Aquaculture Europe 2023,  
Vienna, Austria  
[www.aquaeas.org](http://www.aquaeas.org)

**September 20-22**  
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[www.ildexindonesia.merebo.com](http://www.ildexindonesia.merebo.com)

**September 26-27**  
THRIVE Hawaii Agrifood &  
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[www.TropAgTech.com](http://www.TropAgTech.com)

**October 23-26**  
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**November 13-16**  
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[www.was.org](http://www.was.org)

**November 27-29**  
Giant Prawn 2023  
Bangkok, Thailand

**December 7-9**  
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