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Firm, Tight-Grained Texture Tilapia
Trust Deficit with Functional Feeds
Singapore's Urban Shrimp Factory
Interview with Brett Glencross

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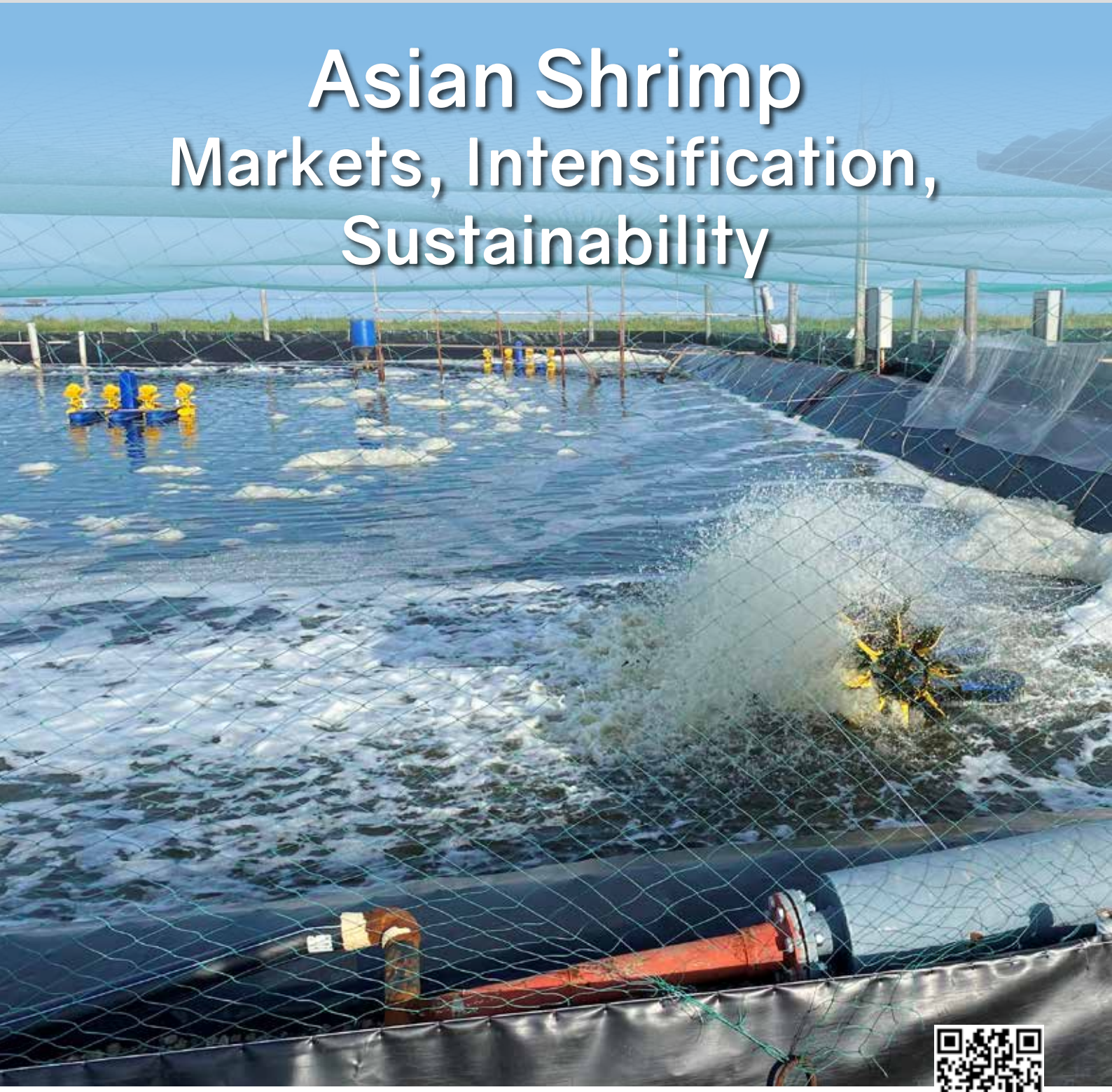
Asian Shrimp
Markets, Intensification, Sustainability



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Zuridah Merican

The problem with Asian shrimp aquaculture today

After 18 months of enduring the Covid-19 pandemic and lockdowns overturning the 'business-as usual' mode, the Asian shrimp aquaculture industry also sees over 45 years of existence as a business. It would be timely to review the state of industry and perhaps the best way is to look at the takeaway messages from TARS 2021 – Shrimp: Markets, Margins and Productivity held from August 18-20 and the breakout panel discussion on September 9.

Let us start with demand and the major markets of the US, EU and China. The common theme is the lockdowns have increased the share of the retail market over food service. With the reopening of food service, the demand has shown a net increase in the US with strong replenishment of the supply chain. A notable surprise is the lack of growth in Asian shrimp in the EU markets while in China, Ecuadorian shrimp has a better reputation. While Ecuador has made headway with its Sustainable Shrimp Partnership (SSP), Asia is still unable to tell a coherent sustainable story.

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Is this due to the largely fragmented industry and lack of traceability in the non-integrated supply chain or competition between countries and even the lack of cooperation amongst players within a country or all three factors? Whichever case, the Asian shrimp is not only lacking a sustainability label but also lacks the impetus to do so. Willem van der Pijl suggested pre-competitive branding led by major players in India.

Does the SWOT analysis reveal that the Asian model is the correct way forward? With increasing demand for shrimp and a lack of resources of land and water, the answer is yes but most farms are still stuck in a model 2.0 while the wish is a model akin to the Industrial Revolution 4.0. The biggest consequence of the current Asian model is the higher production cost per kg resulting from low survival rates and high disease incidences. Asia can only remain competitive if demand continues to grow faster than supply and global prices hold firm, but we are already hearing numerous countries reaching for the 1 million tonne production mark. This outlook does not provide confidence to potential investors. The choice is clear; to be market-led with sustainable shrimp or production driven and struggle with low prices.

To build confidence in potential investors, the following constraints must be answered. Our model today lacks predictability and there are no preventative measures in disease mitigation. Furthermore, there is no learning from the previous failure. The shrimp model 4.0 requires innovations in both hardware and software. The RAS model meets the hardware requirement of climate control and total water management but the cost of production on a per kg basis is still prohibitive to move the industry to make this revolutionary change. Perhaps a hybrid system could be a way forward. Assuming we currently take 100 days to reach size 60, this could be broken down to 20 days in hatchery, 30 days in a RAS nursery and 50 days in a grow-out pond to reduce production costs.

The software comprises 3 components i.e. artificial intelligence for real-time monitoring and predictability, big data analysis for the iterative learning process and the internet of things (IoT) to link all together. In this software area, the industry already sees numerous promising startups and TARS 2021 showcased four of them. Another weak link in the supply chain is our lack of strategy in tackling climate change. Shrimp aquaculture's early history has been tainted by deforestation of mangroves and this still plaques us today. Due to the unique geographical requirement of shrimp farms, many are located far away from the national electrical grid forcing them to rely on diesel generator sets and this is not winning any points on the SDGs agenda.

This TARS highlighted two challenges with information. The first is the ability to determine usable and true data from all the accumulated data but perhaps the bigger issue confronting the industry is the reluctance to share information. Asian players hold the misconception that sharing equates to losing their competitive edge, failing to recognise that a rising tide lifts all boats. Pushing for a disruption here may be expecting too much but we must think of ways to ratchet up the cooperation amongst all of us.

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The Asian shrimp in EU, China and US markets

Market trends, popularity of Ecuadorian shrimp and how to position Asian shrimp in these markets

The virtual edition of The Aquaculture Roundtable Series (TARS) 2021 addressed ways to move the Asian shrimp industry forward. Over three days, attendees networked and posed numerous questions in discussion boxes for presenters and industry players in seven sessions. More questions were posed by groups attending the breakout session which deliberated on how to create alliances along the supply chain with farmers, since it is critical that the farmers succeed in farm operations and hold sufficient margins to be sustainable. At the Hard Talk, three business leaders discussed why is there a trust deficit on the use of functional feeds by shrimp farmers in Asia (see pages 49-53).

This year, the theme was Shrimp: Markets, Margins and Productivity. The COVID-19 pandemic has disrupted Asia's shrimp producers with supply chain and logistics issues. There were combinations of hindering broodstock imports and post larvae deliveries, coupled with uncertain market demands, and low prices, while farmers struggle with disease outbreaks, low survival rates and high costs of production. TARS 2021 had 402 registered attendees and was held from August 18-20. It was organised by Aqua Culture Asia Pacific and Corporate Media Services, in collaboration with industry sponsors: DSM Nutritional Products, INVE Aquaculture, Biomin, Corbion, BASF, Adisseo, Jefo Nutrition, Diana Aqua, and Grobest. The TARS 2021 program started with presentations on the state of markets in the EU, China and the US. The concern raised, with shifts in demand and increasing presence of Ecuadorian shrimp, was how to position Asia's shrimp in these markets.

Markets for farmed and wild penaeid shrimp in EU 27

In 2020, **Willem van der Pijl,** owner of Shrimp Insights, estimated that the total market for *Litopenaeus vannamei* was 250,000 tonnes with 180,000 tonnes coming from South America, while that for *Penaeus monodon* was 30,000 tonnes. Typically, South American shrimp is sold in southern Europe as head-on shell-on (HOSO) and shrimp from Asia is sold in northwestern Europe.

For all shrimp (including Argentinian shrimp) products in Europe, imports were almost flat since 2019. But in 2020, imports of vannamei shrimp increased, demonstrating that vannamei is more a retail product and possibly due to Ecuador's market push. More importantly, he explained, "In 2020, while South America increased its market share

In the first session on State of the Industry – Understanding Markets and Consumers, speakers were from top right, clockwise, Lee Ho, Zhanjiang Gangyang Aquatic Co Ltd, China on China's vannamei shrimp market; Angel Rubio, Urner Barry USA on the US market and Willem van der Pijl, Shrimp Insights, The Netherlands presented on "A close look at the EU 27 market". Lourdes ChingLing Tanco is from Mida Trade Ventures, Philippines; Ronnie Tan was the moderator and the industry panellist from India was S Santhana Krishnan, Marine Technologies.

by almost 15% to 177,300 tonnes, led by Ecuador and Venezuela, Asian suppliers lost market share, from almost 81,200 tonnes in 2019 to 75,300 tonnes in 2020. Asian supplies were mainly vannamei from India and monodon shrimp from Bangladesh. Ecuador is responsible for most of the growth of South American shrimp in Europe, expanding from 89,000 tonnes in 2015 to 123,500 tonnes in 2020!"

Van der Pijl added, "Venezuelan producers say that they can double the volume sold in Europe in the next couple of years (currently at 20,800 tonnes) but it is not only Venezuela - but all the smaller South American countries are also waiting to increase their market share in European markets."

Asian exports of HOSO/HLSO/peeled shrimp comprised an estimated 75% of vannamei shrimp. Asia's cooked and valued added shrimp amounted to 28,000 tonnes in 2020. In Europe, the declining trend with imports from Asia was already happening since 2015; the CAGR (2015-2020) was -4% while South America had a CAGR+7%. Over the same period, India and Bangladesh had -9% and -5% CAGR, respectively, but Vietnam showed a positive CAGR of 6%. India lost its top position in the raw and peeled segment as she continues to have unresolved issues on antibiotics with the European Union.

Is there a future for Asian shrimp in EU markets?

Industry panellists, Lourdes Chingling Tanco, Mida Trade Ventures, Philippines and S. Santhana Krishnan, Marine Technologies, India expressed concerns on difficulties to enter markets in Europe. Van der Pijl said that similar to Ecuador, pre-competitive cooperation is needed for Asian shrimp to be perceived as safe, sustainable and tasty. In the northern European markets, South American shrimp are not yet competitive in the frozen peeled segment. "Even though prices have dropped, I believe that price is not the only factor. Ecuadorian producers will want to ensure that they do not lose market share as they want to be less dependent on the Chinese market."

"At this TARS, this is something to think about. I strongly believe that Asian shrimp can compete on quality and sustainability with South American suppliers. Ecuador, however, has created a market perception of premium shrimp compared to Asian shrimp, asking for higher prices," said Van der Pijl.

"Consumers' perceptions are forcing retailers to put more stringent measures, beyond certification. The time has come in Asia, at the pre-competitive level, for feed companies, processors, farmers and hatcheries to come together and ask, 'how do we tell our story?"

China's vannamei shrimp market

Lee Ho, Procurement Manager, Zhanjiang Gangyang Aquatic Co Ltd, Guangdong, China showed that the import volume of vannamei shrimp reached a peak of almost 90,000 tonnes in December 2019. This changed in January 2020, dropping to 64,000 tonnes and a drastic decline in February 2020, during the Chinese Spring Festival to 30,000 tonnes. "With closure of restaurants, Ecuadorian shrimp prices dropped to USD1.5/kg. When the pandemic was under control, buyers continued buying as prices were low. China imported 650,000 tonnes in 2019, 518,251 tonnes in 2020 and the estimate for 2021 is 520,000 tonnes."

In June 2021, imports from Ecuador took up 64%, followed by India with 17%. Lee attributed the popularity of Ecuador's shrimp to taste and quality. With regards to consumer perceptions between local shrimp versus imported shrimp, Lee said that if there are no reports on imported shrimp carrying the coronavirus, consumers will accept, particularly, large sizes for food service. "As long as the price is reasonable and shrimp are fresh, Chinese consumers are willing to pay. Local shrimp are cheaper than imported shrimp but sizes are also smaller."

How to position Asian shrimp in China's markets

Lee's message to Asian producers is to work on sustainablity, not to use antibiotics and strengthen the concept of quality in all areas. "China imports from many Asian countries, but the offer prices from these Asian countries are always higher than those by Ecuador and India. They should find out the reasons behind the high prices. Chinese consumers need not only fresh shrimp, but also at a cheap price. The market needs large volumes of HLSO raw materials to produce peeled deveined (PD) shrimp since Chinese customs have banned several Indian factories from exporting to China."

He also explained the need to understand risk of exporting to China. "At present, many containers of shrimp exported to China have been returned for the following reasons: poor packaging, shrimp diseases (WSSV, IHHNV), excessive heavy metals and detection of coronavirus in outer cartons. Note that even disinfected cartons with dead virus will still be rejected as COVID-19 positive imports."

US shrimp market

Angel Rubio, Senior Analyst, Urner Barry Consulting, USA, showed that US shrimp imports continue to rise. Based on the January-July import volumes, the estimate for 2021 is 1,062,000 tonnes, a 28% increase over that in 2020. In the first half of 2021, volumes increased by 30.4%. Imports of peeled shrimp rose 41%, shell-on 18% and cooked shrimp, 45%. These are a result of an inflated retail sector with double digit growth yearly and food service come-back. Cooked shrimp went to retail while peeled shrimp went to a combination of retail and food service since March.

Producers and disrupters in 2020-2021

"A big change, accelerated by the pandemic, was that lots of Ecuador products that used to go to China, came to the US and went to Europe. The question is whether Ecuadorian volumes to the US will persist, or will they be diverted once China starts buying again. What will happen with the Delta variant of Covid-19, with China closing ports and further food service restrictions and whether Ecuadorian shrimp will stay in the US?" asked Rubio.

India is the main supplier to the US at 570,800 tonnes in 2020. In the first half of 2021, imports from India rose 28%. Rubio said that India's volume recovery in the US market was attributed to the focus on value-added products for retail and PD raw shrimp for food service. Imports of peeled shrimp from India rose almost 38% but shell-on shipments dropped 10%.

Total imports of Ecuadorian shrimp rose 86%, with more of shell-on shrimp than in 2019. "Ecuador's shell-on imports rose more than 70% but surprisingly, Ecuador has been sending peeled products to the US at a competitive price. The volume is a third of that from India." Rubio also presented data on Ecuador's exports globally.

Before the pandemic, rough volume estimates suggest shrimp constituted 70-74% food service and 26-30% retail. After the pandemic, food service contracted 28%. This was reflected by the retail sales, 415 million pounds were sold in 2019-2020 and Angel's estimate for 2021 was about 539 million pounds, meaning that the share jumped from about 25-30% to 32-39% year-over-year.

Rubio also discussed the "premiumization" of shrimp in the protein market. "It pulls the element that when people have more disposable income, and in the US, this comes with the stimulus packages, as well as expenditures that did not go to other sectors that were paralysed by the pandemic, such as tourism. Despite margins in retail rising and the price to the consumer going up, the consumer has been able to bear the increased cost and retailers will continue to promote shrimp. In summer, food service sales are back to pre-pandemic levels."

Prices and margins

In the US, over the third week of August 2021, prices have stabilised. Rubio said "During this crisis, we have seen demand shocks; usually this comes with spikes in prices and volatility. We have not seen this before and is an element of support to the market." Using UB index for HLSO and value-added shrimp, he reported on the annual average of wholesale prices. "In 2020, we reached the lowest prices overall since 2010. In 2021, in the last 7 months, we have seen a recovery. The prices last year due to the pandemic were absolutely unsustainable. Recently prices shot up. Historically the importers' margins, as measured using import USD/lb and Urner Barry's wholesale index as benchmarks are sustainable at about 5-6%. Recently, we saw margins rising but may decrease as costs are coming up with higher costs of logistics and labour."

Popularity of Ecuadorian shrimp

Evidently, there is the Ecuador factor in these three markets. While Lee said that aside from the price - Ecuadorian shrimp is the cheapest, in China, it is also the commitment given to Chinese importers by Ecuador's government and producers on sustainable shrimp farming practices including no antibiotics is used during the farming process. China's importers still look for low prices, wherever they might come from but ultimately the innuendos from Lee's data point to a preference for shrimp from Ecuador.

Important to Europe, Van der Pijl said, "Ecuador is one of the few countries in the world that has managed to build a country brand, the Sustainable Shrimp Partnership (SSP) brand; built up through the marketing campaign by the national association, Cámara Nacional de Acuacultura and the top five shrimp companies together with feed companies."

In US markets, Rubio said that compared to Asia, Ecuador is more convenient for US buyers; less logistical issues. On top of this, US buyers perceive Ecuadorian shrimp as premium. Admittedly, Ecuador has an advantage as Chingling pointed out, "There are the risks with importing Asian shrimp, which currently can take up to 6 weeks as compared to 14 days with Ecuadorian imports. In addition, logistics and transportation costs are bleeding exporters."

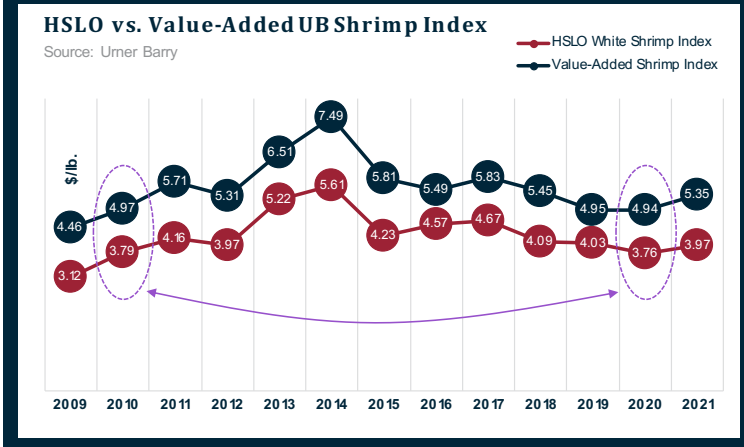
Outlook on demand

In Europe, Van der Pijl expects to see a strong demand for Asian shrimp especially in northwestern Europe all the way into 2022. In the north, the demand is for larger shrimp, and in the south, it is the smaller shrimp. In US markets, despite the threat of the Delta variant, Rubio expects demand and prices to be supportive for the rest of 2021.

Lee expects that China will continue to be the leading importer despite the increase in production within the country itself. China is a potential market for vannamei shrimp because of its high per capita consumption at 1.65kg/year. "The annual consumption in 2021 is estimated at 2.3 million tonnes of vannamei shrimp, rising to 2.4 million tonnes in 2022. This is a large volume and the key driver for shrimp consumption is income, the higher the income, the more seafood consumption. With rising income, we believe that it may not be difficult to reach 2kg/person in 2022".

However, he cautioned, "At the same time, we should be prepared. These are the problems associated with frozen products. If exports are contaminated with the coronavirus pathogen, the container will be returned and permit for exports will be cancelled. In future, solving this is key to business. Many experts are now studying the impact of COVID-19 on cold chain transportation, but the final conclusion is still not available. If it is shown that cold chain transportation helps COVID-19 to spread, it will have a great impact on this business."

Annual Average Wholesale Price (spot market), UB index



- Lowest level reached in 2020 since 2010
- Foodservice recovery early 2021 causing prices to move up quickly
- Seems recovery is well underway
- Value-added major winners
- Shell-on could expand on niches, particularly due to the "premiumization" of many commodities.

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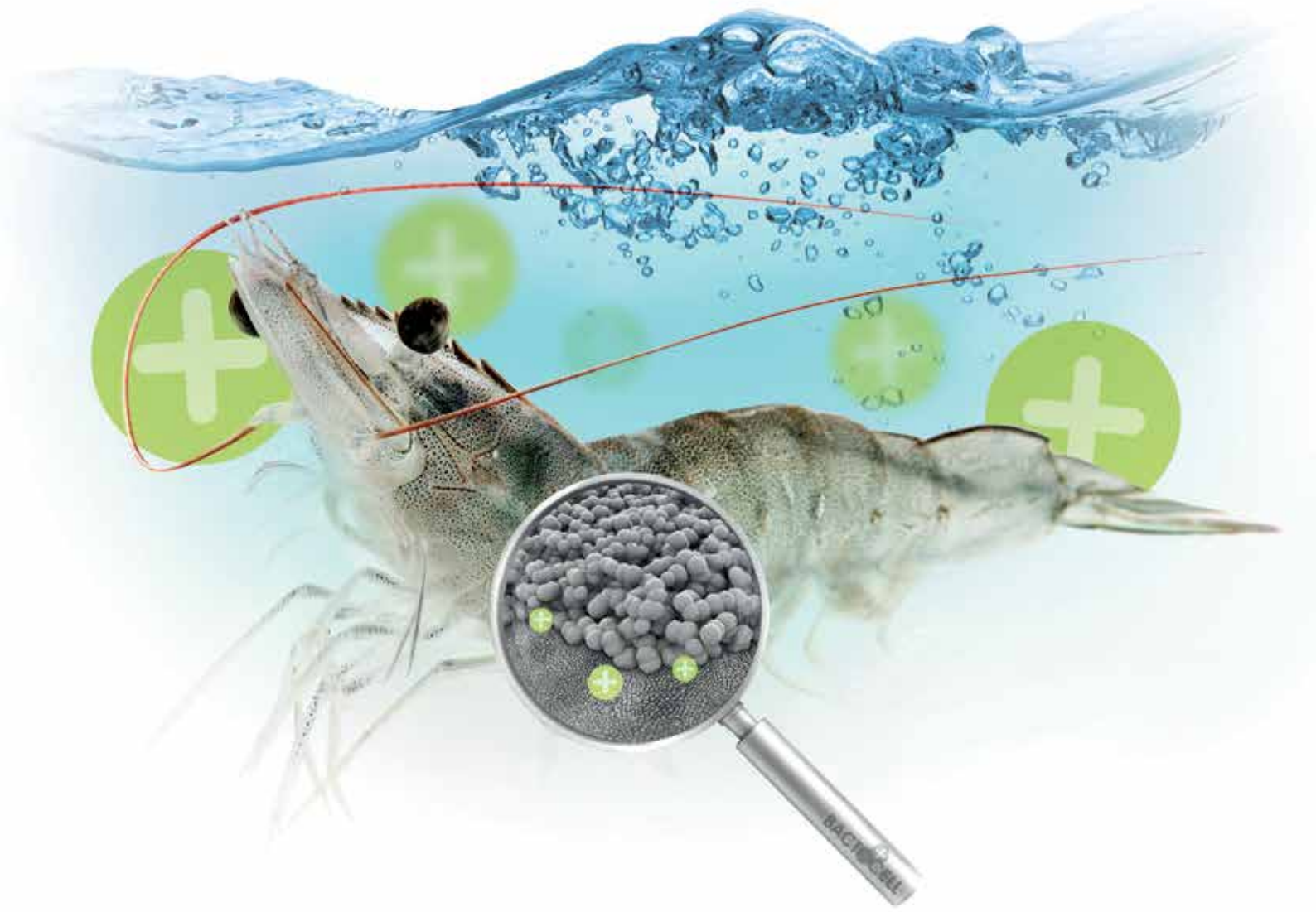

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A decade - long service to the shrimp sector

India's Aquatic Quarantine Facility has played a major role in pathogen control via rigorous disease screening and stringent quarantine protocols

By M. C. Remany, Daly Cyriac, Sruthi Prem O. C, Kannan D, Razak Ali and Kandan S

MPEDA's centralised Aquatic Quarantine Facility is a dedicated quarantine facility for all imports of broodstock to safeguard the industry from transboundary transfer of disease pathogens.

The Aquatic Quarantine Facility or more popularly known by its acronym, AQF in India's shrimp hatchery segment, is located at Neelankarai, Chennai, South Tamil Nadu. The facility is India's one and only state-of-the art quarantine unit for shrimp. Over the last decade, it has played an important role in ensuring specific pathogen free (SPF) status of imported shrimp broodstock.

AQF was established in 2009, when the Government of India permitted commercial culture of the Pacific white leg shrimp *Penaeus vannamei* in the country. The facility was created by the Marine Products Export Development Authority (MPEDA), Government of India with funding assistance from the Ministry of Commerce & Industry (MoCI) and the National Fisheries Development Board (NFDB).

The vannamei shrimp in India

A native to the Pacific coast of Mexico, Central and South America, *P. vannamei* occupies the prime position in the list of cultured shrimp species in Latin America, over the past 20 years. With the development of the first population of SPF *P. vannamei*, and its commercialisation in more than 67 countries across the world, including Southeast Asia, India too successfully introduced its culture. The species now accounts for 77% of the total global production of shrimp and almost 94% of Indian's shrimp production in 2019.

Until 2009, shrimp culture in India had been monocentric, with emphasis on the black tiger shrimp *Penaeus monodon*. Monodon-based aquaculture and production had been spectacular until it experienced severe setbacks due to the emergence of viral diseases during 2005-2008. Shrimp production stagnated and declined to less than 80,000 tonnes and led Indian shrimp farmers to realise that wild and undomesticated broodstock could no longer sustain the shrimp farming sector in the long run. This urged the Indian Government to permit commercial culture of *P. vannamei* which was already the main species being farmed in most Southeast Asian countries.

Accordingly, the Government permitted imports of SPF *P. vannamei* broodstock after taking adequate management measures to mitigate risks associated with the introduction of the exotic shrimp. One such measure is the establishment of a dedicated quarantine facility for *P. vannamei* broodstock. Since then, its production and exports surged exponentially. By 2019, India rose to second position among farmed shrimp producing countries of the world.

About AQF

The AQF, is a central Government run quarantine facility dedicated to serve the shrimp sector. It has 20 quarantine cubicles with well-designed biosecure infrastructure to accommodate and quarantine imported broodstock, arriving from various broodstock suppliers, across the globe. The facility has also a dedicated Parent Postlarvae Quarantine (PPQ) unit to quarantine the post larvae that are imported by government approved Broodstock Multiplication Centres (BMC). The quarantine capacity of AQF is about 412,500 broodstock per annum.

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Parent Post larvae Unit to quarantine post larvae imports by government approved Broodstock Multiplication Centres (BMC).

The cubicles are housed in three phases (Phase I, II and III). The first phase is the oldest phase, established in 2009 and houses four cubicles. Phases II and III were set up in 2013 and accommodate 3 and 13 cubicles, respectively. The largest phase comprises two subunits Phase III (a) and Phase III (b), each with seven and six cubicles, respectively. The construction of an additional phase IV with six more quarantine cubicles, is underway. The interspersed nature of cubicles helps the facility to maintain biosecurity in an orderly manner while at the same time offering year-round quarantine services to importers.

The facility is also equipped with a disease screening laboratory with highly sensitive molecular diagnostic tools to monitor the SPF status of imported broodstocks.

Inside a broodstock quarantine cubicle

Operations at the AQF

The facility operates on a strict SOP (standard operating procedures) framed by six government organisations namely the Coastal Aquaculture Authority (CAA), National Fisheries Development Board (NFDB), Animal Quarantine and Certification Services (AQ & CS), Central Institute of Brackishwater Aquaculture (CIBA) and MPEDA.

The quarantine services are available to all hatcheries importing shrimp from 12 broodstock suppliers which have been approved by CAA (Table 1).

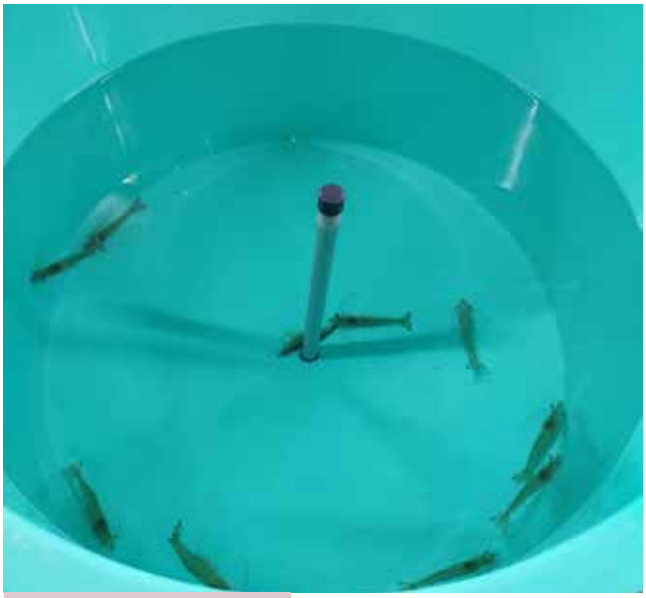
Sl. No	Approved Broodstock Suppliers
1	M/S. Shrimp Improvement Systems LLC, Florida, USA
2	M/S. Shrimp Improvement Systems Hawaii LLC, Hawaii, USA
3	M/S. Kona Bay Marine Resources, Hawaii, USA
4	M/S. American Penaeid SPF Genetic Center, Florida, USA
5	M/S. Sea Products Development LLC, Texas, USA
6	M/S. Molokai Broodstock Company, Hawaii, USA
7	M/S. M/S. Oceanic Institute of Hawaii Pacific University, Hawaii, USA
8	M/S. Shrimp Improvement Systems Pte Ltd, Singapore
9	M/S. Ceniacua – Genetica Spring, Colombia
10	M/S. Blue Genetics, Mexico
11	M/S. PT. Bibit Unggul, Indonesia
12	Syaqua Americas Inc, Florida, USA

Table 1. Current list of empanelled SPF *P. vannamei* broodstock suppliers

Shrimp broodstock imported by private hatcheries are subjected to rigorous disease screening protocols at the facility, for SPF status of the OIE listed shrimp pathogens and pathogens of concern. Once the stock is declared SPF, the consignments are handed over to the importer after issuing quarantine clearance certificate by AQ & CS, Chennai.

History of imports in the last decade

Imports of vannamei broodstock into India from various CAA approved broodstock suppliers are shown in Figure 1. This data covering the last decade (FY2011/12 to 2020/21), showed that broodstock imports were mainly from the USA followed by suppliers from other regions. By the end of March, 2021 imports from Supplier 1, Florida, reached 941,947 broodstocks and 640,285 broodstocks from Supplier 2, Hawaii.



Broodstocks in a cubicle tank

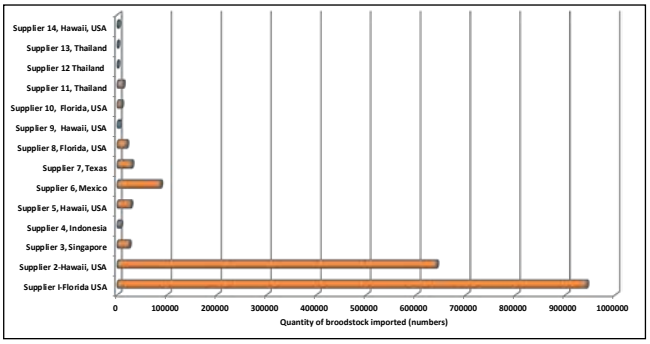


Figure 1. Imports of *P. vannamei* broodstock into India, according to suppliers over the last ten years. Note: Broodstock suppliers from Thailand were banned from exporting to India as per the notification issued by the Ministry of Agriculture dated May 27 2013.

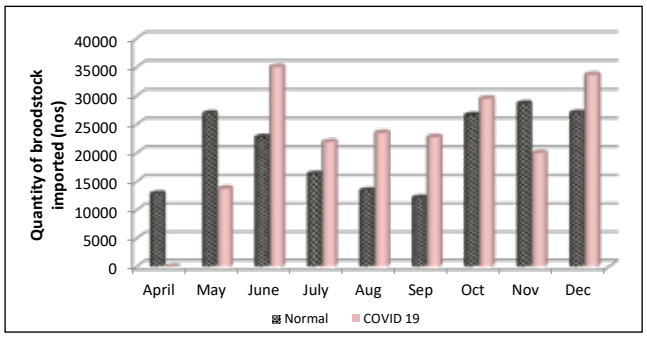


Figure 2. Comparison on imports of *P. vannamei* brooders during normal months in 2019 versus during the pandemic months in 2020.

A solatium to vannamei hatcheries

The facility remained as a solatium to the hatchery operators even during the difficult times of this COVID 19 pandemic which resulted in a national lockdown. Relaxations were given on the sanitary import permit, which was once a mandatory document required for importation of shrimp broodstocks. Considering logistical issues, AQF operated the facility 24/7 without compromising on biosecurity, and accepting large volumes of shipments, despite odd arrival times, as well as providing complete relaxation in its scheduled arrival. Suppliers shipped their broodstocks to India via chartered flights.

The validity of the CAA issued annual allocation permits were also extended by one month as per the ministry's order. All these enabled hatchery operators/importers to carry out their operations without much difficulty. The data on importation registered during the pandemic against the corresponding months of the normal period (Figure 2) indicated an overall surge in imports by 7.3%.

Quarantine survival

This is one of the crucial moments that every importer looks forward to, on completion of the quarantine period, when the quarantined stocks are handed over to the importer.

AQF delivered good quarantine survival rates of broodstocks. The mean quarantine survival recorded by the facility ranged from 90.13 to 99.62%, on completion of the quarantine period of 5 days, irrespective of the source of broodstock.

Conclusion

The AQF stands as a firewall by preventing the spread of diseases into the country. The facility through its stringent biosecurity protocols has commenced quarantining SPF *P. monodon* broodstock and post larvae, since 2019. The facility has so far ensured the SPF status of 2,882 *P. vannamei* broodstock shipments, comprising 1,904,076 broodstocks sourced from various approved suppliers since its inception. Among these, one shipment was declared as non- SPF for an OIE listed disease by AQF. The results of this shipment were validated and confirmed by CIBA, the referral laboratory of AQF. The entire consignment was destroyed within the facility as per the direction of the technical committee on AQF operations. The rigorous disease screening protocols and strict biosecurity measures followed in the facility, cautions suppliers to be more vigilant in health certification of the stocks that they bring into India.

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HENDRIX GENETICS

Vannamei shrimp production in the Philippines: Is there a revolution ahead?

Reaping higher harvests with intensification, new culture systems and using performance functional feeds

By Ronaldo Gatilao, Wilson Dayaday and Thommy Tablatin

Mabini Aquafarms, Inc. has a super intensive pond set-up situated at Mabini, Davao De Oro, Mindanao. Encouraged by three successful crops using Grobest functional feeds and technology, it is expanding with another seven ponds to be operational by September of this year.

Shrimp aquaculture started in the 1980s in the Philippines, reaching an annual production of 120,000 tonnes in 1992, mostly *Penaeus monodon*. However, during the last two decades, shrimp production (*P. monodon and Penaeus vannamei*) has remained below 60,000 tonnes per annum.

In 2019, the mood of shrimp producers was more optimistic, anticipating 60,000 to 70,000 tonnes of *P. vannamei* production. In 2020, the Bureau of Fisheries and Aquatic Resources (BFAR) had approved 3,300ha for *P. vannamei* monoculture and 2,300ha for *P. vannamei* polyculture systems. This increase in vannamei production is reflected in the increased importation of vannamei broodstock. With the development of new farms in the southern regions and the intensification of existing farms in the central regions, production is expected to grow by 3-5% per year.

Despite the COVID-19 pandemic, shrimp production in 2021 is expected to reach 52,000 tonnes, with >45,000 tonnes from intensive farming, which will result in a 4% increase compared to 2020.

Shrimp Sales Head Ronaldo Gatilao (left) with from left, Mabini Aquafarms, Inc. owners Josue "JT" Tesado, Sr. and Josue "Jun" Tesado, Jr., together with Isidro "Ding" Bastida, General Manager of Mabini Aquafarms, Inc.

Compared to many other Southeast Asian countries, the Philippines differs in two ways:

- Most of the shrimp is consumed locally (wet markets, wholesalers, and retail).
- Production is dominated by independent enterprise farms, vertically integrated companies and feed suppliers rather than small-scale farms.


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Zest Cook 117 Inc. located at Bago City, Negros Occidental, Visayas operates a closed-intensive system with a reservoir and HDPE-lined ponds. Their annual production is 200 tonnes per year.

Intensification

Recent developments in the Philippines include an increasingly higher stocking density, from 70 post larvae (PL)/m^2 to 200 PL/m^2 or even 300PL/m^2 and higher yields. With increased stocking density, there is increased investment in the infrastructure but also higher risks, such as disease or mangrove deforestation and pollution of coastal waters.

The intensification of shrimp production in the Philippines has led many farmers to look for the best protocols to sustain fast growth with reduced impact on the rearing conditions. This requires feed with high palatability, digestibility and reduced leaching. Similarly, the increased stocking density leads to potentially stressful conditions and higher disease risks. Farmers rely on water treatment products and a range of additives for the top dressing of feeds. This time-consuming process is prone to human error and it negatively affects feed stability and performance. Consequently, farmers increasingly rely on functional feeds to support shrimp during critical phases of the culture.

Experiences of farmers

We wish to share the experiences of three farmers, key customers in Visayas and Mindanao regions, who are using a range of functional feeds (daily care, immune and growth enhancement) to get the best output for their farming conditions, i.e. post larvae genetics, pond set up, stocking density, etc.

Mabini Aquafarms Inc. is owned by Josue Tesado Jr. The farm is in Mabini, Davao De Oro on Mindanao Island. It has been operating fully lined ponds with a reservoir and a treatment pond.

Partial harvesting at pond 4, Zest Cook 117 in Bago, Negros Occidental.

	Pond 1	Pond 2	Pond 3
Stocking density (PL/m²)	259	312	259
Days of culture (DOC)	115	120	121
Feed conversion ratio (FCR)	1.4	1.4	1.4
Average daily growth, ADG (g/day)	0.17	0.18	0.18
Average body weight ABW (g)	20	21	22
Biomass (kg)	6,004	7,005	7,712
Yield (tonnes/ha)	37.5	43.8	48.2

Table 1. Harvest data from Mabini Aquafarms.

For this crop, three ponds, each of 1,600m² were stocked at 250-315 PL/m² with fast-growth post larvae (0.01g size) and were harvested after 115-121 days of culture (Table 1).

Encouraged by the three successful crops using Grobest functional feeds and technology, Mabini Aquafarms is expanding with another seven ponds to be operational by September of this year.

Over in Bago City, Negros Occidental in the Visayas, Zest Cook 117 Inc. which is managed by Julia Keunhye Lee operates a closed-intensive system with a reservoir and HDPE-lined ponds. Their annual production is 200 tonnes per year. Previous crops were characterised by 120 days of culture (DOC) and an FCR of 1.4-1.5 to produce 23g shrimp.

	Pond 1	Pond 2	Pond 3	Pond 4
Size (m²)	4,800	4,500	4,500	4,800
Stocking density (PL/m²)	104	111	156	146
Days of culture (DOC)	93	97	81	81
Feed conversion ratio (FCR)	1.3	1.3	1.2	1.3
Average daily growth, ADG (g/day)	0.22	0.20	0.27	0.27
Average body weight ABW (g)	16.7	16.7	14.6	16
Biomass (kg)	7,336	8,110	7,819	7,651
Yield (tonnes/ha)	15.3	18	17.4	15.9

Table 2. Harvest data from Zest Cook 117.

By using a daily care functional feed, they were able to reduce both days of culture, FCR and improve profitability (Table 2).

At Noecil Aquaculture Farm, in Toril, Davao City on Mindanao Island, owner Maria Cecilia Egasan operates earthen ponds with concrete dykes under a closed-intensive protocol. This farm produces 200 tonnes per year. For this crop, two ponds were stocked with 0.01g post larvae and cultured for 88-89 days. The crops were extremely successful (Table 3).

Noecil Aquaculture Farm located at Toril, Davao City, Mindanao uses a closed-intensive protocol to produce 200 tonnes/year.

	Pond 1	Pond 2
Size (m^2)	5,300	3,600
Stocking density (PL/m^2)	86	84
Days of culture (DOC)	88	89
Feed conversion ratio (FCR)	1.07	1.06
Average daily growth, ADG (g/day)	0.19	0.22
Average body weight ABW (g)	18	20
Biomass (kg)	6,771	4,663
Yield (tonnes/ha)	12.8	13

Table 3. Harvest data from Noecil Aquaculture Farm.

Maria Cecilia Egasan, owner of Noecil Aquaculture Farm supervising pond clearing operations.

High-performance feed and partnership

These excellent results were obtained with high-performance feed improving farm outputs of these three companies operating under very diverse conditions and in different parts of the Philippines. The unique partnership between the farm managers and the Grobest technical service team providing frequent assessments of the shrimp health status explains these results. There has been a growing feed consumption in recent months, with many new farmers using Grobest feed. This has led to the feed company increasing its market share by 10% within 12 months.

Recent reports of white spot syndrome virus (WSSV) and acute hepatopancreatic necrosis disease (AHPND) in May and June in Negros Island, Visayas Region, have reinforced interests in functional feeds. We expect this trend to continue in the future, thanks to the setting up of laboratory services in more areas and the high level of technical support being provided. The technical service team offers consolidated assistance on farm management and provides a comprehensive consultancy on feeds and other related services. Aside from guidelines on feeds and feeding, the team also shares professional insights on modern farm management, such as onsite laboratory assistance for faster and more accurate results and data analyses.

Shrimp health monitoring by Grobest technical support team.

A technical and sales farm visit to Mabini Aquafarms, Inc.

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Securing the shrimp nursery with water recirculation system

By Henry Cuong, Truong Ngoc Thao, Phong Chau and Van Thi Thai Nguyen

View of the BIOSIPEC model in ADM's R&D centre in South Vietnam.

Over the last decade, as shrimp farmers continue to face increasing pressure from several diseases such as white spot syndrome virus (WSSV), early mortality syndrome or acute hepatopancreatic necrosis disease (EMS/AHPND) and white faeces syndrome (WFS), many of them started to add a nursery stage in their production system. The initial purpose of this nursery stage is to maintain post larvae in the best culture conditions for 3 to 4 weeks prior to the transfer to exposed grow-out ponds, where environmental conditions can be very challenging and unpredictable.

More than 5 years ago, ADM developed the BIOSIPEC or Biosecurity Intensive Production Environmental Control model. This is an innovative shrimp farming model aimed at reducing water exchange, thanks to a recirculation pond that serves as a huge biofilter to manage waste and keep optimal conditions for the sensitive nursery stage (Table 1).

Today, the flow-through system is the main option for farmers in Asia. However, good water quality resources are scarce in Asia, especially with fluctuating water quality conditions brought about by rainy seasons and frequent disease outbreaks. Therefore, reusing water from a recirculation pond is a sensible way to reduce water usage and limit the risk of pathogenic infections from the external environment.

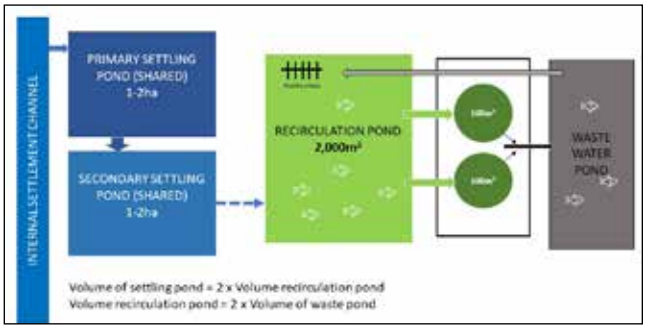
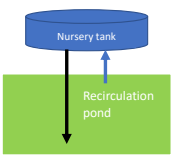
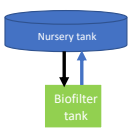


Figure 1. Schematic representation of the nursery system with the use of recirculation pond.

The recirculation model has three main parts, namely the recirculation pond, the nursery tanks and the wastewater pond as shown in Figure 1. The wastewater pond is both a place to accumulate suspended solids and reduce levels of toxic wastes (NH_3, NO_2) and pathogenic bacteria (*Vibrio* spp.).

Table 1. A comparison between a system with water exchange only and the total water recirculation model in the Biosipec system.

		BIOSIPEC		
	WATER EXCHANGE system	**RECIRCULATION pond system**	**BIOFILTER tank system**	**BIOFLOC system**
Waste management	 *Blue arrow: inflow of clean water *Black arrow: outflow of water effluent			
Applicable conditions	▪ Allows water a single pass through ▪ Areas have favourable water resources ▪ Water exchange rate : 12-15 times	▪ Water circulation with recirculating pond ▪ Adapted to areas with limited water supplies ▪ Areas are under high disease burden	▪ Water circulation with biofilter tank ▪ Adapted to areas of extremely limited water supplies ▪ Needs high technical skills	▪ Zero water exchange, waste is kept in water column by strong aeration ▪ Require very high technical skills and experience

Characteristics of the recirculation pond

Based on the results of numerous nursery cycles with different set-ups, we have established the reference nitrification capacity of the biofilter and concluded that the volume of the recirculation pond should be 10 times higher than the total volume of nursery tanks.

Volume recirculation pond **=** **10 times of Volume** nursery tank

The recommended size range for the nursery tanks is 100-250m^3 each. This is a good balance; small tanks (30-50m^3) with a high stocking density will increase the risk of batch collapse. Those which are too large, such as 1,000m^3 are very difficult to manage.

Operating the recirculation pond

Water for the recirculation pond is pumped from the shared intake source into the internal settling channel where it stays for 3-5 days. It is then transferred to the primary settling pond for 15 days before being pumped to the secondary settling pond for another 15 days.

However, before transferring the water to the recirculation pond, the latter should be cleaned, dried, and treated with lime, if applicable. Water should be pumped from the secondary settling pond to a depth of 1.7-2.0m and adjusted for pH, alkalinity and transparency, if needed. Tilapia and Asian seabass or barramundi should be stocked at a density of 0.1 fish/m^2.

When 10 to 20% of the recirculation water is lost due to seepage or evaporation, new water should be added following the same protocol. The recirculation pond water can be used used up to 6 or 7 nursery cycles per year over 2 to 3 years before requiring a full pond maintenance.

Operating the nursery tank coupled to a recirculation pond

Water preparation

Seven days before stocking, water is pumped through a net filter (Ø 100µm or smaller) and chlorine is added to reach an ORP (Oxidation Reduction Potential) of 700mV while maintaining strong aeration. Two days before stocking, it is important to check for chlorine residues and adjust the water parameters to the optimum range (pH, alkalinity, etc.). These parameters should be checked daily during the whole nursery cycle (Table 2).

	Value	Remarks
Temperature	28 – 31°C	Greenhouse, plastic roof, dark netting, etc.
Dissolved oxygen (DO)	4 – 6 ppm	Drop low at night and in high organic matter accumulated
pH	7.5 – 8.3	Δ pH afternoon-morning <0.5/day
Salinity	≥ 10 ppt	Δ salinity ≤ 5ppt/day (rainy season!)
Alkalinity	120 – 140 ppm	High alkalinity will keep pH stable!
Ca/Mg/K	Brackish water, specific mineral content depends on salinity	Basic ratio Mg: K = 3.6: 1
NH_3	≤ 2 ppm	More toxic when high pH (pH > 8.5)
NO_2	≤ 2 ppm	More toxic when low salinity (< 10ppt)
Total *Vibrio*	≤ 10^3 CFU/mL (FAO)	Higher density, more risk

Table 2. Requirements on environmental conditions during the nursery stage.

Post larvae quality

Prior to stocking, checks on the quality of post larvae should be carried out, by applying the following eight criteria: appearance, total length, age, colour of the hepatopancreas, lipid vacuoles, muscle/gut ratio of the 6th segment, external fouling, deformity rate and salinity stress test. All post larvae bags must be disinfected before stocking.

Two nursery tanks with the mechanical sedimentation tank and piping to the recirculation pond.

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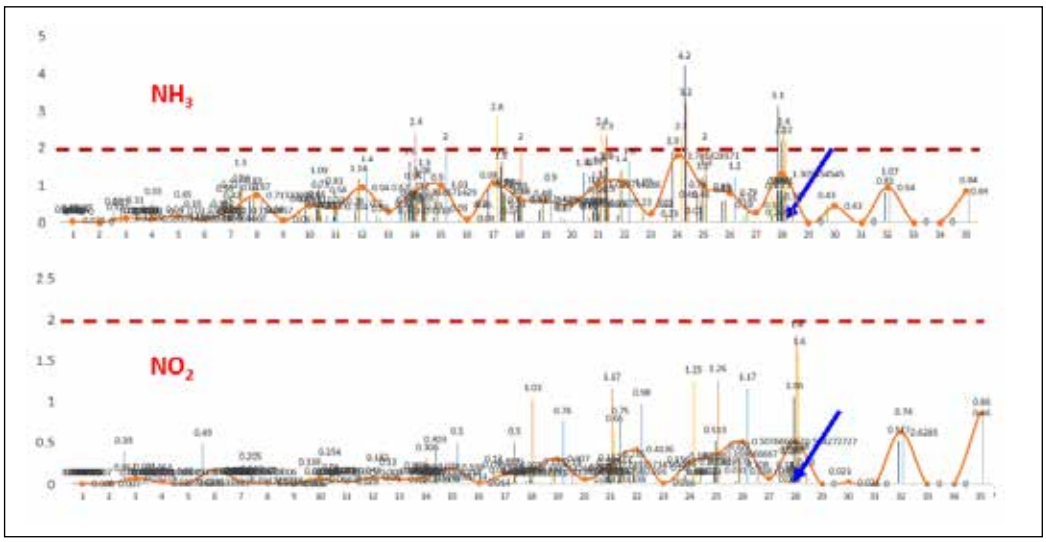

Figure 2. Fluctuations in average NH_3 and NO_2 readings.

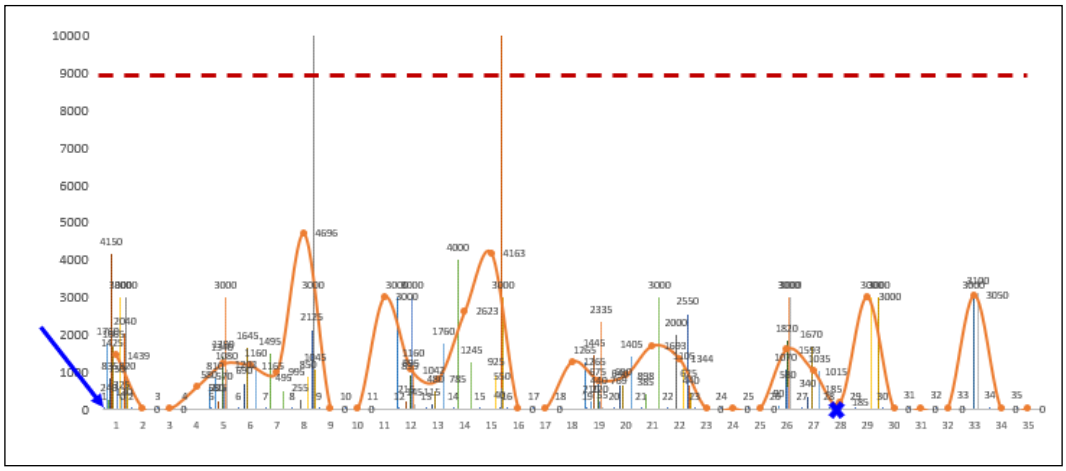

Figure 3. Fluctuations in average values of total *Vibrio* (units 10^3 CFU/mL).

Water recirculation

This is not necessary during the first week of the nursery culture. In the second week, it is critical to ensure a 10% water recirculation before increasing to 30% - 70% from the third week onwards. In the case of any water quality issues such as a high organic matter content, foaming or high NH_3/NO_2 levels, it is recommended to reduce feeding and increase water recirculation.

To support a proper waste treatment system and maintain a healthy balance of bacteria, a premium nursery feed and good strains of probiotics, respectively, are essential to maintain water quality parameters in the system.

Biosecurity compliance for sustainable shrimp farming

To ensure the stability of this nursery model, several measures are applied simultaneously:

- Back-up machinery running alternately day and night
- Biosecurity protocols to prevent the entry of disease pathogens from outside of the farm or their spread within the farm and reduce the contamination from neighbouring farms
- Reasonable use of chemicals by determining the right dosage through the measurement of ORP
- Strict ban on the use of antibiotics
- Good control of feeding rate and use a premium nursery feed to avoid problems of water pollution.

Transfer to grow-out ponds

It is necessary to actively plan the transfer of shrimp to the grow-out ponds before the carrying capacity within the nursery pond is reached or before being forced to transfer due to deteriorating environmental conditions or shrimp performance. In South Vietnam, the transfer is planned when shrimp reach size 0.2g/juvenile or 5,000 juveniles/kg. At this stage, the juveniles have reached their full morphological development and are robust enough to be moved to a less controlled pond environment.

Prior to transfer, farmers should stop 1-2 meals and vitamin C is added to the feed to reduce stress and avoid mass moulting. The transfer can be performed through a gravity pipe or via dry transfer; for the latter, the travel time should be less than 2 minutes. Oxygenated water tanks should be used if the travel time is longer than 2 minutes. In addition, the water parameters of the grow-out tank/pond should be the same as in the nursery tank.

Stocking density	1 – 3 PL/liter
Nursery tank volume	100 m^3
Nursery time	3 – 4 weeks
Initial weight	3 mg
Final weight	0.6 g/juvenile
ADG	26 mg/day
Biomass	1.2 kg/m^3
FCR	0.8
Survival rate	88%
Success rate	95%
ADM product	VANA NANO, MeM & BACTOSAFE H
Nursery production cost	USD10/1,000 juveniles
Remarks	VANA NANO & MeM are nursery feeds; BACTOSAFE H is probiotics

Table 3. Results of average performance level of ADM nursery cycles.

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Key achievement of the recirculation model

After operating 23 nursery cycles at the ADM location in South Vietnam, this recirculation model was proven to successfully separate the suspended solids and control toxic compounds such as NH_3 ≤ 2ppm, NO_2 ≤ 2ppm (Figure 2) and *Vibrio* density at ≤ 10^3 CFU/mL (Figure 3). The average survival and success rates using the recirculation model have been proven to be high at 88% and 95%, respectively. The cost of production at this nursery stage was USD10/1,000 juveniles (Table 3). Comparing with the commonly used water exchange model in Asia, the recirculation model operates with 10 to 15 times lower water volumes during the nursery phase.

Conclusion

At ADM, we recognise the opportunities available and therefore, we work together with our customers to identify and implement farming practices that can reduce adverse environmental impacts and improve on-farm economics. Through our unwavering commitment to sustainability, we deliver solutions that meet customers' aspirations of taking care of their shrimp health and with the adoption of sustainable farming practices.

Water management is a critical issue in aquaculture. As we see an increase in regions classified as water scarce or projected to face water scarcity in the future, the reduction of water consumption and improvement of water quality are vital for aquaculture production. Besides achieving excellent zootechnical results, the recirculation model also promotes sustainable shrimp farming, as water consumption and organic matter discharge are low, the chemical application is minimal and there are absolutely no antibiotics applied.

To conclude, the recirculation model can be adapted easily to the existing water exchange model by re-allocating one or several ponds. This will provide an excellent alternative during times when water quality is difficult to control.

Live vannamei shrimp, from urban shrimp factories to global markets

New scaleup Universal Aquaculture has begun to commercialise vertical high density vannamei shrimp farming using its Hybrid Biological Recirculation System™ (HBRS), with the first harvest in 2021.

The inaugural farm is in a 1400m² warehouse on the sixth floor of a six- storey factory building located in Tuas on the eastern end of Singapore. Tanks are stacked 12m high.

It all started in 2019, with a prototype of a vannamei shrimp farm with four tanks appearing on the fourth floor of a warehouse in Paya Lebar in Singapore. Soon, this expanded to over 300 tanks within a farm of 14,000ft² (1,300 m²)

Universal Aquaculture (UniAqua) officially started in April 2020 with a team of 11 members. There is an interesting story behind this team of aquaculture enthusiasts working to develop a closed aquaculture system suitable for land scarce Singapore.

Serial entrepreneur Jeremy Ong, CEO and one of the founding members, recounted their journey. "I have always been investing in sustainability and started at an early age with vegetable farming. In 2015, a college friend Clifford, who is now our CFO and a few mainly dedicated aquaculturists, wanted to do 'something spectacular in aquaculture'. Together we wanted to have a different take on how we can do aquaculture not only in Singapore but also globally." The mission is to build the global food systems of tomorrow, using environmentally sound and sustainable food production methods.

In urban Singapore where land is scarce, Ong reiterated that their concept was, "To build a system in the middle of the city state and serve the people within the city. We will not export or sell any of our products out of a 30km radius. This is how we started building this whole business. When we did our business modelling, we knew that we needed an indoor system where we can have total control and where we can reduce risks from inclement weather and disease pathogens. Additionally, in Singapore, where energy and labour costs are rather high, we need to be energy efficient and automate operations as much as possible."

The prototype came into play just prior to Covid-19 but in the case of UniAqua it was just in time as in 2020, Singapore, which imports almost 16,800 tonnes annually of shrimp (live and chilled) from Malaysia, saw disruptions to imports. The Government fast tracked its program to have 30% of its nutritional needs by 2030 from 10%, with locally grown food. The ambition of UniAqua is to supply 30% of the live and chilled shrimp demand in Singapore by 2026.

UniAqua has moved fast with a 1,300m² farm on the sixth floor of a six-storey factory building in Tuas Link, on the eastern end of Singapore. Here the target production is 150-200kg of shrimp per day, depending on size at harvest.

Ideal water conditions with a HBRS

The heart of the indoor system is the proprietary and energy saving water treatment system which took 6 years of research. This is the Hybrid Biological Recirculation System™(HBRS) where the team could adjust water parameters and create ideal conditions to match requirements of each species while save up to 80-90% of water and energy. The concept is to mimic the natural environment of the animal with water of equal quality.

"HBRS is groundbreaking using a lot of biological filtration. We do not clean the water totally, but just sufficient to meet the needs of the animals. Unlike, traditional recirculation aquaculture systems, we do not need those energy consuming systems like back wash, micro bubbles, ozone and UV etc. and yet we are able to sustain the water pH and bacteria levels at optimal levels for the shrimp. Of course, some mechanical filtration is still required."

Jeremy Ong, CEO (centre) with team members. With a combined aquaculture experience of 100 years, it took 6 years to develop the proprietary and energy saving water treatment system, the Hybrid Biological Recirculation System (HBRS™) which gave just the right water conditions for the vannamei shrimp.

There is also the adoption of a more holistic approach with this HBRS. "We will be adding 17,000 solar panels. By the end of 2021, we expect to be carbon neutral. It is important to stress that we designed the whole system from ground up. Our priority is to look after the animal and provide it with the best condition to grow well - even with simple factors like salinity and pH, there are certain ranges which are less stressful for the animal." added Ong.

"Our precise advantage is that we can design the system for each customer and assure delivery of a particular shrimp size and volume on a daily basis."
- Jeremy Ong

Indoor high density farming of vannamei shrimp

When the team built their first prototype, they tested farming several species in IBC (intermediate bulk containers) tanks - jade perch, tilapia, lobsters, seabass, freshwater prawn, crayfish and vannamei shrimp. They found that their system was versatile enough to handle the various species.

Then came the choice of which species to farm commercially at high density. "There were 'easy to farm in closed systems' species such as the tilapia and seabass but we chose to challenge ourselves. If we can farm *Penaeus vannamei* shrimp at high density, then it would be easy for any other species," Ong added that it was also for commercial reasons since UniAqua wants to target the live shrimp market in Singapore to sustain its business.

At the Tuas Link farm, the grow-out area has 296 grow-out tanks, all stacked vertically in six levels reaching 12m high. It has a hatchery and nursery. It does its own broodstock maturation and breeding, and grows post larvae over 30-45 days, selecting the best for stocking into the 2.8m^3 tanks for grow-out. Both hatchery and nursery are segregated from the grow-out section to minimise risk of cross contamination.

"Based on 10g shrimp, we can produce 60 tonnes/year, and with 25g shrimp, the yield will be 30-40 tonnes. In general, each tank has a 3-4kg or about 24,000 post larvae and we move shrimp along as the carrying capacity exceeds," said Ong.

"Selection of the best performing post larvae is important for us as in Singapore, space is expensive and so are feeds," said Ong. "Having a hatchery inhouse means that we only check for the pathogens in the broodstock. In our highly biosecure 'factory like' facility, we are able to keep diseases out."

Clearly, from the onset, UniAqua cannot depend on post larvae deliveries and secondly, cannot afford any introduction of disease pathogens. As part of the biosecurity planning, there are 33 independent systems, such that when any system is compromised, they can impose a lockdown.

"Our precise advantage is that we can design the system for each customer and assure delivery of a particular shrimp size and volume on a daily basis. This is where having an inhouse hatchery is important to have full control of the production chain and ensure a consistent post larvae quality."

Sump tanks are all where most of the biological filtration happens before water is recirculated back to the grow-out tanks.

UniAqua harvests daily and sells its live and chilled Ziro Bay shrimp brand in Singapore. The promise is zero additives and zero antibiotics. Currently the demand is mainly for 12g and 22-25g shrimp.

Marketing Ziro Bay in Singapore

UniAqua harvests daily and sells its live and chilled fresh Ziro Bay shrimp brand in Singapore. The promise is zero additives and zero antibiotics.

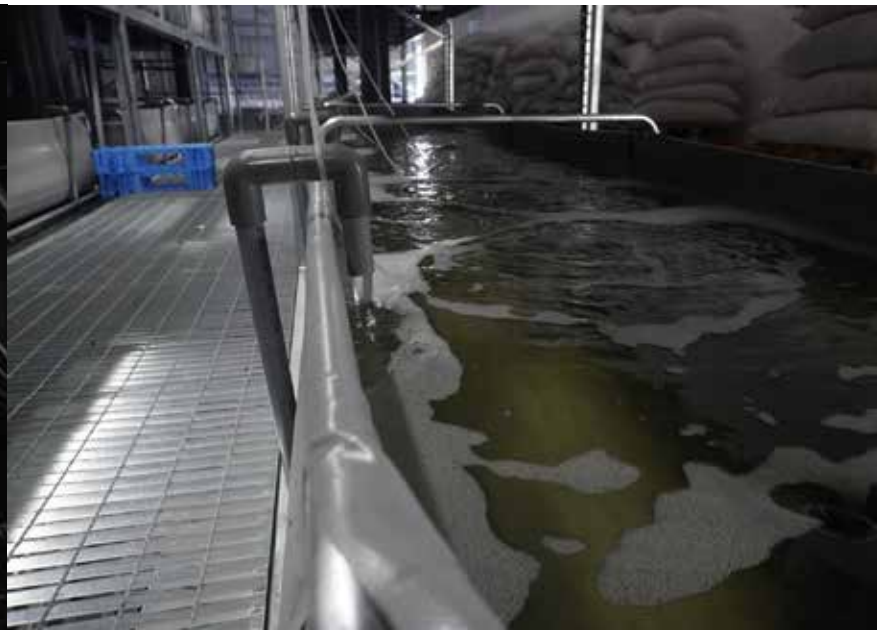
"Amid this Covid-19 pandemic, we solve the supply problem as retailers and restaurants usually depend on imports. We assure consistency in supply which restaurants need. Although using land-based systems is usually not a cheap production method, we have managed to produce at a very competitive cost. We have received accolades from chefs privately and some have complimented our shrimp as sweet," said Ong.

AquaOS

In a farm like UniAqua, automation is a necessity, and the team members believe that they need to think out of the box on operating and monitoring systems. They have AquaOS, equating to a 'digital farmer' automatically controlling feeding and water quality management. Plans on big data analyses in the near future will cover monitoring of broodstock mating, health sorting at the nursery level, regulating transfer from nursery to grow-out and managing sludge.

UniAqua has to improve on predictive farming and continue to collect data and optimise AquaOS. A big challenge is auto feeding 296 tanks and as it expands to up to 3,000 tanks, the challenge grows. "Imagine a system to cater for feeding shrimp in this number of tanks 8-12 times per day. There are no suitable models in the market, so we had to reinvent the wheel. We needed cutting edge technology - a robust yet simple feeding system which can deliver feed at an accuracy of 1g. We believe that visual checks are more accurate than acoustics. We are now testing a prototype."

"We will export our farm technology but will not export shrimp. This means that in any place, the market will be local, thus ensuring a low carbon footprint."
- Jeremy Ong



Next phase of growth

With regards to feeds, there is the need for an ideal feed for this zero water exchange HBRS and in situations such as during this pandemic, where food security is important, the farm wants to ensure a year's feed supply to continuously produce shrimp. At the same time, the team has been busy measuring digestibility and waste output of around 30 feed types, both extruded and pelleted; these were made easier in the grow-out tanks with zero water exchange. Interestingly, the team saw through changes in water quality parameters, the vast range of protein quality in the feeds.

In the next phase of its growth, UniAqua expects to have 2,000 to 3,000 tanks in a new farm and scale up 7-fold to an annual production of 1 tonne per day. By 2024, it expects to reach revenues of more than SGD525 million (USD374 million).

Meanwhile, in 2022, Ong will be leading the team to expand globally. "Because our system is portable, we can easily transfer it any where in the world. We will export our farm technology but will not export shrimp. This means that in any place, the market will be local, thus ensuring a low carbon footprint."

Finally, Ong said, "We are farmers and understand the situation in shrimp farming. We are not a technology company. We want to use our farming technology to help farmers elsewhere. So you have a warehouse empty and would like to start shrimp farming and market live shrimp, I will be happy to discuss with you."

A collaboration to develop world's first functional performance shrimp feed for HBRS™

In September, **Universal Aquaculture (UniAqua)** and **Grobest Group** jointly announced a partnership to collaborate on the development of the world's first next-generation functional performance shrimp feed for UniAqua's proprietary Hybrid Biological Recirculating System™. In initial trials, Grobest functional performance feeds have outperformed competitive products by yielding healthier, tastier shrimp and significantly better water quality.

The cooperation between the two companies comes at a time when Singapore is pursuing the goal of 30% home-grown food by year 2030. The roughly 730 km^2 city-state heavily relies on imported food due to its relatively small land available for food production, which effectively reaffirms the importance of intensified production to satisfy the food demand of its growing population.

In UniAqua's six-tier system, shrimp are farmed in stacked units with juveniles at the top level and grow-out tanks the bottom waiting to be harvested and shipped to the market. The combination of recirculation, biofloc and mechanical filtration ensures that the farming environment remains stable and secure while minimizing energy consumption.

"With a vertical indoor system of such high density, every parameter's impact is magnified.", said UniAqua CEO Jeremy Ong, "Hence, we designed the systems to be especially modular and systematic with the intention to incorporate IoT and machine learning within our operating system to ensure scalable efficiency. A major component would be the feed that we put in the tanks - how soluble they are, how receptive our shrimps are to them, the residue left and other aspects like taste profile. We are really excited to see how this partnership with Grobest will help to bring us closer to the optimal feed."

This intensive aquaculture system requires safe, antibiotic-free and highly palatable aquafeed with the least possible leaching to further streamline the process and remain at the apex of innovation. Grobest will work closely with UniAqua to develop next-generation feed that is tailored for this model to facilitate all its technological advances.

In announcing the partnership, Grobest Group CEO, Samson Li, stated "We are looking forward to working closely with the UniAqua team to develop the world's first Functional Performance Shrimp Feed specifically formulated for RAS systems. Grobest has always led innovation in the aqua feed industry since the introduction of our proprietary bio-tech Functional Performance Feeds over 15 years ago. Making our farmers more successful, more productive and more profitable across all farming models is the essence of 'The Grobest Difference' and is why this partnership with Universal Aquaculture is an exciting next step that reaffirms our commitment to leading the industry by partnering with other leading innovators. The development and expansion of new farming models, such as UniAqua's proprietary Hybrid Biological Recirculation System™ will be critical in the development of the industry over the next decade and it brings a unique set of challenges that urgently need a solution."

Interview: A story of complementarity rather than replacement

Brett Glencross talks about his new role at IFFO, the science behind the outlook for marine ingredients and having the right reasons for replacing fishmeal and fish oil.

In June 2021, Professor Brett Glencross moved from academia onto a global institutional stage to join IFFO, The Marine Ingredients Organisation as its Technical Director. Since 2016, Glencross has been the Professor of Nutrition at the Institute of Aquaculture in Scotland's University of Stirling. At academia, he was contributing and making ripples from the side lines through his research and writing. Now the IFFO appointment puts him right where the action is, in the marine ingredients sector.

Commenting on his decision to move to IFFO which opens a "fantastic" challenge to make a bigger global impact on the aquafeeds scene, Glencross also reflects that "he is more of a pragmatic person at heart than one who likes writing academic papers". Nevertheless, the appointment capitalises on his 20-year rich research background which spans applications of functional feeds for animal health, refining nutritional requirements and the use of nutritional modelling strategies, as well as a strong background in raw material assessment.

Complementing this is the experience gathered from 25 years of taking on various academic, institutional, business and industrial roles across Australasia, the Middle East and Europe, working closely with many aquaculture production and feed companies in these regions. These research efforts and experiences have delivered many industry outcomes resulting in the development of new processes, products and applications.

These have won him multiple awards and commendations from both governments and organisations. When queried, Glencross takes a cognitively insightful view. "A close, working relationship with the industrial sector helps in generating those achievements, but there is also a large degree of luck to it – right piece of work, right place, right time." In many aspects, he often observes that the work that won him accolades are not the ones he personally thinks are more notable or based on quality of science per se, but that it hinges on what others value is most relevant and impactful. The fact that his contributions are valued is most important for him; these drive him rather than the physical display of awards lining the shelves of his professional life.

In an email interview, *Aqua Culture Asia Pacific* posed several questions on his views and expectations for the future of the marine ingredients industry. As a well-recognised aquaculture nutritionist and one of the few in the world with both commercial and academic interests, Glencross knows that science is crucial to understanding the future trends affecting the development of aquafeed ingredients. Technical projects led by IFFO contribute a great deal to increasing the knowledge on marine ingredients and driving change for the benefit of the whole value chain, especially the aquaculture sector.

As IFFO's Technical Director, Dr Brett Glencross combines his experiences in academia and commercial nutrition from working closely with many major international aquaculture feed companies across the world. The appointment capitalises on his 20-year rich research background which spans applications of functional feeds for animal health, refining nutritional requirements and the use of nutritional modelling strategies, as well as a strong background in raw material assessment.

"Any growth discount arising from the replacement of fishmeal or fish oil is clearly substandard and should not be accepted."

What do you hope to achieve in your new appointment at IFFO?

There are many things to focus on. We are at an interesting point in history for the marine ingredients sector. Over the past twenty years, there has been a period of consolidation of the sector as it was increasingly scrutinised under the lens of sustainability. The introduction of third-party certifications for responsible sourcing, like the MarinTrust, MSC and ASC certifications, have been a real benefit for the sector in demonstrating its value to the feed-food chain. Combine that with the growth of fishery by-product recycling and the projections of aquaculture by-product contributions, and into the future, there are some clear opportunities ahead. It is a good time to be reaffirming the role of marine ingredients in our feed-chain.

From a point of view of a commercial nutritionist, why is it so difficult to replace fishmeal in several aquafeeds?

Fishmeal contributes a range of beneficial features to animal feeds, but particularly so for many aquaculture species. Not only are they rich in many essential nutrients (e.g., essential amino acids, essential fatty acids, phosphorus, etc.), but the balance of these nutrients is also near ideal. Fishmeal also confers excellent palatability effects to feeds as well. While some other ingredients might be rich in some nutrients, not many give that ideal balance and most do not have that palatability enhancing value. It is this duality of properties (nutrient content and palatability) that makes fishmeal so challenging to replace.

Do algae-based oils with DHA and EPA, completely fulfil the animal's requirements for these HUFAs?

The problem with some of the algae-based oils is that they are deficient in EPA (eicosapentaenoic acid). While EPA may not have a dominant role in the omega-3 story from a growth perspective, it does have a clear role in the function of the immune system of many animals (including humans). It is clear that many species have co-evolved with the presence of both EPA and DHA (docosahexanenoic acid) in their food-chain and their physiologies have capitalised on this. Important signalling molecules like resolvins, maresins and protectins, derived from EPA and DHA, play a critical role in regulating inflammatory processes. I suspect we are about to see a lot more on this story in the near future.

What would be your standard of lower growth performance when there is a replacement of fishmeal/fish oil with alternatives in aquafeeds?

Any growth discount arising from the replacement of fishmeal or fish oil is clearly substandard and should not be accepted. Proper formulation of a balanced diet including alternatives, ensuring that palatability constraints are also observed, provides the feed industry with flexibility in their ingredient use. However, that said, I actually believe there is no need for replacement of marine ingredients anyway. So long as the ingredients we use are obtained from responsible sourcing, whether that is fishery ingredients or by-product ingredients, or even non-marine ingredients for that matter, there should not be any issue with their use in our feed-food-chain. In recent years we have seen an increasing proportion of marine ingredients coming from by-products. Forecasts indicate that this sector is growing strongly and is already exceeding volumes of many of the other alternatives.

Another key issue here is the sustainability role of different ingredients. Presently, 51% of all marine ingredients produced worldwide are certified against the MarinTrust standard. The ambition is to reach 75% certified, in assessment or in a FIP (fishery improvement project) by 2025. This level of independent certification is already a long way ahead of that of any other feed ingredient. We are also seeing that volumes of fishmeal and fish oil produced each year are stable at roughly 6 million tonnes and have been stable at this level for about a decade.

So, with those considerations, we go back to my original point: what is the need for replacement? I believe that all those additional ingredients that are being developed need to be used effectively alongside fishmeal and fish oil to provide optimal nutrition for many years to come. For me, this is a story of complementarity.

Re FIFO ratios, what levels would IFFO consider good enough? What kinds of levels are you aiming for?

FIFO (Fish In-Fish Out) was always just an arbitrary metric, that unfortunately the sense of which has become lost over time. At a base level once the FIFO value approaches 1, the logic of the original argument is somewhat lost. But some have argued that we should keep trying to push this value lower and lower. We also need to consider this across the sector more broadly and not just species-by-species.

I think if we take that approach, we can see that aquaculture overall is a massive net contributor of food production (FIFO close to 0.2 sector wide). Another way to look at this argument is to consider the economic allocation of inputs and outputs to the calculation. Some interesting work by Kok et al. (2020) has published an account of this approach. However, such simplistic analyses, like FIFO, tend to miss many of the broader critical issues in food production. Use of modern lifecycle assessment methodologies in my thinking offers so much more than FIFO ever has.

Is UGF still a black box or have we progressed with new information?

I am not sure I subscribe to the unknown growth factor (UGF) story in fishmeal. Much of the benefits of marine ingredients are quite well known. Whether it is the ideal nutrient balance, the high levels of nucleotides, or the palatability stimulating aspects, among various other things, they all contribute well known parts to the feed formulation process. There are enough studies around now that show that most of the variability in performance is largely due to vagaries in feed intake, so long as you have formulated the diets on a digestible nutrient basis first. Therefore, if you can control palatability and ensure diets are formulated properly, most of the issues around ingredient flexibility are solved. Fishmeal just makes this process more cost effective and easier to manage.

Would 2021 be a boom year for fishmeal since prices of soybean meal and some other plant meals have escalated, while fishmeal prices are stable?

There are several things emerging that look to be making 2021 a good year for the marine ingredients sector. Price stability is one of those, but we are also continuing stabilisation in the levels of fishmeal and fish oil production over the past decade.

The supply of fishmeal and fish oil has over the last decade shown to be quite resilient, still with around 5 million tonnes of fish meal and 1 million tonnes of fish oil on an annual basis since 2010. A strong focus on regulation of fisheries globally and focus on responsible supply are important factors that help contribute to stable production volumes.

From a marketing point of view, is there a particular segment of species/geography that you would like to target?

As an organisation, IFFO is keen to make more of an impact in Southeast Asia in particular. Countries like Vietnam, Thailand, and Indonesia we believe could really benefit from engaging with IFFO's global community. One aspect of this would be to work with stakeholders in those countries to help them better utilise their fishery and by-product resources for their long-term benefit. Changing practices offer lots of benefits, like increasing the flexibility of resource use as well as improving the longevity of the material.

This was part of the recommendations that were outlined in the joint IFFO/Global Aquaculture Alliance report conducted by Duncan Leadbitter in 2019. We also work closely with groups like the Sustainable Fisheries Partnership (SFP), who have done some excellent work in the region but have highlighted some ways in which the sustainability of many of the fisheries in the region may be improved. Through partnership arrangements like that between IFFO and SFP, we see a bright future for the Southeast Asian region.

IFFO is the global organisation that unites people wanting support behind marine ingredients production (fishmeal, fish oil). It has members in more than 50 countries, accounting for over 55% of world production and 75% of the fishmeal and fish oil traded worldwide.

The IFFO of today has a collective history of 60 years, from its predecessors: the Fishmeal Exporters' Organisation (FEO), International Association of Fish Meal Manufacturers (IAFMM) and International Fishmeal and Oil Manufacturers' Association (IFOMA). In 2012, it became the Marine Ingredients Organisation. Since the 1990s, aquafeeds, mainly for the salmonids and shrimp, has been a large user of fishmeal and fish oil and conversely, fishmeal and fish oil created the modern aquaculture industry.

Today, as exigent consumers focus on sustainability of the seafood value chain, IFFO wants to strengthen the global standing of the marine ingredients industry, while supporting responsible sourcing worldwide. It does this with evidence-based information and by promoting marine ingredients as a high quality, high performance and sustainable product. www.iffo.com

Production of tilapia with firm, tight-grained texture flesh

Specific diets change the characteristics of certain parts of the tilapia

By Nie Xiao Feng, Zhong Guo Xiong and Su Shi

Indoor greenhouse facilities (top) with recirculation water tanks (left) and water treatment system.

According to FAO, China produces 1.8 million tonnes of tilapia in 2016, ranking first in the world, with an export volume of 393,000 tonnes. Maoming is the main breeding area for tilapia in China and is known as the tilapia capital of China. At present, two species are mainly farmed: hybrid tilapia (*Oreochromis mossambicus* × *O. niloticus*) and Genetically Improved Farmed Tilapia (GIFT).

Through a direct introduction of Nile tilapia strains from four African countries (Egypt, Ghana, Kenya and Senegal) and four Nile tilapia strains that are more widely farmed in Asia (Israel, Singapore, Thailand and Taiwan), the GIFT tilapia was selectively bred by the International Center for Living Aquatic Resources Management (ICLARM, and now known as the WorldFish Center) and other institutions.

Flesh characteristics

The production of firm, tight-grained texture tilapia (known also as crispy tilapia) can be similarly compared to the production of the French *foie gras* where a specific diet changes the characteristics of goose liver. Why is there a market demand for firm, tight-grained texture tilapia in China?

The answer is because Chinese consumers are used to eating hot pot and cooking food in boiling water. Fish is also a common ingredient in hot pot dishes. However, traditional hot pot cooking mostly uses firm, tight-grained texture species such as grouper and snakehead. The flesh of tilapia and grass carp are rather soft that they quickly dissipate and no longer remain in one piece during the boiling process. Therefore, the firm, tight-grained texture tilapia flesh that remains as a solid piece during cooking has a wide market demand.

Transformation of tilapia flesh

The transformation of tilapia is made by adding broad beans or faba bean to the feed. Studies have shown that broad beans can induce an increase of reactive oxygen species (ROS) in the blood, which results in cell protein and lipid peroxidation. By reducing collagen transport, it leads to an increase in collagen accumulation, thereby promoting the formation of thicker interstitial muscle fibres.

Yu et al. (2017) reported that in the 1970s, fish farmers in Dongsheng Town, Guangdong Province, China, accidentally discovered that the muscle structure of grass carp changed significantly after they were fed only with faba bean (*Vicia faba L.*) and exhibited a significant increase in muscle hardness and crispiness, and thus became popular locally.

The difference between the muscle slices of ordinary grass carp and crispy carp was observed through a microscope and muscles of crispy carp showed a sturdier white texture with changes in the muscle fibre structural protein. The role of collagen is to produce good structure

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connective tissues with mechanical properties, such as tensile strength, tension, elasticity, etc., to support and protect the body. This explains why the crispy carp is firmer and more elastic. In addition, crispy flesh has more fine fibres, which also means that the flesh is more tender. Compared with ordinary grass carp, the flesh quality of crispy carp has improved hardness, elasticity and cohesiveness.

Based on this principle, to create the firm, tight-grained texture of tilapia, feed in this project used broad bean flour as the main raw material. With the help of a Hinter company formulator, special tilapia feed was made with 31% protein content. The project lasted for two months and was completed in Maoming, China with Hinter technicians.

Farming system

In this project, we adopted a recirculating pond water culture model combined with water treatment system. The latter included two main treatment tanks - the brush sedimentation tank, and the bacterial biochemical tank. The brush tank mainly settled most of the remaining feed and faecal mucus and other solid matter, through a simple solid-liquid separation. The biochemical tank with a large number of bacteria groups was added to convert ammonia nitrogen and nitrite to improve water quality. The water finally flowed back into the fishpond. This study mainly focused on the feasibility and cost-effectiveness of land-based pond culture of crispy tilapia.

Fish were fed twice a day in the morning and afternoon. Ammonia nitrogen and nitrite levels were kept low. Water loss was adequately replenished. The health condition of the tilapia was observed during feeding.

Table 1 shows the culture situation of tilapia fed over two months. Since tilapia were about 0.75kg at the start of the trial, by maintaining excellent water quality and a stable water temperature, the survival rate reached 98%. After two months of feeding, the growth rate of tilapia was 0.5kg per month, attaining a weight from 0.75kg to 1.75kg. Feed conversion ratio (FCR) was higher than in a traditional tilapia farming model. Unlike traditional pond culture which contains a lot of algae and insects for tilapia as food, this recirculating pond water culture model gave better FCR.

Compared to tilapia farmed in the traditional method, the flesh quality of the tilapia cultured in this recirculating pond water culture model was better and chewy, with less fishy taste. As can be seen in Figure 1, the crispy tilapia flesh on the left is more elastic. However, because the special feed production technology has not been fully mastered, there is still room for technology improvement. At present, based on all the information available, we are of the opinion that low temperature extrusion is a key step to prevent destruction of active ingredients in broad beans by high processing temperatures.

Figure 1. Comparison of flesh quality between crispy tilapia (left) and regular tilapia (right)

Cost of production

In terms of costs, including feed, fish species, labour, water, electricity and heath treatments medicines, the cost to produce crispy tilapia is USD2/kg. The cost of feed will account for a 70% higher proportion than non-crispy tilapia feed. The selling price is around USD2.5-3.6/kg. At an average of USD 3/kg, the profit is USD1/kg. In contrast, the average profit for tilapia produced using a traditional system is USD 15 cents/kg.

Therefore, we conclude that the profit of crispy tilapia is relatively high. The profit/pond over a cycle can reach about USD460, which is suitable for farming in high-cost facilities such as recirculating pond system.

Judging from the anatomy of tilapia (Figure 2), after two months of feeding, the tilapia was generally healthy, with no bleeding or other abnormal external symptoms. The scales were neat and tight.

Tank area	24m^2
Numbers	450
Density	19 tail /m^2
Initial weight	0.75kg/pc
Days of Culture	60 days
Survival rate	98%
Feed conversion ratio (FCR)	1.7
Final weight	1.75 kg/tail
Growth rate	0.5 kg/month
Viscera index	17.1%
Relative fatness	6.1
Cost	USD2/kg
Selling price	USD3/kg
Profit	USD1/kg

Table 1. Cost of production of a firm-texture tilapia in a recirculating pond water culture model

Figure 2. Crispy tilapia. After two months of feeding, the tilapia was generally healthy, with no bleeding or other abnormal external symptoms and scales were neat and tight.

However, there was mild enteritis (Figure 3). Stool drifting was also observed during feeding. According to some farmers visiting the facility, the crispy tilapia diet would cause digestive system problems, including enteritis or fatty liver. This may be related to the toxicity of broad beans. While on one hand, broad beans strengthen muscles, the ingredient also puts pressure on the intestines. Mixing of probiotics or digestive enzymes with feed may reduce the occurrence of digestive tract diseases. This needs to be verified by subsequent tests.

Tilapia is a hardy fish and is widely farmed all over the world. As a high value aquatic product, crispy tilapia combines its excellent breeding characteristics and raises its value to a new level through this special diet.

This recirculating pond water culture model can greatly reduce the risk of aquaculture. At the same time, the relatively large profits can make up for the cost of a large amount of infrastructure investment in the early stage. This is a culture model with strong degree of replicability and a promising future.

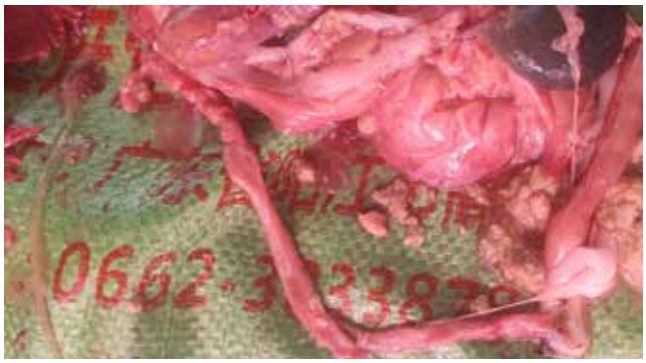

Figure 3. Inflammation of the front of the intestine due to mild enteritis

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On-farm strategies demonstrating the efficacy of a functional feed additive to reduce the impact of white faeces syndrome

These trials at a farm in Lampung, Indonesia, cover a large number of ponds with shrimp fed preventive and corrective application levels of the feed additive

By Martha Mamora, Jaka Raharjo, Maria Mercè Isern-Subich and Waldo G. Nuez-Ortín

Feeding at Tambak Udang Babarafi, Indonesia

The rapid growth and intensification of the shrimp farming industry have resulted in the emergence of devastating shrimp diseases. Among them, white faeces syndrome (WFS) is a major cause of crop failures of *Penaeus vannamei* shrimp farming in Southeast Asian countries, India and China. WFS affects the digestive system of shrimp resulting in production losses due to smaller harvest size from stunted growth and decreased survival rates.

WFS arises because of a series of complex interactions involving the host, pathogen and environment. Outbreaks are associated with changes in environmental conditions and water quality leading to physiological stress and a compromised ability of shrimp to resist infection (Alfiansah et al. 2020). Although the causative agent of infection remains inconclusive, it has generally been associated with pathogenic *Vibrio* bacteria and the microsporidian *Enterocytozoon hepatopenaei* (EHP).

Prevention is important to reduce the impact of WFS. A first strategy is pond management measures to maintain water and sediment quality and to reduce the presence of EHP and *Vibrio* (Tang et al. 2016; Aldama-Cano et al. 2018). A second strategy is to adopt functional nutrition to promote a stable bacterial community within the digestive tract of shrimp. Since shrimp are highly exposed to exchanges of microbiota between the pond environment and the digestive system, functional nutrition contributes to counteract the development of pathogens favoured by the destabilising effect of environmental stressors.

SANACORE®GM (Adisseo) is a functional feed additive which comprises a synergetic blend of phytobiotic extracts with a broad antimicrobial spectrum, antiparasitic activity, and immunomodulating properties (Coutteau and Goossens, 2014). It can be incorporated into feed during feed manufacturing or via top-coating at the farm; both ways will deliver antimicrobial activity that has been proven to promote a more diverse and stable microbial community in the digestive tract in marine fish (Robles et al. 2017).

The efficacy of this functional additive to reduce the impact of WFS has been demonstrated under field conditions (Nuez-Ortín and Isern-Subich, 2019). This article brings new evidence of its efficacy under different application strategies in an Indonesian farm which has had a previous history of WFS outbreaks. This farm trial was conducted under a high degree of replication and demonstrates the effectiveness of the product under farming conditions.

Stocking date	Jul 30, 2020	July 3, 2020
Density (shrimp/m^2)	100	100
Number of pond replicates (1,000 m^2 per pond)	10 (1 block)	10 (1 block)
Application strategy	Corrective	Preventive + corrective
Dosage	High	Low (preventive) + high (corrective)
Application period	10-14 days after DOC 30-40 when infection symptoms appeared	Preventive: DOC 7 until harvest Corrective: 10-14 days after DOC 30-40 when infection symptoms appeared

Table 1. Stocking information and application strategies of SANACORE®GM

Farm experimental set-up

A shrimp farm located in Bratasena Lampung, Indonesia with 110 ponds was selected for this trial. The 110 ponds were distributed in 11 blocks of 10 ponds each. Each block is one ha. Historical farm data of two of the blocks and during the last four crops showed water *Vibrio* load over 10^2 CFU/mL and positive PCR to EHP. The same two blocks and 20 ponds were used in the present trial in order to evaluate the efficacy of corrective and preventive application strategies of Sanacore.

The stocking information and application strategies are described in Table 1. Historical farm data were used only for comparison purposes and were not included in the statistical analysis. Independent t-test was used to assess the difference in efficacy between the two application strategies using 10 pond replicates per strategy. Performance parameters reported here correspond to the average values of the two blocks and four crops for the farm historical data (where the additive was not used), and of the same two blocks with one crop each for the two application strategies. Each crop has an approximate duration of 110 days of culture (DOC).

Results and discussion

Supplementation of Sanacore under corrective application and under the combination of preventive and corrective applications improved average daily growth (ADG) and survival when compared to previous crops. The target ADG for the present farm was 0.3g, while lower values of 0.21g were observed in previous crops with reported WFS outbreaks. The corrective approach increased the ADG to 0.25g, while the combined preventive and corrective approach reached an ADG of 0.33g. Survival improved by 58% and 169% by the corrective and the combined strategies, respectively, when compared to previous crops (Figure 1A). The use of a preventive dosage from DOC 7 until harvest resulted in an additional and numerical improvement of 48% when compared to only the corrective application.

Improvements in ADG and survival with supplementation of the functional additive were reflected in better pond productivity (Figure 1B). The corrective strategy improved pond production by 105% when compared to previous crops, while the combination of preventive and corrective strategies achieved a 219% improvement. Likewise, the preventive dosage showed an additional and significant improvement of 50% when compared to only the corrective application.

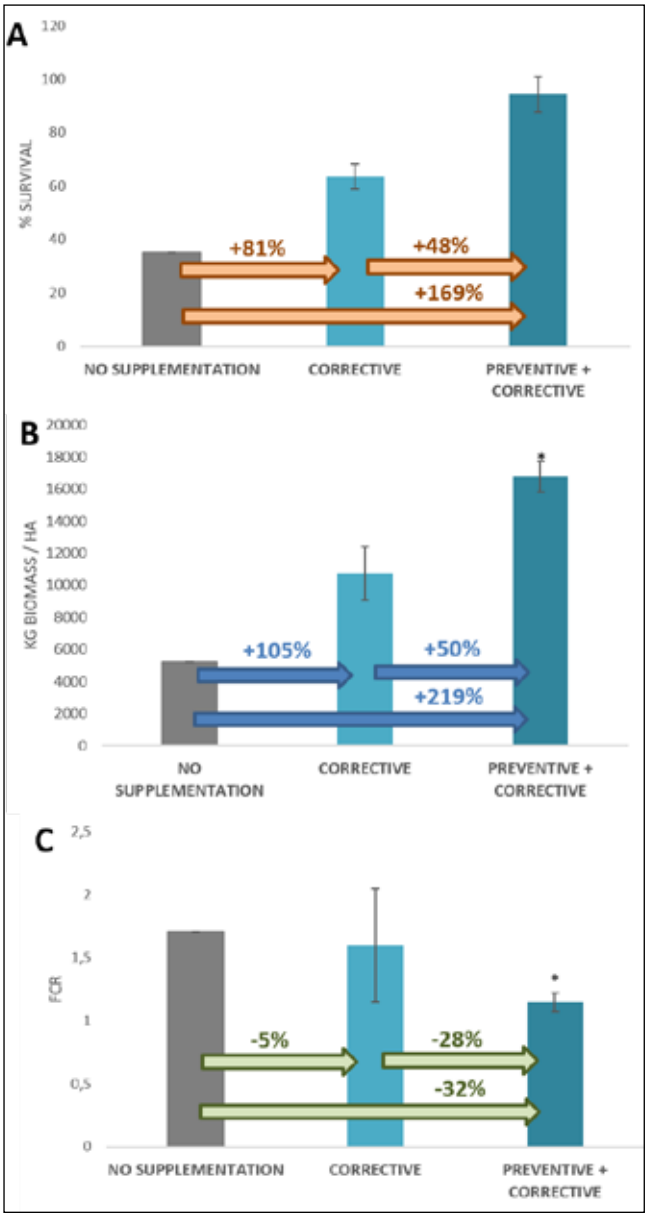

Figure 1. Efficacy of supplementation strategies of SANACORE®GM on shrimp performance and survival over two crops. A) % survival. B) Biomass per ha. C) Feed conversion efficiency (FCR). A total of 10 ponds were used per application strategy (n=10).

* Denotes significant differences between corrective and preventive + corrective application strategies.

Feed conversion efficiencies were also positively affected by supplementation (Figure 1C). The corrective application showed an improvement of 5%, while the combined strategy significantly resulted in an additional 24% improvement.

Pale hepatopancreas was observed at DOC 30-40; however, the application of the functional additive under both strategies prevented further symptoms such as white faecal strings at the water surface.

Altogether, these results are consistent with previous farm trials showing that while the corrective application is sufficient to mitigate signs of infection and improved survival, the combination of preventive and corrective applications is a more successful approach to maintain or increase growth rates and survival to pre-WFS levels (Nuez-Ortín and Isern-Subich, 2019). The efficacy of Sanacore against WFS is firstly attributed to the counteracting effect against pathogen development. The inhibitory activity against *Vibrio* spp. and EHP isolated from WFS infected shrimp has been proven and attributed to the combination of bactericide/bacteriostatic properties, quorum sensing inhibition, and antiparasitic properties (Nuez-Ortín and Isern-Subich, 2019). The additive also supplies antioxidant and immune-stimulant activities that support shrimp in dealing with the stress associated with changes in water quality and the subsequent increased susceptibility to infection.

The return on investment (ROI) can be defined as the ratio between the money gained from an investment relative to the amount of money invested. ROI was calculated based on the costs of post larvae, feed, additive, improved biomass gain and selling price per kg of shrimp. The functional additive increased feed cost per ha when compared to the farm's historical data, but this investment was well paid off by the biomass gain and economic returns. The ROI calculation indicated that for each US dollar invested in the additive application; USD18 and USD40 were additionally gained for the corrective and combined preventive and corrective strategies, respectively.

In conclusion, the present trial brings new evidence on the efficacy of Sanacore to prevent WFS under farming conditions. The high level of pond replication used in this study is not easily achieved at farm level and increases the reliability of the results. The corrective application of the additive positively impacts performance and survival, but only the preventive dose from stocking onwards successfully recovers farm standard growth rates and pond productivity. Under risk of disease outbreak, the net returns from additive applications exceed the net investment.

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A mix of free amino acids influences survival of whiteleg shrimp post larvae challenged with AHPND and WSSV

Bacteriological and viral challenges help in the understanding of how natural free amino acids obtained from extensive poultry keratin hydrolysis improve survival of whiteleg shrimp

By Pierrick Kersanté, Guillaume Le Reste and Luxsanawadee Soonngam

In two previous articles published in *Aqua Culture Asia Pacific* in March/April 2018 and July/August 2019, we described how Kera-Stim®50, a natural mix of free amino acids (MFAA), could provide some significant gains for shrimp farming. This MFAA added to the feed at a low inclusion rate (5kg/tonne of feed) effectively generates significant improvements in terms of feed intake, growth and feed conversion ratio (FCR) with a positive effect on shrimp behaviour with respect to feed attractiveness.

In addition to these zootechnical and behavioural results, we conducted further experiments to find out whether the better survival rates observed under normal conditions during these trials with the supplementation of MFAA could also be obtained in the case of immune challenges with acute hepatopancreatic necrosis disease/early mortality syndrome (AHPND/EMS) and white spot syndrome virus (WSSV, Kersanté et al., 2021).

To explore this subject and evaluate the effect of Kera-Start®90 MFAA (a more concentrated MFAA), we launched two separate studies (Trial I in 2018 and Trial II in 2020) in collaboration with Incabiotec/Concepto Azul Research Centre located in Tumbes, Peru.

Mix of free amino acids (MFAA)

Evaluated MFAA (Kera-Start®90), was obtained from BCF Life Sciences (Boisel, France). This mix of 17 amino acids (AA) obtained from extensive poultry keratin hydrolysis is highly concentrated with 88.7% of total AA, of which 94.5% are in their free form (Table 1).

Items	Value
Dry matter	98.6%
Total amino acids (CE 152/2009)	88.7%
Free amino acids (CE 152/2009)	83.8%

Table 1. Proximate composition of the MFAA tested in experiments I & II

Feed

Two locally produced commercial feeds for shrimp post larvae (PL), Nicovita Origin 0.5 for PL11-20 and Nicovita Origin 0.8 for PL21 -1g, with 45% crude protein and 10% lipid were used as base diets. The composition is given in Table 2. MFAA was top coated on these feeds at three concentrations 10g/kg of feed, 50g/kg of feed and 100g/kg of feed (MFAA 10, MFAA 50 and MFAA 100,) respectively.

MFAA was mixed with a fixed quantity of water (3/5 of MFAA and 2/5 of water). This solution was homogenised and applied by coating on the feed for 3 minutes in a mixer. Control feed followed the same process with the same amount of water but without MFFA. After 12 hours of drying, each feed was then spray-coated with a 2:1 mix of fish oil and soy lecithin at 30g/kg of feed. After drying at room temperature, feeds were stored in individual bags in a clean and cool room (4°C).

Items	Control diet
Dry matter, %	> 90%
Crude protein, %	> 45%
Lipid, %	> 10%
Ash, %	< 10%
Fibre, %	< 2%

Table 2. Proximate composition of feeds used in experiments I and II

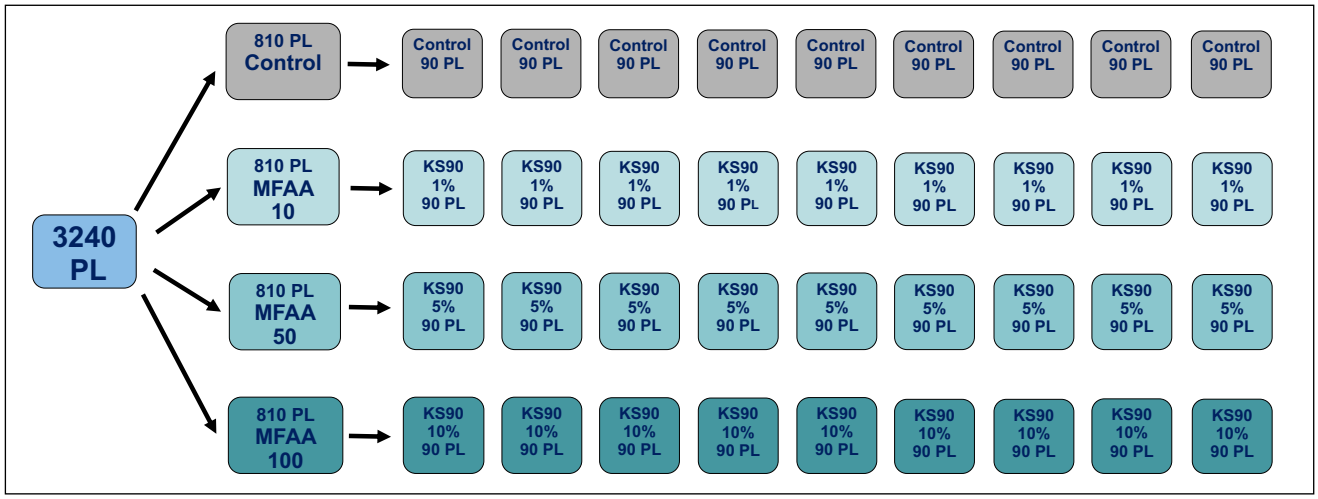

Figure 1. Experimental plan for the growth phase.

Experimental protocol for the growing and infectious challenge phases

Litopenaeus vannamei post larvae, PL14 and PL21 for trials I and II, respectively, were obtained from certified broodstock and previously analysed by PCR to confirm the absence of WSSV, infectious hypothermal and hemotopoietic necrosis virus (IHHNV), necrotising hepatopancreatitis, (NHP) and AHPND.

Growth phase

We started with a classical growth phase for 28 and 21 days, respectively. During this time, shrimp were placed into 36 glass tanks of 20L capacity, each filled with 15L of seawater (32ppt). Each tank was stocked with 90 healthy PL. The tanks were divided into four groups of nine tanks following the experimental plan described in Figure 1. Each of these groups were fed with diets described previously.

Challenge phase

At the end of the growth phase, 324 PL from each treatment were placed in nine tanks of 15L filled with the same source of water as described above. Animals were divided into three groups (non-infected control, AHPND and WSSV groups) following the experimental design described in Figure 2. The average body weight of the PLs were 0.26g and 0.09g at the beginning of the infectious challenge period for trials I and II, respectively.

AHPND and WSSV infections were processed by dipping, following standard infection protocols for these two pathogens: *Vibrio parahaemolyticus* 10^6 CFU/mL and adding of infected WSSV tissues at 20% of initial biomass.

Each of these groups of shrimp were fed with one of the previously described diets, for a period of 28 days for both trials I and II.

We observed survival rates and biomass weekly during these two phases (growth and infectious) to identify potential effects of MFAA in case of immune challenges.

Results for the growth phase

Survival and biomass were in the normal path during the first growth phase with survival rates above 81% and 87% for control groups in trials I and II.

		Control
Trial I	Survival (%)	85.17 ± 1.62
	Biomass (g)	41.6 ± 8.22
Trial II	Survival (%)	73.15 ± 1.6
	Biomass (g)	12.82 ± 0.98

Table 3. Survival and biomass of non-infected group of *Litopenaeus vannamei* post larvae fed the control feed at the end of the infectious challenge phase in experiments I and II.

		Control	MFAA 10	MFAA 50	MFAA 100
Trial I	Survival (%)	59.23^{b}	63.87^{ab}	66.67^{ab}	68.53^{a}
	Biomass (g)	26.19^{a}	24.51^{a}	26.23^{a}	27.85^{a}
Trial II	Survival (%)	47.22^{b}	56.48^{a}	63.89^{a}	56.48^{ab}
	Biomass (g)	7.19^{b}	8.26^{ab}	9.03^{a}	8.12^{ab}

Table 4. Survival and biomass of AHPND infected group of *Litopenaeus vannamei* PL fed feeds containing respectively 0, 10, 50 and 100g/kg of the mix of free amino acids (MFAA) at the end of the infectious challenge phase in experiments I and II. Data within the same rows with same superscript letters are not significantly different $P>0.05$.

		Control	MFAA 10	MFAA 50	MFAA 100
Trial I	Survival (%)	3.73^{d}	18.5^{b}	6.5^{c}	27.8^{a}
	Biomass (g)	0.65^{c}	4.13^{b}	0.82^{c}	7.38^{a}
Trial II	Survival (%)	46.3^{b}	61.11^{a}	57.41^{a}	54.63^{a}
	Biomass (g)	5.93^{bc}	7.41^{ab}	8.08^{a}	5.9^{c}

Table 5. Survival and biomass of WSSV infected group of *Litopenaeus vannamei* PL fed feeds containing respectively 0, 10, 50 and 100g/kg of the mix of free amino acids (MFAA) at the end of the infectious challenge phase in experiments I and II. Data within the same rows with same superscript letters are not significantly different $P>0.05$.

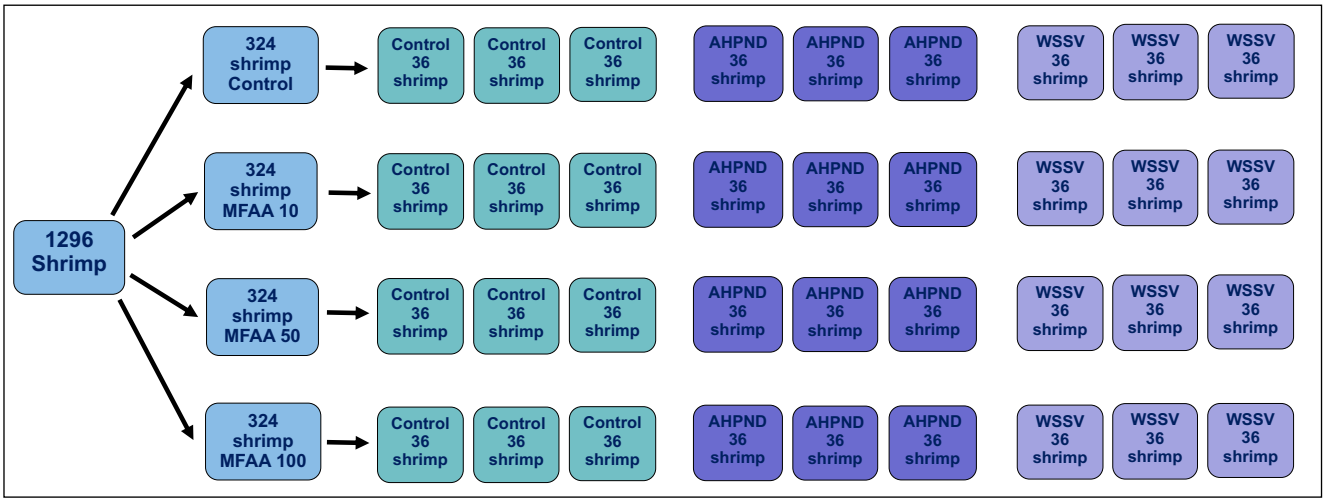

Figure 2. Experimental plan for the infectious challenge phase.

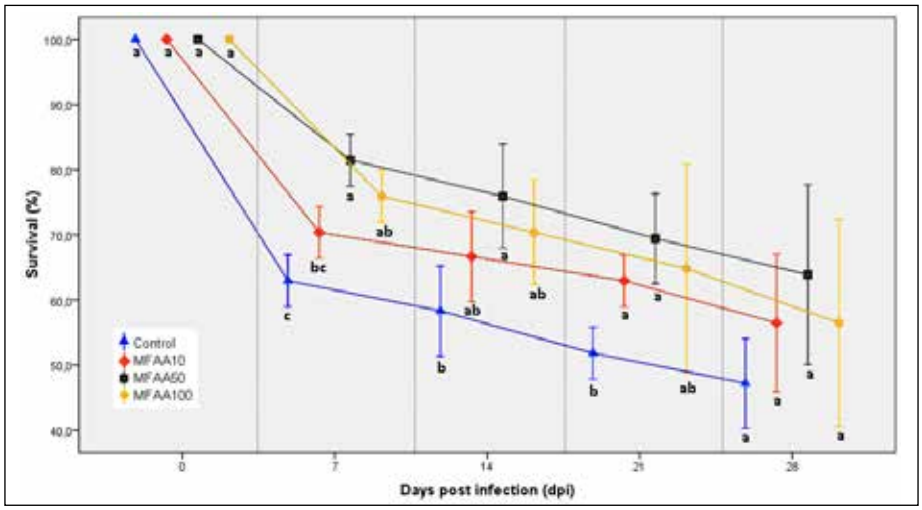

Figure 1. Evolution of weekly survival after AHPND infection in Trial II (95% CI of averages and Duncan test by week) Same letters denote no significant differences at $P>0.05$.

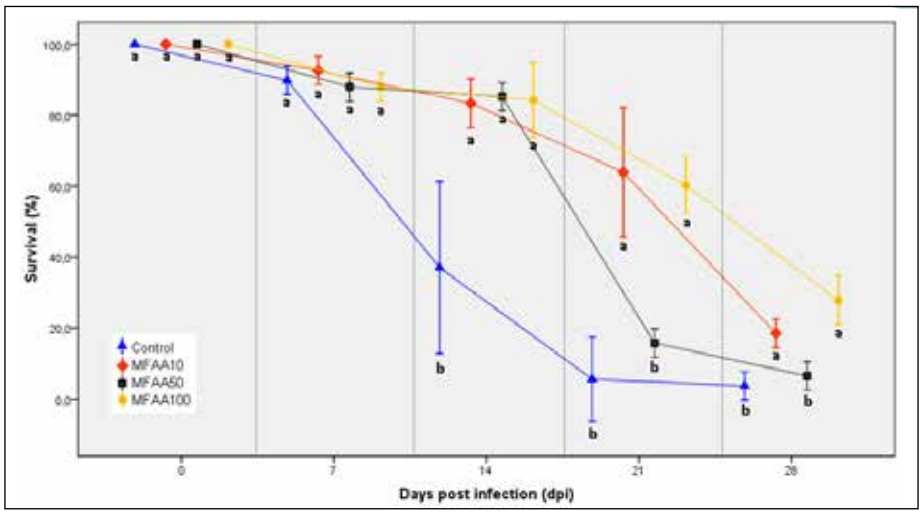

Figure 2. Evolution of weekly survival after WSSV infection in Trial I (95% CI of averages and Duncan test by week). Same letters denote no significant differences at $P>0.05$.

Results for the infectious challenge phase

After four weeks of infectious challenges, AHPND and WSSV infected groups showed a significant decrease in survival and biomass increases while these parameters remained steady in non-infected groups (Table 3). In WSSV infected groups of trials I and II and in AHPND infected group of trial II, shrimp fed with MFAA treatments showed significantly higher survival rates from the second week to the end of the infection challenge (Graphs 1, 2, 3 and Tables 4 and 5), in comparison with those fed with the control diet without MFAA.

Discussion

Throughout the duration of the experiments, infected groups faced a strong drop in post larvae population in comparison with the non-infected control groups. In these very challenging conditions, shrimp fed with feed supplemented with different levels of MFAA showed significantly higher survival and biomass increase when challenged with AHPND and WSSV infections.

In general, research studies mainly focus on single amino acids and their individual effect on feed performance. To our knowledge, there was no previously available scientific work in shrimp nutrition underlining the role of MFAA in the case of immune challenge. Evaluated MFAA in the present study is composed of 17 amino acids in soluble form with some of them already identified to generate positive actions on immune response of aquatic species (Li et al., 2009).

Mechanisms of action are probably multiple as each amino acid acts at different levels of metabolic pathways and we can hypothesise that with regards to immune response through animal nutrition, it is preferable to have a holistic approach.

In evaluated MFAA, high soluble form (100%) and high *in vivo* digestibility (96.8% measured on cockerel), both in relation with extensive hydrolysis, induce fast and high level of assimilation. This characteristic is particularly important for young animals with immature digestive tracts if we consider that a fast absorption after feed ingestion can contribute to improved general metabolic pathways (Rønnestad et al., 2003).

Today, the purpose of AA supplementation is mainly oriented for nutritional balance. Therefore, the present results open new possibilities for AA utilisation in aquafeed formulations.

In addition to previous investigations demonstrating their positive effects on shrimp zootechnical performances (Le Reste et al., 2019), mixes of free amino acids obtained from extensive hydrolysis appear as new potential efficient solutions to improve immune response of white shrimp, *L. vannamei*, in cases of bacteriological and viral challenges. This new field of application confirms their interest as a sustainable protein source converted into an efficient functional ingredient for shrimp nutrition.

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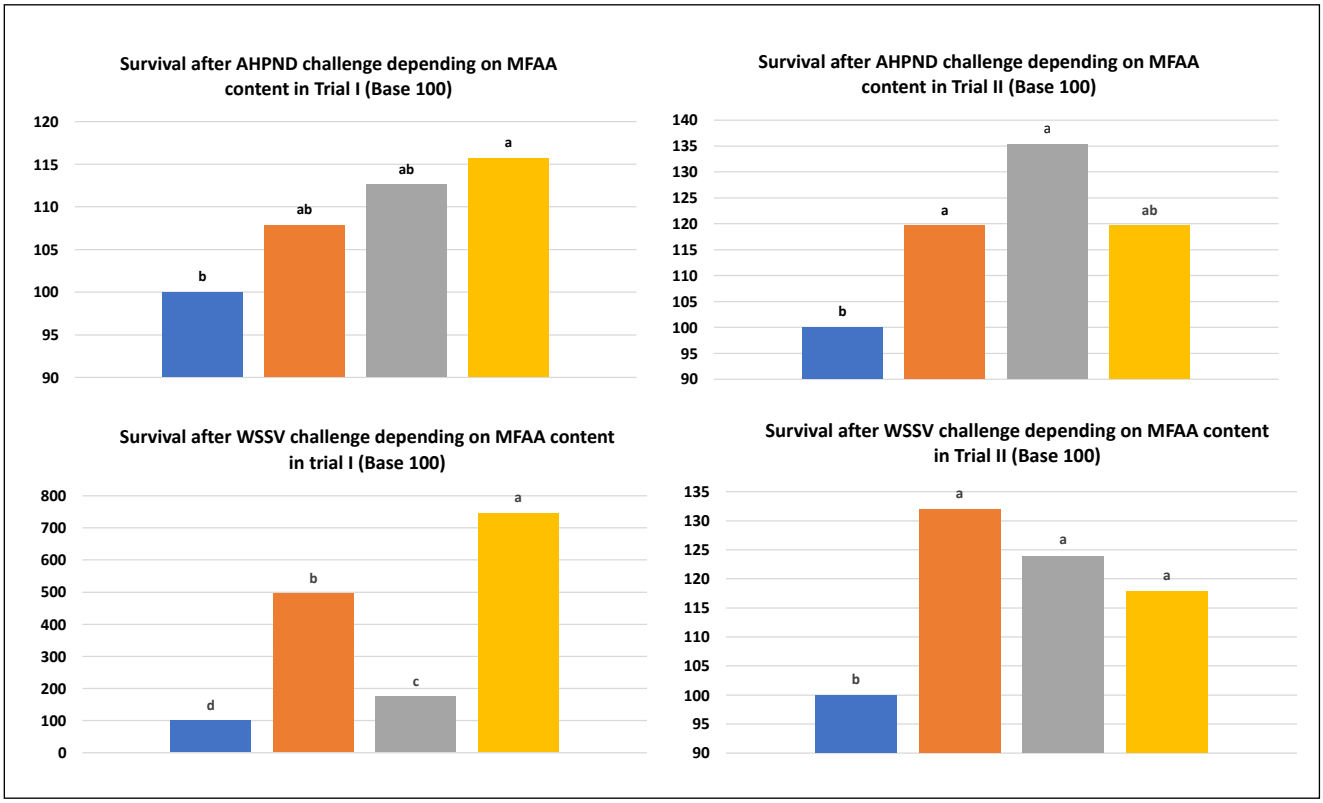
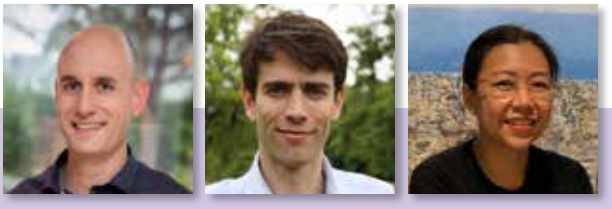


Figure 3. Influence of different MFAA treatments on survival (Base 100) after AHPND and WSSV infection in Trials I & II (95% CI of averages and Duncan test by week). Same letters denote no significant differences at $P>0.05$



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Protein in aquafeeds, a major cost and strategies for its use

Valuation of formulations for optimum cost savings with a feed additive in fish feeds

By Pierre Fortin

Protein is a major cost in aquafeed. Indeed, aquatic animals have high protein requirements compared to terrestrial animals (Figure 1). Furthermore, fishmeal is very often used in fish and shrimp diets. Its price increases faster than other ingredients. Over a 25-year period, fishmeal prices have increased by 350%, while soybean meal increased only by 150% (Source: Indexmundi). It is true especially in these days of raw material price uncertainty. Soybean meal price increased by 65% in the last half of 2020. Even if prices have lowered this year, they are still 25% higher than in 2019 or early 2020.

In this situation, feed producers need to be careful when using protein sources to fulfil the needs of animals. First from an economic point of view, but also with regards to its quality. In fact, protein itself does not mean a lot. Protein could have low digestibility (because of the intrinsic composition of an ingredient, or for example, effects resulting from processing methods) and it could also be unbalanced. This could result in lower growth performance of the animal. This brief article will help you save some costs on your feed while safeguarding its quality.

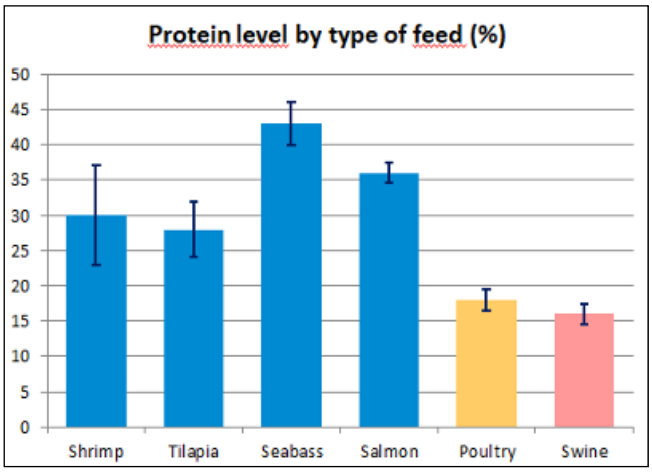

Figure 1. Crude protein requirements for various aquatic species in comparison to that for poultry and swine (Source: Techna).

Feed quality depends on the quality of its ingredients

"Quality inputs lead to quality outputs" - this saying is also true for feed. If one does not pay attention to the supply source or does not handle the product properly, even fishmeal could be lower in quality than plant ingredients. It will depend on the raw material quality and how it is processed, cooked and dried, extracted, protected and finally stored. These key points are similar for other ingredients. Therefore, analysis can give a good overview of the quality of ingredients. Specific analyses are needed for different types of raw material.

	Fish meal	Meat products	Soybean meal	Expeller meals	DDGS
Pepsin digestibility	V	V			
Oxidative values	V	V		V	
Specific amino acid levels					V
Biogenic amines	V				
Urease test (+anti trypsic)			V		
Amino acid profil variation	V	V			

Figure 2. Some important analysis to ensure the quality of several ingredients (Source: Techna).

For example, fishmeal quality could be impacted before processing if the fish, or trimmings are not stored properly. This will be evaluated by the TVN (total volatile nitrogen) or biogenic amine values, which are the result of degradation of specific amino acids. Processing could also have an impact on the quality of the product by overcooking; this could be evaluated by oxidative parameters. Overall quality of the proteins of fishmeal is often evaluated by pepsin digestibility. Similar parameters could be analysed on animal meals such as poultry meal and meat and bone meal. For soybean meal, different tests exist such as the urease test and anti-trypsin factors. Analysis of the protein is important to determine whether it is well-cooked and digestible, but without overcooking it which may result in lower digestibility of certain sensitive amino acids such as lysine. Free lysine could also be an indicator of the quality of DDGS or distillers dried grain with solubles. The main risk with these products is overcooking which reduces the overall digestibility. Figure 2 summarises some important analyses to ensure the quality of several ingredients. It is important to analyse these parameters according to importance and risk.

Beyond protein: digestibility and amino acid profile to fulfil the needs of each species

Once the raw materials are sourced, analysed and validated, the second step is to know if they are digestible by the targeted animals. Digestibility of protein depends on several factors but mainly on the type of raw material. Indeed, the form of protein, amino acid chain, together with other compounds such as carbohydrates affect the way fish or shrimp enzymes can fully utilise the raw material. As an example, fishmeal digestibility is affected by ash content; the more ash there is, the less digestible it will be. But note that this is not the only parameter to take into consideration. Within the various plant protein sources available globally, some are more digestible than others. Some of the most digestible will be soybean, peas and beans whereas copra, alfalfa or linseed will be among the least digestible.

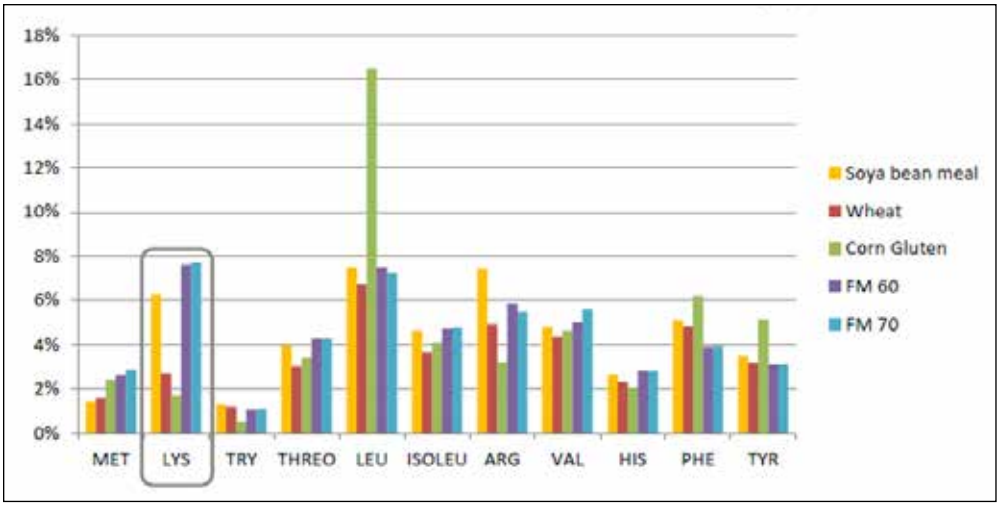

Figure 3. Comparison of amino acid content (%) of selected raw materials (Source: Techna).

Another parameter to consider is which part of the raw material is in the final product. When extracting different parts of a seed, protein digestibility may change. For example, wheat grain or wheat flour, which are roughly the whole grain, almost have the same digestibility. However, with wheat bran, digestibility will be reduced as this part of the grain contains more fibre affecting the overall protein quality. On the other hand, with processes of protein concentration, digestibility will increase. Wheat gluten meal with 80% protein is more digestible than wheat gluten feed with 20% protein, which is more digestible than wheat grain. Similar patterns will also occur in other plant products, or in animal proteins.

Aquaneo, the aquaculture brand of Techna Group, has been gathering information over several years and integrating this specific knowledge into its own formulation matrix. The aim is to ensure feed quality while formulating at the lowest cost for our customers.

Amino acid profiles

Another aspect to take into consideration is the amino acid profile. This is usually quite stable for plant-based products, but it could fluctuate a lot in fishmeal or animal proteins depending on the species and the part of the animal being processed (whole, trimmings, feather, blood, meat, bones etc). Amino acid profile analyses should be performed on these varying ingredients. In Figure 3, we can see that amino acid profiles are very different according to the raw material. For example, using wheat and corn products as protein replacers may create lysine deficiency as their lysine/protein ratio is around 2% compared to fishmeal which is usually above 6% of total protein. Once again, all these information are part of our formulation matrix and will be used to prepare the feed formulation. Furthermore, Aquaneo's laboratory offers the analysis of amino acid profile of raw materials.

The above mentioned gives a very good overview of the quality of different raw materials available. How can the formulation fulfil the requirements of the targeted animal? This is achieved not only by adding a certain amount of protein, but also including quality, digestibility of protein and its amino acid profile.

A solution to reduce costs and improve protein utilisation

As mentioned earlier, protein is the major cost for most feeds for aquaculture, but there are ways to reduce this cost. Acting on the overall digestibility of feed, specific additives such as Economix, developed by Aquaneo, can help the animal's digestive system to increase the digestibility of protein and therefore the performance of the animal.

	Control Formula	Economix Formula
Nutritional values		
Crude protein (%)	42.5	41.5
Digestible protein (%)	38.5	38.5
Digestible lysine/Digestible protein(%)	2.20	2.20
Digestible methionine/ Digestible protein (%)	5.60	5.60
Digestible energy (MJ)	18.5	18.5
Composition (% of feed)		
Fishmeal	20	18
Wheat	17.3	18.5
MCP	0.12	0.35
Economix	0	0.2
Other raw materials and additives	62.6	63.0
Price (€/tonne)		
Formula costs	859.3	846.9
Savings *		12.4

(*) Savings are context dependent and may vary according to feed formulations and raw materials prices.

Table 1. Formulas and nutritional composition of test diets for the European seabream *Sparus aurata* digestibility trial (Source: Techna).

	Unit	Control	Negative Control	Economix
Nutritional values				
Crude protein	%	42	41	41
Digestible protein	%	36.7	35.9	36.7
Digestible energy	MJ	19	19	19
Fat	%	22	22.1	22
Starch	%	11.4	12.1	12
Fibre	%	1.1	1.2	1.2
Ash	%	8.3	7.9	8.1
Composition (% of feed)				
Wheat		16.9	18.3	18.2
Soybean meal		18	19	19
Other plant proteins		3.6	2.9	2.8
PAPs		23	23	23
Fishmeal		20	18	18.1
Oils		17.2	17.5	17.4
Premix & additives		1.3	1.3	1.3
Economix				0.2
Price (€/tonne)				
Formula costs		780	/	768
Savings *				12

**Savings are context dependent and may vary according to raw material prices and local conditions*

Table 2. Formulas and nutritional composition of test diets for the rainbow trout *Oncorhynchus mykiss* - growth trial (Source: Techna).

Results of a trial carried out at SPAROS Portugal on the European seabream *Sparus aurata* (115g) showed an increase of protein digestibility from 93.8% up to 94.3% with the use of Economix (Table 1). It also showed a significant increase in methionine digestibility from 87.9% to 91.7%. In the Economix formula, crude protein level was reduced by 1%, but the digestible protein (38.5% in Aquaneo's formulation matrix) and amino acid profile were maintained. The composition of the feeds was very similar, but we replaced 2% fishmeal from the control formula. Fishmeal was replaced mainly by wheat, monocalcium phosphate (MCP) and Economix. The use of this additive allowed a cost reduction of €12.4/tonne on a typical Mediterranean fish feed while improving the digestibility and keeping the same growth performances.

Another trial was done on 100g rainbow trout with three different types of feeds. The first was a commercial diet as the control. The second was a negative control, where crude protein was reduced by 1 point and fishmeal by 2 points. The third was a diet where the protein and fishmeal were also reduced but the Economix additive was included. The digestible protein was the same as the control diet. The cost saving with the use of Economix compared to the control diet was €12/tonne.

Results of the trial showed a decrease in growth performances for the negative control, both in terms of biomass gain and feed conversion ratio (FCR). Fish fed diets with Economix showed slightly better biomass gains and FCR compared to control. This demonstrated that it is possible to save some costs while safeguarding performances (Figure 4).

With these trials we showed that reducing feed costs is possible while maintaining feed quality and fish performance. The additive can be used with matrix valorisation for optimum cost savings or with an easy ingredient substitution. This simple use is done by replacing 2% of fishmeal by 0.8% of soybean meal + 1% of cereals (wheat, corn or rice) + 0.2% of Economix.

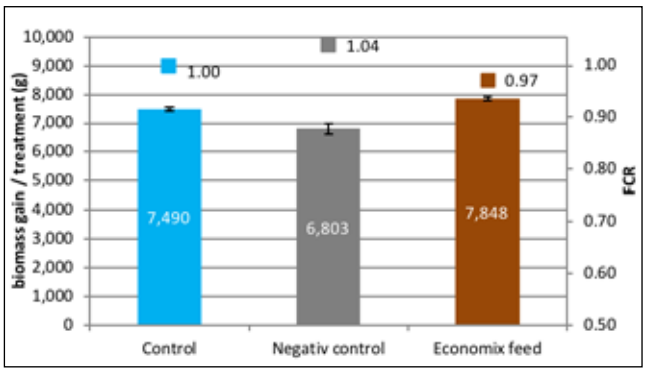

Figure 4. Biomass gain and comparison of feed conversion ratio (FCR) between several diets of of rainbow trout *Oncorhynchus mykiss* (Source: Techna).

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The trust deficit on functional feeds among shrimp farmers in Asia

Three business leaders representing the supply chain tried to make sense of the situation

At the virtual TARS 2021, the Hard Talk topic was on why there is a trust deficit on functional feeds among shrimp farmers in Asia. Representing the supply chain were, clockwise, from top right, Guntur Mallarangeng, CEO, Dewi Laut Aquaculture; Samson Li, CEO Grobest; Dr Peter Coutteau, Business Unit Director Aquaculture at Adisseo and moderator Ronnie Tan.

Functional shrimp feeds were first launched in Asia in the 2000s but received more attention around 2014 after outbreaks of acute hepatopancreatic necrosis disease/early mortality syndrome (AHPND/EMS). However, the question is – why is there still a trust deficit among Asian shrimp farmers on using functional feeds?

Farmers have different opinions along the spectrum; some are happy, some unclear on whether it works and on the cost benefits, while others have either stopped or used only for certain cycles. Complicating matters are those who believe in functional feeds but prefer to top dress at the farm site. At Hard Talk during the virtual TARS 2021, held from August 18-20, Ronnie Tan, Consultant, together with three business leaders in the supply chain tried to make sense of the situation.

Dr Peter Coutteau is Business Unit Director Aquaculture at Adisseo which produces functional feed additives. **Bluestar Adisseo** has a specialised portfolio of feed additives for aquaculture and functional feed additives to reduce the impact of diseases on performance of fish and shrimp. The latest addition is an R&D facility to run trials, ASA (Aquaculture Station by Adisseo) in Singapore.

Samson Li is CEO of Grobest, a leader in the functional shrimp feed market in Asia. Founded in 1974, the **Grobest Group** has 14 feed mills across Asia producing aquafeeds, from starter to grow-out, pelleted and extruded for more than 20 aquaculture species but focuses mainly on shrimp and high value warm water species.

The new generation Indonesian shrimp farmer is **Guntur Mallarangeng**, CEO who started **Dewi Laut Aquaculture (DLA)**, on the south coast of Garut in 2016. This is a 5ha farm on 10ha of land, and the farm has achieved survival rates of 80-95% and profitability within 2 years. The stocking density ranges from 180-200 PL/m^2 and production averages 41.8 tonnes/ha of sizes 70/kg to 40/kg from 70-90 days of culture. The farm avoids diseases such as infectious myonecrosis virus (IMNV) and white faeces syndrome (WFS) by optimising the feeding strategy and recirculating water to minimise the volume of low-quality water.

Functional feeds are generally recognised as important in shrimp health and disease management, but there is a multitude of problems on their acceptance and use. The panel delved into issues of hesitancy, acceptance and cost benefits, and discussed some approaches on what can be done to further advance the industry.

Hesitancy, cost issues and price premiums

Peter: There is a lot of misunderstanding on what is a functional feed, from the perspectives of the farmer and feed miller. Unfortunately, this has been exacerbated by a lot of bad practices-magic bullets in shrimp farming. Another key issue is the reluctance by farmers to focus on disease prevention, preferring to correct only when the problem appears. Functional feeds are rarely effective as a therapeutic treatment. Also, it requires focused efforts to evaluate the effect in a practical farm situation. On

costs, functional feeds are well adopted by producers of other high value species, such as salmon and marine fish.

The industry will learn that you can get an increase of 10-25% in productivity. This is justified by price premiums of 5-10% in grow-out to get good returns on investments. Again, it will depend on the farmers' objectives and economic environments.

Samson: It has all to do with the trust issue and expectations of the farmer. There is nothing wrong for a farmer to focus on the cost issue, but, if a good harvest is the goal, then it is essential to use a feed that performs. We equate this functional feed to a car insurance.

"There is nothing wrong for a farmer to focus on the cost issue, but, if a good harvest is the goal, then it is essential to use a feed that performs." - Samson Li

We can improve the health status of shrimp and dramatically reduce the risks of disease outbreaks, whether it is white spot syndrome virus (WSSV), shrimp haemocyte iridescent virus (SHIV) and others, but we see that some farmers choose to cut corners and depend on luck for a good harvest. An important need is to select a functional feed with a history of data to back up feed performance.

There is no silver bullet, even the best performance feed that we have is not therapeutic. We have been clear with farmers, that if the pond has a problem, they cannot expect to save a crop just by adding a feed additive or functional feed. We have to be responsible and honestly tell the farmer what is in the feed, what to expect and what they should do.

We see a lot of data in Thailand, China, Vietnam and Indonesia showing that the correct protocol and dosage do help to increase survival rates. Shrimp is a high value species, and farmers know that a 5-10% increase in output is profitable.

Grobest strongly believes that there is no one size fits all and offers a range of protocols that are adapted to the local conditions and farmers' needs. Feed formulations are based on what the customer needs. A high-quality functional feed, when applied with the correct protocol with the support of the technical team, will benefit the farmers. I stress that what is most important is the output per kg of feed.

Key drivers of buyers: Top dressing versus in-feed

The functional additive producers have two different segments of customers to handle: the feed miller and the farmer who insists on top dressing with functional additives at the pond site. What are the key drivers between these two groups?

Peter: We have to work with both segments to solve the complex disease challenge in shrimp farming. We start from a good preventive in-feed program at the feed mill. For some diseases, we need to reinforce this in the correct timing at the farm with top dressing. The three of us, feed additive supplier, feed miller and farmer have to collaborate. It helps when the feed mill also has farm care products for their farmers. Increasingly we are seeing big farmers and those using automatic feeders reluctant to apply top dressing.

There can be flexibility to combat diseases in shrimp and an interesting idea is to have therapeutic feeds, i.e. feed (with specific treatment or functional additives) which are already available at the farm. We know that logistically, we cannot ask the feed miller for a specific functional feed at the time of a disease outbreak. So, if there are therapeutic feeds ready, we could eliminate the need for top dressing at the farm.

Samson: Some farmers top dress at the farm with functional additives as well as utilise a host of other solutions. After 47 years in aquaculture, we understand their situation. In Indonesia, we have farmers with 30-40 years of experience, but Grobest, which focuses on aquaculture only, will do all we can to help them mitigate the risks.

"We see functional feeds at DLA, as a derisking tool. ... Any additional increase in cost is typically outweighed by the decreased risk that is undertaken from cycle to cycle." - Guntur Mallarangeng

"Not all functional additives are created equal, there are broad spectrum and more specific ones." - Peter Coutteau

Understanding functional feeds

Guntur: At DLA, we use functional feed because we understand what it can be used for and what it cannot. I agree with both Peter and Samson, that it is not a panacea and cannot solve all the problems.

We see functional feeds at DLA, as a derisking tool. Shrimp is a very high margin business if you do it right. Any additional increase in cost is outweighed by the decrease in risk that is undertaken from cycle to cycle.

The relatively small additional expenditure is covered by the increase in revenue due to stable survival rates, as well as improved growth rates and average weights of shrimp at the end of each cycle. At DLA, feed (including functional feeds) is anywhere between 37-45% of our overall cost structure. We buy the additives and mix them into feeds ourselves.

The main issue is not a matter of lack of trust between the farmer and the feed miller but being able to purchase the type of functional feeds that suit our requirements at a volume that makes sense for us and them. Needs may also vary among farms - shrimp farming is both an art and a science. We understand the science – the disease and biological processes, but every shrimp farmer has their own way of farming. I understand that for the feed miller it is difficult to create a premixed product that can be both tailored and produced at scale.

The feed guys are helping the new farmers such as myself with technical help and planning. There is better trust between the new generation of shrimp farmers and feed millers. I have the historical data and understand that risks at my farm will be different from the 10 other farms in my area. I do not expect feed millers to cater for me only unless I and others in my area have the same specifications in a functional feed. In summary, the industry is not wholly data driven and cannot come to a consensus on what we need.

The new generation of Indonesian farmers are more open to technology and have a better understanding of the science in shrimp farming. To trust a product, we need to understand the science and the data behind it. The older generation of farmers are very averse to price increases and do not understand data-driven decision making.

On the ground, I know that there is some misunderstanding on functional feeds, and unfortunately, at the field level, functional feeds are marketed as a panacea. Some products work more against specific pathogens while others are broad spectrum. They support disease prevention programs, but they do not eliminate all risks, the risk of disease outbreaks nor the pathogens. Once a farmer tries using it and it fails, the farmer is going to lose trust in the product.

Over promise

Functional feeds are used against various diseases but are we over promising?

Peter: We have seen, in scientific literature as well as in our own field trials, that functional feeds charged with the right additives can reduce the impact of a wide variety of diseases as well as co-infections. Contrary to fish where vaccines play an important role in disease prevention, in shrimp, diseases are caused by multiple pathogens. That is why we believe that the functional feed can do with a preventive approach, by derisking the impact of the disease. Instead of a full crop loss, the farmer can still have a profitable harvest.

Some functional feed additives work more against specific pathogens while others are more broad spectrum. They support disease prevention programs, but they do not totally eliminate the risk of disease outbreaks nor eliminate the pathogens. They are not a therapeutic agent but aim at reducing the impact of the disease. In some cases, such as WFS, the corrective action is increasing levels or types of products to complement the current preventive action. Importantly, the functional feed can never replace the management of the farm or health management of the shrimp – it is an integral part of it.

At ASA (Aquaculture Station by Adisseo) in Singapore, Adisseo works with a global network of research partners in aquaculture to run R&D trials.

The fermentation system at Grobest's manufacturing facility in Taiwan. Grobest has 14 feedmills; in Taiwan, China, India, Indonesia, Thailand, Malaysia, Philippines and Vietnam.

Not all functional additives are created equal, there are broad spectrum and more specific ones. Broad spectrum products work through a variety of modes of action, such as boosting the immune competence and gut health in the host, whereas attenuating the virulence of the pathogens. They tend to be more effective to reduce the impact of co-infections. For example, in the case of parasites we often do not see a decrease in the parasite counts, but a reduction in the secondary damage caused by the parasite, resulting in significant effects on survival and productivity.

Samson: Grobest has its own R&D centre and testing facilities, such as ATIP (AquaTech Innovation Park) in Vietnam and is working on new diseases and challenges. One example is that we have helped farmers reduce the effects of SHIV in China. This is a solution but again I emphasise that it is not a silver bullet. We have functional feeds supporting farmers when facing problems with WFS, WSSV, IMNV and EMS. Working with farmers, we can advise them in advance, before a problem is expected. We have seen that functional feed cannot help when the disease outbreak is already there.

In East Java, a farmer had WSSV, IMNV, *Enterocytozoon hepatopenaei* (EHP) and EMS outbreaks in some ponds. After using the functional feed, we could not solve all the problems, but we helped him to increase productivity by 44%. The other ponds where the functional feed was not used, were total wipeouts. This 44% increase in output justified the extra costs of the functional feed.

We have developed an app which simulates the cost situation based on the shrimp price to assess the output and profitability of production.

A derisking tool

What are farmers derisking against and when prices fall would DLA stop using functional feed to save costs?

Guntur: We try to derisk against various factors, depending on the time of the year such as climate, other farmers' waste in the water, etc. Our water quality data show that disease pathogens such as IMNV, WFS etc. are in the water. But the shrimp remain resilient to these diseases.

Within the farm, we know the factors that we can control and the factors that we cannot. We can create the right environment for the shrimp and influence productivity. We cannot control price. Therefore, the answer is no, we will not stop using functional feeds when prices fall, if we can operate well over the years and generate a consistent harvest at every cycle. Even with low prices (which I cannot control), from an organisation perspective, I would want to maintain the same productivity levels of around 40 tonnes/ha.

Addressing the trust deficit issue

Arguably, there is a trust deficit, and this is on both ends. How can the feed miller and feed additive supplier improve their image in the eyes of the farmer?

Peter: This is a job for all, feed additives suppliers and feed millers to educate industry. I do not see any competition here; for all, there are benefits to gain if functional feeds work well. Even if we have a solution, there is room for improvement and how to work better in the field. It is definitely a science, and as a feed additive provider, we continue to work hard to understand how products work, how components in products work and modes of action in immune and digestive functions.

This scientific work is the basic homework but the real hard work is in the field. Latin America is an easier market to get hard data by working with large farms with more replicated ponds and willingness to share data. This is more difficult in Asia where there is less tradition of data collection and sharing. We strongly believe in the power of having new generation farmers like Guntur understand the scientific background of innovative functional additives and optimise their application in function of the needs.

Dewi Laut Aquaculture, on the south coast of Garut, Indonesia, was started in 2016. There are 2.5 cycles/year at 90 days of culture/cycle. Productivity has reached 41.8tonnes/ha.

Image of functional feeds

To improve the image of functional feeds, should there be self-regulation among credible functional additive suppliers to counter bad publicity coming from those in the market with unsupported claims?

Peter: I recommend that when farmers want to optimise their production using functional feeds, they should work with reputable partners and select products that have a scientific track record to document their development for the issue they wish to tackle. These partners, feed miller and/or feed additive supplier, offer technical services and expertise which is a must to optimise the functional additive strategy under production conditions. We all know by now that magic bullets do not exist, sustainable solutions are only created by hard, collaborative work.

Samson: We go through regulatory approvals for all our feeds. Farmers trust farmers and we have the biggest integrator in Vietnam as an opinion leader with testimonials that our functional feed works.

Guntur: We do want to buy functional feeds from the feed millers. The issue is what mix, what quantity, and what terms of payment. If I have a different request on what I want in terms of functional feeds from others in my region, the feed miller will need to produce different kinds of blends. This may put the feed miller in a dilemma since he needs to consider producing a minimum amount of feed to achieve economies of scale.

Today, we spend a lot of time on top dressing feed and when we are bigger and our farm reaches a size of 100ha, we will need to buy premixed functional feeds. The additional income really outweighs the costs. The issue is how to figure out the quantities which are economic for feed millers and at the right price based on our specifications. Producers know that the new generation of farmers is a target market. We understand the science behind functional feeds and I would love to talk to feed millers willing to listen and work something out.

Sustainability - Building confidence in Asian shrimp

Discussed but often left asunder is the sustainability of Asian shrimp. This question was brought up in the earlier session on markets (see pages 4-6). Asian shrimp is probably trailing behind Ecuador and needs concerted efforts to catch up. Therefore, how can we improve our sustainability quotients, especially when the Netflix documentary Seaspiracy made this front and centre of an aquaculture target. Preparedness is key.

At TARS 2021, **Dr Marcela Salazar**, Chairman of the Welfare Committee for Benchmark PLC, brilliantly described the progress made with sustainability along the supply chain but she also said that there is a lot more to be done. Benchmark has been pioneering sustainability in aquaculture over the past 20 years.

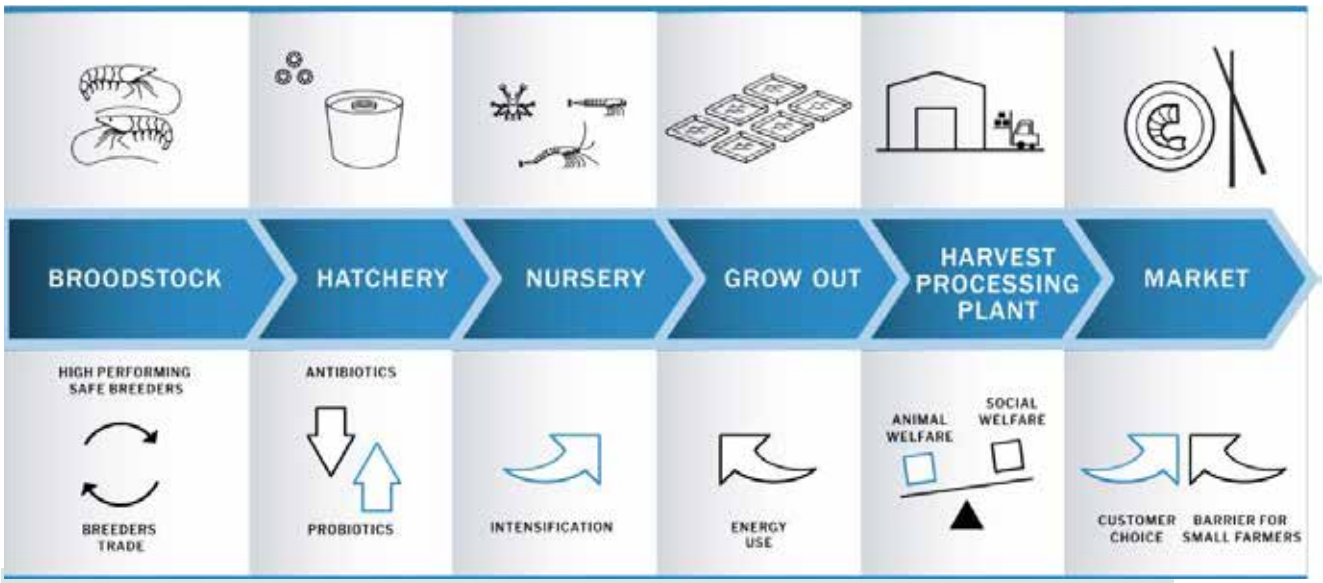
There have been some significant changes in the last 2 decades, raising the bar for all in several areas: from awareness on the use of antibiotics; habitat destruction and loss of biodiversity, diseases, animal welfare, emission and effluents, to aquafeed supply. In the latter field, two examples of sustainable feed ingredients were presented. **Dr Fuci Guo**, Business Development Asia, Corbion Algae Ingredients outlined the efforts made on replacing fish oil with a sustainable microalgae omega-3 source. **Dr Vincent Fournier**, R&D Manager at Diana-Aqua said that the current linear model of "take-make-waste" is outdated and wasteful and not befitting the modern aquaculture industry. He discussed how side stream products can be converted into high quality and functional ingredients.

Retailers and customers

Salazar walked the audience through the shrimp value chain, examining where progress has been made while discussing some relevant issues. At the end of the supply chain is the customer who should be foremost in our minds. "There is perceived customer effectiveness (PCE), which means that the customer believes that his/her actions will have an impact. Customers with high PCE are willing to pay more for eco-labelled shrimp, hence we should increase customer awareness and create incentives for the sustainable production of shrimp."

Retailers and investors are also key players in this race for sustainable shrimp. A consumer survey showed that a majority of Vietnamese consumers prefer shrimp labelled with eco-certification logos over conventional shrimp. High premium was accorded to third party certified shrimp. "European and US retailers are leading the trend of selling sustainable certified seafood. Most French retailers and institutional food service companies have committed to selling only sustainable seafood." ESG (Environmental Social Governance) issues are considered, added Salazar. "In 2006, only 63 investment companies incorporated ESG into their investment decisions. At present, more than half of global asset owners are implementing or evaluating ESG into their investment strategies."

This session on building sustainability in Asian shrimp had three presenters and two industry panellists, from top left, Dr Marcela Salazar, Benchmark Genetics, Colombia; Dr Fuci Guo, Corbion Algae Ingredients, Malaysia; Vincent Fournier, Diana-Aqua, France; Haris Muhtadi, Associate Director, PT CJ Feed and Livestock Indonesia and Han Han, Founder and Executive Director, China Blue Sustainability Institute, China.



In her presentation on "Emerging sustainability themes in aquaculture," Dr Marcela Salazar, discussed progress in sustainability along the supply chain but she also said that there is a lot more to be done.

In shrimp markets, especially in Europe, Ecuadorian shrimp producers have raised the bar with their Sustainable Shrimp Partnership (SSP) branding. Perhaps it was easy to get producers together within a country but how can Asian producers come together and have a similar product? Developing sustainable Asian shrimp was heavily discussed in the breakout sessions. The possibility of the Shrimp Club Indonesia developing its own sustainable shrimp is something to consider for shrimp producers in the other countries.

Broodstock: The availability of genetically improved broodstock has been one of the main drivers in the expansion of shrimp farming leading to intensification of culture systems and production levels. However, the downside is the broodstock trade and the effects of freight on the environment.

The global market for broodstock is huge; in 2019, 1-1.3 million broodstock were shipped from the Americas and Thailand to Vietnam, India, China, Indonesia etc. The impact on the environment is in terms of the volume of water and PEP boxes used. "For 1g of shrimp, 40g of water is used; for 1,000 broodstock moving 12,615km from Honolulu to Chennai, 11.46 tonnes of CO_2e will be produced." To drive sustainability, Salazar suggested carbon offsetting.

"We can also optimise the shipment of animals, decrease the amount of water and increase the number of animals, and we can set up multiplication centres and ship post larvae instead of big broodstock."

Hatchery: The rise in antimicrobial resistance has put a stop to the practice of using antibiotics. In the hatchery segment, to combat infections, probiotics, phage therapy, prebiotics and nano technology can be deployed instead of antibiotics. Their use has been increasing with excellent results.

"We have to share the best practices for sustainability and communicate the good work and improvements, define the issues that must be improved, and we have to include the small producers."
- Marcela Salazar

Nursery and grow-out stages: It is a fact that shrimp culture was one of the main drivers of mangrove deforestation in the early days. Salazar said, "This is still a problem although the situation is changing in the past years with marked decline in the percentage of area destroyed, from 2% in the 1980-1990s to less than 0 .3% from 2000-2012.

The evolution of shrimp culture is driving less mangrove deforestation, moving from the extensive large ponds located in mangrove regions to intensive and super intensive farms in smaller ponds with higher production and which can be located inland. These shifts can result in higher productivity and increase predictability, and a reduction in the use of chemicals and antibiotics."

However, this comes with a need for higher energy use. To be sustainable, it is essential to harness the potential of solar and wind energy. An example is a collaborative project between Germany and Vietnam designing shrimp ponds with photovoltaic cells to harness solar energy for culture; using renewable energy as well as enact measures to counteract climate change, expand shrimp production yet protect water resources, decrease land use, and reduce CO_2 emissions at the same time.

Harvesting and processing plant: Here Salazar discussed animal welfare. "This is more than survival. It should consider the environment, handling, and harvesting practices, as well as questionable protocols such as the use of ablation techniques in hatcheries. In the shrimp industry, animal welfare has been improving, a result of certification programs.

A survey showed that the main gains of certification are related to the welfare of employees and improvement in the working conditions." She added, "We have to combat the bad press that shrimp farming has been receiving. We can counter the adverse write ups with what we have put right in terms of the improvements in working conditions and animal welfare."

However, Salazar noted that because of the wide spectrum of producers and environments, involved in shrimp farming, reaching sustainability goals is not easy. Shrimp producers range from small and medium companies to large companies and integrated enterprises. "But we have to find ways to include all of them in our road to sustainability"

Her message is that "We have to work together. We can be competitors in selling shrimp, broodstock, services, feeds, or other solutions but we are not competitors in sustainability. We have to share the best practices for sustainability and communicate the good work and improvements, define the issues that must be improved, and we have to include the small producers."

Keeping up with sustainable feed solutions

According to Guo, to reduce the impact on the ecosystem, the need is for new and innovative solutions to create sustainability within the industry. A key element is the use of alternative feed ingredients. A high-level panel for the sustainable ocean economy has recommended quick adoption of sustainable feed ingredients, such as microalgae-based omega-3s and insect proteins to reduce dependency on limited marine ingredients. However, the need is for scalable affordable and sustainable alternatives for the future.

"They are not alone as a growing number of farmers, retailers and governments are calling for a shift towards more sustainable feed solutions. Two examples are the European Green Deal which calls for a transformation of the food system. Alternatives in feed ingredients in aquaculture and livestock is part of this strategy. There is a specific callout by retailers for sustainable feed ingredients. In 2021, Tesco revised its target for FFDRO (forage fish dependency ratio for fish oil) of less than 1 by 2030, pointing to algae oil to meet this target. The industry baseline is 1.70," said Guo.

> **"Produced mainly in Asia, shrimp is exported to the same consumers as the salmon, who are using the same sustainability yardstick."**
> **-Fuci Guo**

The salmon industry has taken a lead in responding to this need. Over the past years, salmon farmers are increasing omega-3s in their feed to raise levels of omega-3s in fillet. Some 40% of Norwegian salmon feed already contain omega- 3s from marine microalgae. "You will probably say that sustainability in shrimp is futuristic ideal. Produced mainly in Asia, shrimp is exported to the same consumers as the salmon, who are using the same sustainability yardstick. They are demanding sustainably farmed shrimp fed with feed containing sustainable ingredients."

Fuci showed how the adoption of Corbion's AlgaPrime DHA is ramping up in shrimp feed following trials in 2019 with the Thai Union Group in Thailand. The product is produced at scale and is affordable. The company is driving costs down by increasing production efficiency, innovations in strain development for higher omega-3 content and larger volumes. "In 2020, we completed a full Life Cycle Assessment (LCA), analysing the cradle-to-gate environmental impact of this microalgae omega-3, covering the full supply chain from raw material sourcing to production. It affirms a lower carbon footprint compared to fish oils, a consequence of its use of renewable energy, a high yield feedstock and efficient use of land."

Closing the loop

As aquaculture develops, it will generate a lot of side stream products. It is estimated that by 2030, from salmon, tilapia, pangasius and shrimp farming, by-product volumes will increase to 9.5 million tonnes from the 5 million tonnes in 2012. These are sources of high-quality protein. Fournier said that the potential of valorisation of these products is huge. "In theory a lot of functional ingredients can be produced from seafood by products. By 2030, 50% of fish meal can be produced from by-products."

At Diana Aqua, the enzymatic hydrolysis process produces free amino acids and small peptides. In the latter there are some bioactive peptides with functionalities such as immunity, gut health, stress resistance etc. However, the prerequisites are good raw material supply chain and expertise in the hydrolysis process coupled with product standardisation.

Fournier said, "Functional protein hydrolysate is a source of antimicrobial peptides that are not found in fish meal or fish silage. It will support a better fish and shrimp resistance to pathogen. There are a lot of antimicrobial peptides in side stream products which can directly kill microbes or modulate host immunity."

In terms of performance, the results from 22 shrimp trials conducted with a pelagic hydrolysate showed improvements in feed conversion ratio, weight gain, survival and overall farm productivity. "In the shrimp cycle, using a controlled enzymatic hydrolysis of shrimp head, we get shrimp hydrolysate and a palatability enhancer which can be offered to marine fish and salmon feeds." He compared the specifications of the shrimp hydrolysate to shrimp meal, such as higher protein (68% versus 62%); soluble protein (64% versus 9%) and <1000 Da peptides (60% versus 6%) and 95% digestibility as compared to 62%.

"In red seabream, we show that 1% shrimp hydrolysate can help to replace 3% of fish meal and provide better fish and feed performance and a positive impact on FIFO. At the end, when we challenged with a pathogen *Edwardsiella tarda* and saw an increase in fish resistance."

Fournier concluded that side-stream products can support the sustainable growth of aquaculture. This model of valorisation can be applied to any other land-based animal protein, as far as the raw materials are absolutely fresh and the manufacturing process adapted to the intrinsic composition of the raw materials.

Reducing GHG emissions from Indonesia's shrimp aquaculture

Dr Ilman Muhammad, Director of Oceans Program, Yayasan Konservasi Alam Nusantara, Indonesia presented on "Challenges and Opportunities in Reducing Greenhouse Gas Emissions from Indonesia's Shrimp Aquaculture" at TARS 2021.

The current shrimp aquaculture model in Indonesia can be divided into three types: extensive (no input with low outputs); semi-intensive and intensive, or super-intensive. Each type has their own unique greenhouse gas (GHG) emissions. For intensive ponds GHG comes from feed materials, farm energy and effluent. For extensive ponds, the GHG comes from vegetation loss (conversion of mangrove) and soil carbon. Cutting mangrove means loss of carbon into the atmosphere.

Dr Ilman Muhammad from Nature Conservancy Foundation, Indonesia (Yayasan Konservasi Alam Nusantara), highlighted some steps to reduce the impact of shrimp aquaculture on the environment.

Ilman showed data where intensive shrimp farming (annual harvest 60 tonnes/ha) produces far less CO_2: emissions are 2.3-14kg CO_2e from energy and feed, whereas for extensive systems (annual harvest <100kg/ha) emissions are 2,250 kg CO_2e due land use change. In Indonesia, Ilman estimated that extensive farming contributes 10-20% to the national production which is relatively low. Between 1990 to 2019, 400,000ha of new ponds were created. Most were extensive ponds. Mangrove loss was around 380,000ha, mostly in Kalimantan and Sumatra. The worst-case scenario is the projected loss of 600,000ha which is equal to one billion tonnes CO_2e by 2035.

There is the Indonesian experience in Mahakam Delta, Kalimantan on how to normalise productivity. "In 1996, when mangroves dominated the delta, productivity was 300kg/ha/year. This went down to 100kg/ha/year when mangroves were reduced by 50%. This means we can reverse the situation if we restore the mangrove forest."

"When costs of restoration, certification and other costs are considered, the economic feasibility is viable only with premium price paid to shrimp with certification at USD1/kg..."

In Kalimantan, he measured the soil carbon of active ponds. In Thailand, abandoned ponds function as carbon sinks (Elwin et al. 2019). There are, however, some costs, as mangrove restoration may not increase incomes of farmers. "In 2015, we used 1,000ha shrimp farm as a case study. When costs of restoration, certification and other costs are considered, the economic feasibility is viable only with premium price paid to shrimp with certification at USD1/kg and carbon emission reduction is sold at USD5/tonne CO_2 and with soft loans and government support. Our problem is that the farmer may not wish to borrow money and in the first 4 years, income is negative.

"This was evaluated in a site in Berau, Kalimantan. The mangrove was restored, and ponds were reduced. Productivity was normalised with better aquaculture practices from 30kg/ha to 200-300kg/ha. In stage 2 (year 3-5), we will upscale to 5,000ha and in stage 3, (year 5-15) increase productivity with green energy from 300kg/ha to 2-3 tonnes/ha."

The way forward is low emission and carbon reduction in shrimp aquaculture. In intensive aquaculture, it will involve increasing the efficiency of feed and ingredients, reducing energy use, and utilising renewable energy.

The key takeaway messages are, " In extensive aquaculture, we must stop opening mangrove areas for shrimp ponds. In existing farms, we need to restore mangroves by reducing pond sizes by 20-50% and improve technology in smaller ponds to increase productivity. "

GSA completes rebranding initiative with unveiling of new brand identity

The Global Seafood Alliance revealed on September 13 that it has completed the rebranding initiative that kicked off in April when Global Seafood Assurances merged with the Global Aquaculture Alliance and the non-profit organisation's name officially changed to the **Global Seafood Alliance (GSA)**.

The rebrand reflects GSA's budding involvement in wild-capture fisheries through the introduction in June of Best Seafood Practices (BSP), the world's only third-party certification program capable of providing credible third-party assurances linking responsible wild-capture fisheries to Responsible Fishing Vessel Standard (RFVS)-certified vessels and Seafood Processing Plant Standard (SPS)-certified facilities through the Chain of Custody (CoC) Standard.

The highlight of this announcement was the unveiling of a new GSA brand identity. The new GSA logo adopts the icon and font of the familiar BAP logo, which underwent a rebranding initiative itself in 2019, while providing brand continuity throughout the organisation. Unveiled in June, the BSP logo also inherited the icon and font of the established BAP logo.

In addition to the new GSA logo, the GSA website has been redesigned, featuring a new URL (www.globalseafood.org). GAA members and endorsers and customers of the BAP and BSP third-party certification programs are encouraged to visit the new rebranding toolkit to download the new GSA logo and other rebrand assets and share the new 30-second rebranding video on social media. There is also a new video featuring GSA CEO Wally Stevens and GSA COO Brian Perkins.

The journey toward GSA began in 2018 with the formation of Global Seafood Assurances to address gaps in certification in the wild seafood supply chain. Since then, SPS has been updated to include processing plants that handle wild seafood, and RFVS has been acquired from the United Kingdom's Sea Fish Industry Authority (Seafish), internationalised and put to market.

"Since 2018, we have been working diligently to establish an umbrella under which credible third-party assurances for both aquaculture and wild-capture fisheries can be linked. The completion of the rebranding initiative and the transition from the Global Aquaculture Alliance to the Global Seafood Alliance is a major step forward in our journey, as we continue to fulfil our vision of a world that embraces the role of responsible seafood in meeting global nutrition needs," said GSA CEO Wally Stevens. "Thank you to our supporters for helping to see us through this transition."

"While the rebranding initiative is a rewarding accomplishment for our organisation, we still have a lot of work ahead of us as we embrace this unique opportunity to work across both farmed and wild-capture seafood, helping to ensure that responsible practices are applied throughout the seafood supply chain," added GSA COO Brian Perkins, who joined GSA from the Marine Stewardship Council in March to help guide the organisation through the transition and into the future.

GSA Founder and President George Chamberlain in his message to GSA individual and corporate members said, "It's hard to believe sometimes, but it was nearly 25 years ago that I became part of the team that founded the Global Aquaculture Alliance, a fledgling group of shrimp producers and buyers who believed that wider industry collaboration was the key to overcoming the major environmental and social license challenges they were facing. As an association, GAA faced an uncertain future in its early days, but we felt strongly that the only way for the industry to reach its full potential was to unify and focus on sustainable development. We're proud of the continuous improvement and growth that has been achieved."

The Global Seafood Alliance is an international, non-profit trade association dedicated to advancing responsible seafood practices through education, advocacy and third-party assurances. Through the development of its Best Aquaculture Practices and Best Seafood Practices certification programs, GSA has become the leading provider of assurances for seafood globally. The organisation's work addresses the full spectrum of responsibility, from environmental responsibility and social accountability to food safety. Established in 1997 as the Global Aquaculture Alliance, GSA is headquartered in Portsmouth, N.H., USA.

A million tonnes of salmon feed with microalgae

In September, **BioMar** announced that it has reach a million tonnes of salmon feed with microalgae. This is a major sustainability milestone with the adoption of microalgae omega 3s into feed diets.

"By including microalgae in aquaculture feed diets, we can bypass the wild fish stocks and go straight to the original source of essential omega 3s. This helps to relieve pressure on our oceans while ensuring that the fish are getting the optimal nutrition required", said Vidar Gundersen, Global Sustainability Director, BioMar Group.

The innovation process began back in 2013 with the first microalgae, AlgaPrime in commercial salmon feeds realised during 2016. The first movers were Kvarøy Fiskeoppdrett with Blue Circle and Whole Foods and Scottish Sea Farms with Marks & Spencer. Not long after Ventisqueros in their coho Silverside and Lerøy in their salmon adopted microalgae in their diets. These higher volumes help it achieve commercial viability and today, the inclusion of microalgae is becoming more common in BioMar salmon feeds.

"To bring something this novel to market required the support from the entire value chain. We found this among several salmon farmers and retailers that were willing to take a chance on microalgae and today's success is owed to them all. Also, to the numerous people in BioMar production sites that found solutions to some challenging technical issues that we experienced over the years", said Paddy Campbell, VP Salmon Division, BioMar Group.

Microalgae is one of several novel ingredients in the BioMar innovation pipeline. With limited planetary resources, the need to decouple aquaculture feed supply chains from directly competing with food for human consumption will increase. BioMar recently announced an ambitious target of 50% circular and/or restorative ingredients in their aquaculture feed diets by 2030.

BioMar continues innovation towards securing raw material flexibility and low impact feed solutions with several trials underway at various BioMar Aquaculture Technology Centres. These trials continue to deliver valuable insights that will help drive the aquaculture industry even further towards a more sustainable future.

Biomar reaches 1 million tonnes of salmon feed with microalgae

Introduction to Tilapia in Sub-Saharan Africa

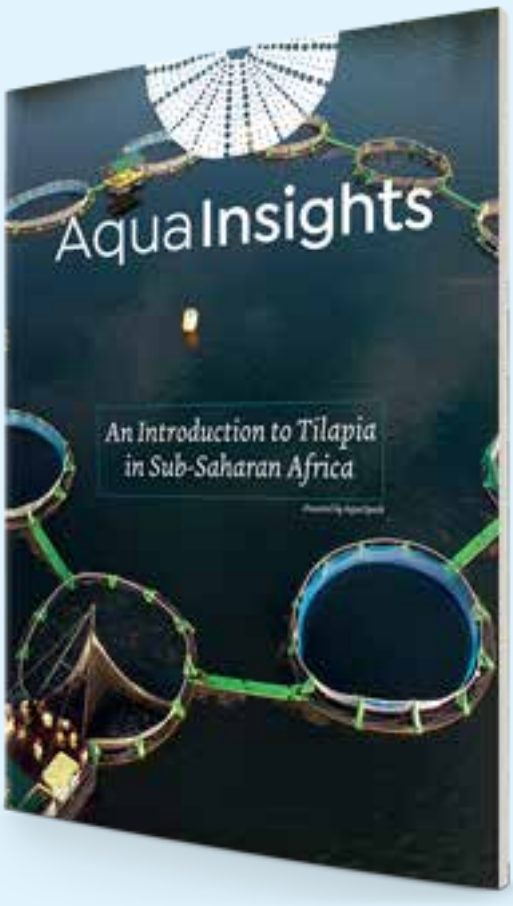
Aqua-Spark, the first investment fund focused on sustainable aquaculture, released the first edition of the free industry report series **Aqua Insights: An introduction to tilapia in sub-Saharan Africa.** With the aim of galvanising more investment into the development of a sustainable aquaculture industry, Aqua Insights has been designed to be relevant for a broad range of stakeholders—from industry insiders, who can use the report in their fundraising efforts, to those looking to better understand the sustainable aquaculture opportunity.

Mike Velings and Amy Novogratz, co-founders of Aqua-Spark, said, "We believe that reliably meeting the world's demand for protein while simultaneously sustaining our environment will require a radical transformation of global aquaculture. This type of shift calls for a large-scale collaborative effort of diverse stakeholders and investors committed to supporting innovation and long-term growth. With this report, we intend to openly and freely showcase the insights we have gathered over the last ten years to help shape the development of a sustainable aquaculture industry and catalyse investment towards scaling."

This first Aqua Insights report takes a closer look at tilapia in sub-Saharan Africa in the lead up to Aqua-Spark Africa, a new branch of the fund launching in the last quarter of 2021. This first 92-page in-depth report addresses why and how farmed tilapia can and should play an important role in solving sub- Saharan Africa's challenge to produce sufficient food for its growing population. Aqua Insights offers an overview of tilapia production, the producers involved, the various segments of the supply chain, insights into sector challenges, and an overview of the investment opportunities and current landscape.

Willem van der Pijl, Editor in Chief of Aqua Insights said, "With the upcoming launch of the Africa fund and tilapia being the region's main species of commercial interest—and one of the most sustainable options—our decision to focus the first report on sub-Saharan Africa came about naturally. Moreover, and no less important, sub-Saharan Africa is where much of the world's future population growth will happen and where the food challenge will become most severe. Raising awareness around the role that aquaculture can play in solving this challenge in a sustainable way is pivotal.

Guided by van der Pijl, a leading market intelligence expert and the owner of Shrimp Insights, the report features insights from companies and organisations involved in tilapia in sub-Saharan Africa, such as the major tilapia farmers, feed manufacturers, and genetics suppliers. Illustrations are provided by Marnix de Klerk and Nina Mathijsen at Detour. www. www.aqua-spark.nl



- In the sub-Sahara regions, tilapia is currently the most farmed fish. Here the estimate is that actual production was around 125,000-150,000 tonnes. This region is the new frontier for farmed tilapia, primarily for domestic consumption.
- Since the early 2000s, the expansion of tilapia farming has been driven by commercial cage farms. Some of the largest farms have reach scale and dozens of small and medium-sized commercial farms are ready to step-up too.
- To reach a yearly production capacity of 10,000 tonnes, a greenfield cage farming project requires an investment of around USD9-10 million and about 7-10 years to reach scale.
- In some markets in sub-Sahara Africa, tilapia prices may, at present be around USD3-3.5/kg, a future retail price at USD2-2.5/kg is realistic. These prices require its producers to reduce production costs to at least USD1.5-2/kg. This calls not only investments to scale up farms but also investments along the value chain.
- Governments and farmers need to work together to prevent diseases from putting production and investments at risk. For individual farms, genetics and vaccination play an increasingly important role but good farm management and use of technology to monitor fish health are of equal importance. This is the moment to get the industry right: a digitalised data-driven industry is part of the vision.
- Even if customers have access to farmed tilapia, they must be sufficiently convinced of its health, taste, and sustainability to buy the fish. Marketing-both online and offline, therefore is a must.

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Public input sought on new BAP Hatchery Standard

The Global Seafood Alliance announced that the **Best Aquaculture Practices (BAP)** Hatchery Standard Issue 2.0 is now available for public comment. The 60-day public comment period ends on **November 8.**

Issue 2.0 will replace Issue 1.0, which was initially adopted in September 2014. The standard applies to all aquaculture hatchery and nursery facilities for finfish, crustaceans and molluscs that produce eggs and/or juvenile aquatic animals for live transfer to other aquaculture facilities and to all species covered by the any BAP farm standards. Production facilities can be ponds or tanks on land with directed inflows and outflows of water, trays located intertidally on the foreshore, or rafts or net pens floating in a body of water.

A number of new requirements have been added to the standards, including:

- Hatcheries are now required to conduct a risk assessment of potential human food- safety risks associated with their operations.
- The worker safety and employee relations requirements have been updated, including requirements for wages and benefits, working hours including overtime, voluntary labour, child labour and young workers, use of workers from recruitment agencies, discrimination, disciplinary procedures, worker voice, and worker health and safety.
- The effluent monitoring parameters and limits for land-based systems have been updated and include unique parameters and limits for recirculating aquaculture systems (RAS).
- The water quality monitoring requirements for cages or net pens in fresh or brackish water have been revised, consistent with the approach adopted in the BAP Farm Standard Issue 3.0.
- The BAP Fish-In Fish-Out (FIFO) limits for hatcheries using over 50 tonnes dry feed/year have been revised, and a requirement to calculate the Forage Fish Dependency Ratio (FFDR) has been added.

To comment on BAP Hatchery Standard Issue 2.0, review the standard and fill out and submit the public comment form to dan.lee@globalseafood.org or to david.yunker@globalseafood.org. Both the standard and public comment form can also be found on the BAP program standards webpage. All interested stakeholders are encouraged to comment, and all properly submitted comments will be acknowledged. www.bapcertification.org/Standards

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The virtual **13th Asian Fisheries Aquaculture Forum** will be held from **May 31- 2 June 2022** in Tainan, Taiwan. This follows the success of the Virtual 3rd International Control of Aquatic Animal Diseases (CAAD) Symposium held September 10, 2021. During a day, the 160 attendees (out of the 290 registered participants) from 15 countries enjoyed the interactive experience on Gather Town and the interactive scientific discussions on the Webex platform. Organisers will use these two platforms for hosting the upcoming 13th AFAF. The link to Gather Town CAAD 2021 is available on 13AFAF website for future participants to visit and enjoy the experience.

In a joint welcome statement, Dr His-Chiang Liu, the fourth President of Asian Fisheries Society (AFS) and Dr I Chiu Liao, the sixth President of AFS, said, "This is our first virtual conference and we want to thank the organisers for making this happen. The theme of the forum is the 3S principle which stands for ***Sustainable fisheries, Smart Aquaculture, and Splendid Future***. Uncertainties due to the ongoing COVID-19 pandemic have prevented us from travelling and meeting you all in person. Nevertheless, the technology still makes it possible and provides us with a unique opportunity to hold a dynamic virtual event."

They added that in this virtual conference, "keeping with our aims we bring together scientists and experts from different corners of the world to discuss the prevailing trends and future directions for sustainable aquaculture and fisheries. The sessions and topics are chosen to emphasise the theme of the forum and stimulate discussions and participation of all attendees to make this event prolific and valuable."

This forum will be an excellent platform for participants to present their new research outcomes, gain international visibility and focus on the future trends and needs for implementing sustainability in the fishery and aquaculture industry.

More information: Deadline for Early Bird Registration: January 15, 2022
Web: https://13afaf.tw/index.php

Following the success of the 9th International Conference of Aquaculture Indonesia (ICAI) 2019, attended by more than 250 speakers and participants from approximately 16 countries, the Indonesian Aquaculture Society (MAI) and Faculty of Fisheries and Marine Science Diponegoro University will organise a virtual 10th ICAI on **October 13-14, 2021**, using a Zoom meeting platform.

The theme of the conference is ***"Aquaculture Keeps Thriving During the Pandemic"***. There will be plenary sessions and topics based parallel class sessions for two days of the conference, to be held in Semarang City, Java Island. For this annual meeting, MAI will join forces with more international and national aquaculture stakeholders. It expects more new MAI members to join the meeting.

In his welcome note, Professor Rokhmin Dahuri, MAI President said that the conference theme was chosen to encourage and manifest how sustainable, effective and profitable integrated aquaculture production can be achieved. This needs commitment and cooperation among aquaculture stakeholders/communities - academics, researchers, practitioners, businessmen, producers, processors, and government representatives. "I firmly believe that a mutual cooperation from all of us in aquaculture is key for a stronger and sustainable aquaculture industry position for the present and for the future."

The conference will feature sessions of plenary and parallel scientific and business classes. The four parallel scientific classes are on diseases and environment; management and technology; feed and nutrition; genetics and breeding. Web: www.icaiconference.org

VNU announces new dates for Asian shows

Although vaccination programs are speeding up in Thailand, Vietnam, Indonesia, and other ASEAN countries, travel restrictions continue and the timeline to reopen the countries looks longer than expected. The control of the pandemic has also met extra challenges in the recent months with further delays in the overall Asian region recovery plan. VNU has announced the following changes for Asian shows

The organisers VNU Asia Pacific and VNU Europe have announced that **VIV Asia** will take place on **March 8-10, 2023**, instead of January 2022. The IMPACT Challenger 1-3 Halls, in Bangkok, Thailand is the confirmed venue for the coming edition of this leading event. The co-location of VIV Asia with the first edition of **Meat Pro Asia** is also confirmed on March 8-10, 2023 by Meat Pro Asia organisers Messe Frankfurt (HK) Ltd. and VNU Asia Pacific.

"Looking at the recent official statistics regarding the overall vaccination program in Thailand and surrounding countries, we foresee that the Covid situation will not improve fast enough to clear travel restrictions and allow such an international show as VIV Asia, with more than 65% of visitors coming from outside Thailand, to welcome the expected high number of Feed to Food professionals in the beginning of 2022" said Heiko M. Stutzinger, Director VIV worldwide and Managing Director VNU Asia Pacific and VNU Europe.

VIV Asia is thus officially returning to the traditional March cycle in the odd years, after Covid pandemic disruption. The organisers trust that this decision will bring a clear and final direction for all stakeholders' future business planning. VIV Asia is coming back as the #1 leading international event for the livestock, animal proteins, feed to food industry with global and regional players and industry professionals finally gathering in 2023 in the exciting city of Bangkok from the entire Asian continent. Exhibitors and visitors will also enjoy by then the complete BTS Skytrain extension from city centre directly to the venue.

VIV Asia postponed to March 8-10, 2023, in co-location with Meat Pro Asia

While preparation for the next physical shows will start shortly, the V-Connect Asia Edition digital event from **22-24 September 2021** is confirmed to bring very soon important and concrete business opportunities. V-Connect is the web-based, smartphone-supported online platform to meet, learn and make deals during current travel limitations. VIV worldwide organisers strongly recommend the industry to take advantage of this unparalleled business chance now. Registrations for V-Connect Asia Edition are open on www.v-connect.net and the extensive high-end conference program is also available.

ILDEX Exhibitions rescheduled to the second half of 2022

ILDEX organisers have to reschedule **ILDEX Vietnam** from its original date on March 2022 to **August 3-5, 2022** at Saigon Exhibition & Convention Center (SECC) in Ho Chi Minh City.

With a population of 98 million, Vietnam has administered 5.3 million vaccine doses as per July. According to the statement of the Health Ministry, Vietnam plans to vaccinate 50% of the population age 18+ by the end of 2021 and set a goal of 70% of its population to be vaccinated by March 2022. By postponing the event to the second half of next year, we anticipate cross-border travel will be gradually back to normal and the event is set at an ideal time to meet the market's demand after a long downturn.

ILDEX Indonesia and **Aquatica Asia** are also rescheduled to **9-11 November 2022** at Hall 3-3A, Indonesia Convention Exhibition (ICE), Jakarta. Daily Covid cases remain at high levels in Indonesia and a partial lockdown has been implemented by the local authority. Besides, according to the ASPERAPI (Indonesia Exhibition Companies Association), there is no official statement on the reopening of physical exhibitions this year. Therefore, by postponing the event to Q4, 2022, we anticipate widespread mass vaccination can be expected in Indonesia. In the meanwhile, following the Vietnam Edition and Asia Edition, VNU Asia Pacific is delighted to confirm that the digital version of the show **V-Connect** *Indonesia Edition* is still scheduled to take place from **24-25 November 2021**. on www.v-connect.net. www.viv.net/events

VICTAM Asia in co-location with Health & Nutrition Asia are planned on September 7-9, 2022

Due to the ongoing worldwide pandemic, the management teams of VICTAM Corporation and VIV Worldwide have decided to postpone VICTAM Asia and Health & Nutrition Asia in Bangkok to the third quarter of 2022. The current situation is still not as optimal as it was estimated. Above all, the health of exhibitors and visitors and the successful outcome of the event are most important to the organisers. In a joint press release, Sebas van den Ende, General Manager, VICTAM Corporation and Heiko M. Stutzinger, Director VIV Worldwide and Managing Director, VNU Asia Pacific and VNU Europe announced these new dates.

Considering the recent increase in COVID-19 cases, which has forced the Royal Thai Government to implement new strict measures to control the spread of the pandemic, and the delays of the vaccination programs in several Asian countries, VICTAM and VIV do not see the opportunity to realise a large-scale event on the short term. Looking at the ongoing travel restrictions from and to Asia, the organisers also believe that it is not possible to guarantee the event quality as we know them for. The postponement to the third quarter of 2022 is in the interest of the whole industry.

VICTAM Asia in co-location with Health & Nutrition Asia are thus rescheduled to **September 7-9, 2022.** The new venue selected is IMPACT Halls 9-10, in Bangkok, Thailand. The objective remains the same: to realise the Total Animal Feed and Health event.

The dates secured in September 2022 will give all stakeholders room to breathe and pay attention to other vital issues. The organisers' mission is to present a strong, value-adding event to the industry with high benefits for all parties. For more information, www.victamasia.com and www.vivhealthandnutrition.nl

AQUA CULTURE Asia Pacific

EDITORIAL CALENDAR 2022

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

Volume 18	Jan/Feb	Mar/Apr	May/Jun	Jul/Aug	Sep/Oct	Nov/Dec
Deadlines -*Technical articles*	***Nov 16, 2021***	***Jan 18***	***Mar 15***	***May 17***	***Jul 12***	***Sep 13***
Deadlines - *Advert Bookings*	***Nov 23, 2021***	***Jan 25***	***Mar 22***	***May 24***	***Jul 19***	***Sep 20***
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 2022 will be leaders pushing for sustainable aquaculture					
Issue focus Emerging trends and challenges	Nursery & Hatchery	Health & Disease Management	Sustainable & Responsible Aquaculture	Demand & Supply Equilibrium	Aquaculture Innovations	Health & Disease Management
Industry Review Developments, outlook, demand & supply	Marine Shrimp	Marine Fish	Aquafeed Production	Tilapia	Marine Shrimp	Catfish & Freshwater Fish
Feeds & Processing Technology Technical contributions from industry	Larval & Nursery Feeds	Fish meal/oil Replacements	Sustainable Feeds	Functional Feeds/ Additives	Novel I ngredients	Feed Enzymes/ Post Pellet Applications
Production Technology Technical information along the value chain	Controlled Systems (hybrid/ RAS)	Offshore and Industrialisation	Hatchery 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					
Events ***Distribution at these events as well as local and regional meetings*** ****Show preview***		**RAStech 2022** *South Carolina, USA March 30 - 31* **Seafood Expo Global** *Barcelona Spain Apr 26 – 28*	****World Aquaculture 2021*** *Merida, Mexico, May 24-27*	****TARS 2022:*** *August (TBA)* **DAA11** ***Kuching, Malaysia*** *Aug 23 – 26* **Vietfish 2022** *(TBA) Ho Chi Minh City, Vietnam* ****Nutrition and Health Asia/ Victam 2022*** *Bangkok, Thailand September 7-9*	**Aquatica Asia** *Jakarta, Indonesia November 9-11* **Aquaculture Europe 2022** *Rimini, Italy, September 27-30* **Taiwan International Fisheries and Seafood Show (TIFSS 2022)** *(TBA)*	****World Aquaculture Singapore*** *November 29 – December 2*
For advertising/article contributions, and guidelines contact: zuridah@aquaasiapac.com						

NEW DATES

WA'21

World Aquaculture 2021

#AquacultureNow

May 24-27, 2022

Mérida, Mexico

Centro Internacional de Congresos de Yucatán, CIC

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Trade Show Contact: mario@marevent.com

Rescheduling of WAS aquaculture events to 2022

The World Aquaculture Society has announced the following changes:

World Aquaculture Singapore 2022 will be rescheduled to **November 29-December 2, 2022.**

While Singapore has high vaccination rates, the restrictions on large meetings are still quite stringent and look to continue for some time. While Singapore is doing better, most countries in Asia-Pacific region are far behind in vaccinations and at this time are not allowed to travel to Singapore without quarantine. The success of the meeting in Singapore depends upon drawing large numbers of attendees from other countries in the region with large aquaculture industries.

New dates are November 29 exhibitors moving in – set-up booths and registration day. November 30-December 2 – Trade Show and Conference. More information: www.was.org; APC Secretary apcsec@was.org. Contact: mario@marevent.com, with Mario Stael for commercial stands.

World Aquaculture 2021-WA2021, #AquacultureNow

This has been rescheduled to **May 24-27, 2022**

After a detailed assessment of the current situation of the pandemic, the Organising Committee of the World Aquaculture 2021- WA2021, #AquacultureNow has decided to reschedule the date of WA2021 for the second quarter of 2022. WA2021 will take place in the City of Mérida, Yucatán, Mexico, as initially scheduled.

With the main objective of safeguarding the health and integrity of attendees, WAS, in collaboration with the local authorities of the State of Yucatan, as well as other organisations that are part of WA2021, have made the decision to reschedule the event. This decision was made when considering the current situation of the COVID-19 pandemic in the world. However, the Organising Committee will continue working to offer in 2022 a high quality event that meets the expectations of all participants.

Registration and receipt of papers are open. More information: www.was.org; Carolina Amézquita, carolina@was.org. Contact: mario@marevent.com, Mario Stael for commercial stands.

2021

October 4-7
Aquaculture Europe (AE2021)
Madeira, Portugal
www.aquaeas.org

October 13-14
International Conference of Aquaculture Indonesia (ICAI)
www.icaiconference.org
(Online event)

October 13-15
Aquaculture Vietnam
Can Tho City
www.aquafisheriesexpo.com/vietnam

December 2-4
Taiwan International Fisheries and Seafood Show (Hybrid)
Taipei
www.taiwanfishery.com
(Hybrid event)

December 11-14
African Aquaculture 2021
Alexandria, Egypt
www.was.org
(In person event)

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Uni-President implements traceability through all sectors along with supply chain. Biosecurity hatchery produces SPF (Special Pathogen Free) and SPR (Special Pathogen Resistant) larvae. Quality program of prawn feed plants was certified by ISO 22000 & HACCP.

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