

# AQUA CULTURE

Asia Pacific

A dense pile of live shrimp, likely tiger prawns, filling the background of the cover. They are piled high, with their long bodies and thin legs visible.

**Biosecurity, sanitary status  
and genetics at TARS 2016**

**Rain and shrimp farming**

**Anti-dumping tariffs for  
Vietnam's pangasius**

**Gut flora modulation with  
clay complex in shrimp**

**Promising freshwater prawn  
farming in Thailand**

**Quality shrimp for best prices**





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Macrobrachium harvest in Kerala, India. Picture credit, Dr Salin R Krishna, AIT, Thailand (see p38)

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Zuridah Merican

# 2016 - A rather difficult year

*As 2016 draws to a close, AAP looks in the rear view mirror to review the year. The US dollar remains strong and stable against Asian currencies while Brexit has depressed the British pound making the UK a less attractive export market for everyone.*

For the shrimp industry, as discussed at the recently concluded TARS 2016, there is no doubt that living with diseases is the new normal. The microsporidian EHP and white faeces disease that have threatened production since 2015, together with EMS continue to hamper the general recovery of the industry in Asia. Alongside diseases, instability with yields came with El Niño bringing droughts, high salinity and rains at unusual times.

We learnt that the industry in Thailand is slowly changing and growth is incremental but at the moment, a cautious optimism is predicted. According to industry sources, China's production is much lower than what is emanating from official sources. Its frenzied demand for shrimp, particularly for large sizes, is attracting black tiger shrimp producers from countries like Vietnam. This shortage in production, together with lower production in India, is expected to trigger price increases at the end of 2016. A stakeholder familiar with the industry in India says that the expected increase in production has not happened but turned into a decline due to WSSV and white faeces disease.

A major concern is whether to use SPT stocks in our shrimp farms. We learnt that there is no exclusivity, SPT should also be SPF. The industry in Latin America, such as in Ecuador is doing extremely well with SPT against WSSV stocks and the tendency is to emulate this practice. As culture systems in Asia are more intensive, clean stocks are needed. Robins McIntosh said at TARS, "We want tolerance to a specific disease but we should have this in a clean body."

The price elasticity relationship between price and volume continues to plague the marine fish industry. A case in point in 2016 is grouper production in Taiwan and absolute dependence on one market - China (see news

in brief). The authorities are now seeking ways to help farmers sell their stocks of whole fish. This demonstrates major weaknesses in marine fish production; a focus on production rather than marketing. Selling live or chilled whole fish for good margins and with little effort in developing frozen, value added products and non-traditional markets will limit the demand. Most farms in Asia target the Chinese market while cage farms in China are increasing production volumes.

At the end of 2015, I wrote that tilapia was the hero with Vietnam diversifying into this species. In 2016, the country is going full speed into tilapia production whilst pangasius catfish production remains static with low ex-farm prices. Come 2020, Vietnam hopes to produce 300,000 tonnes of tilapia. It wants to be among the big league of tilapia producers. The bad news this year is that demand for tilapia is down in the US markets while current producers in Latin and Central America have increased their supply. In China, volumes were down because of a cold wave in Hainan in early 2016. An online media report proclaiming the negative aspects of eating the tilapia really does not help the situation either. Meanwhile exports of frozen pangasius fillet from Vietnam to the US continue to face the flip flops with antidumping duties. Anh Quynh Nguyen explains how this came about (see pages 43-44). Year 2016 is the 13th year for these duties.

In the aqua feed sector, the IUU issue (illegal, unreported and unregulated fishery) affecting fish meal supplies in Thailand is still pending. Replacing fish meal and fish oil continues to be challenging tasks for the feed industry. The year saw some interesting and promising developments: the introduction of a bio-processed protein concentrate and a methionine dipeptide, opening of a market introduction facility for a single cell protein as a sustainable fish meal replacement and salmon feeds containing marine fatty acids from microalgae.

## OUR MISSION

We strive to be the beacon for the regional aquaculture industry.

We will be the window to the world for Asia-Pacific aquaculture producers and a door to the market for international suppliers.

We strive to be the forum for the development of self-regulation in the Industry.



The Aquaculture Roundtable Series  
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**TARS 2017** will be on Finfish Aquaculture: Strategies for Growth.

It will be held from 16-17 August in Bali, Indonesia. For updates, visit [www.tarsaquaculture.com](http://www.tarsaquaculture.com)

## In the print version

**Correction for page 24, Issue September/October**

In the article on "Mitigating the high risks of WSSV and AHPND outbreaks", there were errors in Table 1 on production data of the three crops. The 1st crop should be May-Aug 2015 and the 2nd crop Oct-Dec 2015. We apologise for these errors.



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# Aquaculture industry engagement day 2016 in Singapore

A day for aquaculture experts, industry and students to discuss global trends, emerging technologies and sustainable practices.

Singapore's aquaculture industry has an important role in the nation's food security program for its 5 million population. The local aquaculture and capture fisheries industries supply 8% of the fish consumed in Singapore and the Government hopes to increase this to 15%. There are about 120 coastal fish farms in Singapore ([www.straitstimes.com](http://www.straitstimes.com)), producing seabass, pompano, groupers, mullets and milkfish. There are also a few land-based fish farms culturing species such as tilapia, marble goby and snakehead. The land-based Agrotechnology Parks, is dominated by the ornamental fish farming industry (Heng, 2015).

With mariculture, one of the challenges is the occurrence of harmful algal blooms leading to the occasional mass fish mortality. There is also the impact of climate change. With limited land resources, there is a pressing need to ensure that aquaculture industry players adopt new and emerging technologies to counter these environmental challenges and enhance productivity, while ensuring that aquaculture practices remain environmentally sustainable.

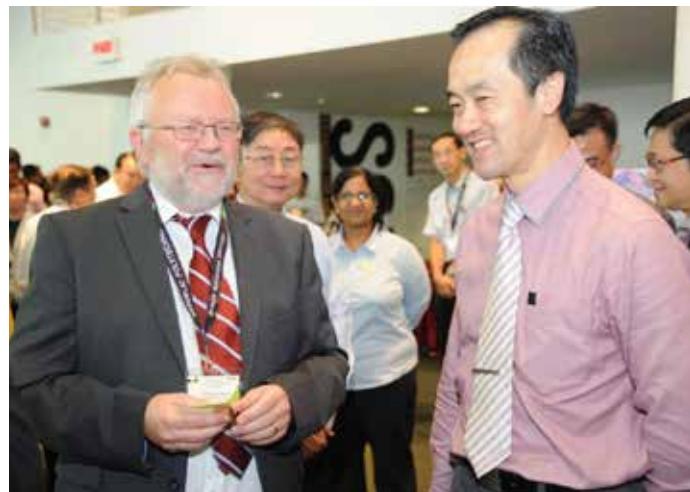
The second edition of the Aquaculture Industry Engagement Day, with the theme '*Sustainability through Innovation*' was jointly organised by the Republic Polytechnic (RP) and Tropical Marine Science Institute (TMSI). RP conducts a three year diploma course in Marine Science and Aquaculture which was introduced in 2014. The students receive practical training via industrial attachments at farms, hatcheries, and research institutes. This is the first such pre-employment training (PET) course in Singapore and the interaction with industry will help students decide on potential career pathways in aquaculture. The Centre for Environment, Fisheries and Aquaculture Science, Resorts World Sentosa, Wildlife Reserves Singapore and TMSI participated in the small trade show.

In his opening address, Dr Koh Poh Hoon, Minister of State, Ministry of National Development and Ministry of Trade and Industry, said that Singapore has limited areas for marine-based aquaculture. "Sustainability through Innovations will enable us to do more with less. By working together and pooling our creative ideas, we can turn our seeming vulnerability into a strength we can tap into."

"We will need to strengthen the nexus between our institutions and our industry. We know research institutions look for solutions in a focused and academically rigorous way. We need to open our minds to technology. Many commercially viable solutions already exist today, but the question is, as an industry, are we open to adopting some of these measures and technology that are out there?"

## New generation of aquaculturists

"The industry needs to attract a new generation of players into the industry. However, to attract today's young, we must change not just the image of the industry, but also the nature of work in the sector. With technology, fish farming will definitely



Dr Koh Poh Hoon and Professor Yngvar Olsen (left)

become more like an industrial process, because today you can do it much more intensely, in a controlled situation, and with good science behind it. It has become not just commercialised, but more industrialised as well. In that sense, this will make the whole proposition of aquaculture more exciting for our young generation," added Koh.

## Sustainable and innovative practices

In his speech, Koh gave two examples in Singapore of innovations and controlled systems. At Metropolitan Fishery Group (MFG), containment systems protect against external environmental impacts such as plankton blooms, common in Singapore's coastal waters. The company has adopted automation with sensors to remotely monitor parameters including temperature, pH, salinity and dissolved oxygen to maintain optimal farming conditions. An app alerts the farm on changes in conditions threatening the stock. The second example is at Apollo Aquarium which has a land-based recirculating aquaculture system (RAS). This system reduces water consumption by 90% and requires less manpower for maintenance. Multi- layers of tanks reduce the foot print for the farm.

## Global and local trends

Several international experts and local industry players shared examples of sustainable and innovative practices that the industry can adopt. In his presentation on how can mariculture better feed humanity - a roadmap for sustainability, Professor Yngvar Olsen, Norwegian University for Science and Technology, Trondheim, said that production efficiency can only be efficiently controlled in mariculture. A strategy for a sustainable increase of seafood yields must involve actions to reduce metabolic losses in the seafood chain. Mariculture production has shifted towards lower trophic levels. Seaweeds and molluscs are the fastest expanding groups. Ecological considerations are important for a roadmap to expand mariculture; ecological laws rule and waste of one organisms is the food for another. A roadmap for economically and environmentally sustainable mariculture involves also farming and breeding technology, knowledge on biology of farmed species, along with knowledge



Republic Polytechnic students with Dr Koh Poh Hoon



A marine fish cage farm in Singapore

on environmental interactions, health and welfare aspects. Governments of coastal states, scientists, industrial actors and society must cooperate to develop mariculture, to support healthy food production and global food security.

Matthew Tan is Co-Chair WG1, Sustainable Development for Agriculture & Fishery Sector, APEC Policy Partnership on Food Security (PPFS). He is also Chief Technology Officer of Oceanus Group, the world's largest abalone aquaculture company. He discussed sustainable development in the aquaculture industry for food security, specifically the role and use of technology as one of the key drivers to achieving sustainability.

Professor Rocky De Nys James Cook University, Townsville, Australia said that the integrated culture of seaweeds in waste waters from aquaculture industries is a particularly attractive model for sustainability, reducing discharge of contaminants while delivering biomass as a resource. However, in reality, the success is dependent on profitability, with key drivers being monetized environmental and product values. He presented a case study on the integrated culture of seaweeds with intensive land-based aquaculture of shrimp, adjacent to the World Heritage listed Great Barrier Reef Marine Park. The selection of species, optimization of productivity and assessment of biomass quality to deliver a product were keys to its success.

"Integrated multi-trophic recirculating aquaculture system (IMTRAS) is a way forward for sustainable urban farming," said Professor Emeritus Lam Toong Jin, formerly Head of Zoology at the National University of Singapore. He explained that farming of fed fish species, plants (inorganic extractive species) and shrimp or tilapia (organic extractive species) together is sustainable and scalable from a small home system to a large farm one. Lam is active in aquaculture research, particularly on culturing the marble goby with shrimp and plants in an integrated multi-trophic aquaculture system. To improve nitrogen recycling and water management, bioflocs are incorporated and shrimp/tilapia culture included.

Keith Jeffery, Aquaculture Development Officer, CEFAS, UK was recently a lead author on a large project for the European Union providing background information on sustainable aquaculture. He presented examples of innovation in aquaculture from the UK and Norway which helped the industry to develop sustainably. These innovations covered areas of aquatic animal health management, engineering and regulation.

Ang Ting Cheong Chief Executive Officer, Trapia Sdn Bhd and COO, Genomar, shared how these two companies have employed genetics and sustainable practices since the start of their cage culture of tilapia in round cages in a pristine lake environment in the northern part of Peninsular Malaysia. This sharing of ideas was to empower the next generation to join Trapia in its journey of sustainable aquaculture.

*Photos credit: Republic Polytechnic*



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**Project Director**

## Marketing Taiwan's farmed groupers

According to Feng Chia University professor of agricultural economics Yang Min-Hsien, the overproduction of farmed grouper in 2016 highlights the need for a public institution to monitor export markets in China and beyond. In a report in [taipeitimes.com](http://taipeitimes.com), Yang said that while the government is looking to the Middle East to export farmed grouper, it also needs to establish a system to warn of potential unfavourable market fluctuations. The government needs a system to track changes in international markets through real-time information and market forecasts.

In 2016, sluggish demand in the Chinese market have spilled over to the domestic market, triggering overcapacity. The Fisheries Agency said that although cold weather is expected to reduce grouper production to less than the 26,000 tonnes/year, there is still a surplus of 3,000 -5,000 tonnes. It added that Taiwanese grouper farmers have 'put too much in one basket'. From January to August 2016, Taiwan exported 9,840 tonnes of various groupers of which 7,905 tonnes or 80% were exported to China. There are a number of initiatives to either sell or reduce the glut, including a subsidy of NTD16/ 600g of fish to either farmers or exporters. To ameliorate the glut, the government may consider exporting grouper at cost. To enter markets in the Middle East, US, Japan and Singapore, grouper producers are encouraged to diversify products and include whole-frozen, filleted and flash-frozen grouper.

While the agency's policy to double grouper production between 2009 and 2016 was partly to blame for the glut, Chinese grouper producers also increased production in recent years, and eroded the market share of Taiwanese exports. The industry is in a 'post-boom consolidation,' and the agency aims to guide it to long-term sustainability

through balancing production volumes and pricing. A suggestion is to change species to the golden threadfin bream and blue threadfin and some producers have already made the transition.

## Precision feed for automated feeders using acoustics

Cargill is revolutionising how shrimp are being fed through iQuatic™, a first-of-its-kind shrimp feed produced exclusively for automated feeders using acoustic technology. iQuatic™ feed will be available in Central and South America soon. Through this acoustic technology, the automatic feed dispensers use microphones to detect when shrimp are eating, delivering more precise amounts of food when shrimp are hungry. iQuatic™ feed is designed and formulated with all the nutrients required in a pellet.

"Our iQuatic™ feed gives shrimp farmers a big competitive advantage because it maximises feeding times," said Adel El-Mowafy, Cargill Global Technology Director for Aqua. "Giving shrimp food during their natural feeding patterns makes a huge impact on productivity, but the nutritional and functional design of the feed itself has to be right. Otherwise, the key nutrients can dissolve. This new feed leverages on Cargill's R&D capabilities to give the precise pellet qualities needed to help ensure productivity gains."

Making better use of the nutrients delivered, the shrimp grow faster and produce less waste. This results in improved feed conversion ratio and better water quality, allowing for a more environmentally sustainable operation with healthier, larger shrimp. Cargill said that field trials have shown improved feed conversion ratios as much as 15 to 20%.

## Erasmus Mundus scholarships in Aquaculture, Environment and Society

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To provide for a growing human population we will need to grow more food. Seafood is particularly healthy and fish farming is more energy efficient than farming other livestock. As the fastest growing animal production sector, aquaculture must grow sustainably. This requires new species and innovations in feed supply, space and environmental impact. A career in aquaculture aims to solve these challenges.

This programme addresses the major scientific, technological and social obstacles facing the sustainable development of the aquaculture industry. Students gain practical, professional and communication skills for senior management careers in the aquaculture industry or in environmental, governmental and international trade organisations.

### International partnerships

The course has an international ethos, from student recruitment to course content and in the team of educators. The programme is led by three European universities with expertise in aquaculture: the Scottish Association for Marine Science (part of the University of the Highlands and Islands), the University of Crete (Greece) and the University of Nantes (France). Academics from the United Nations University and the Chilean Huinay Research Station, who host a 10-day field-trip, also contribute expertise, as do industrial partners from France, Scotland, Greece, Chile, Belgium, Canada, Jersey and England.

Applicants should have a relevant bachelor's degree or equivalent and proven English competence. They need to submit an application form, a curriculum vitae, a professional reference and copies of their passport, degree certificate, transcript of marks and IELTS English test results. Documents in languages other than English must be accompanied by certified translations.

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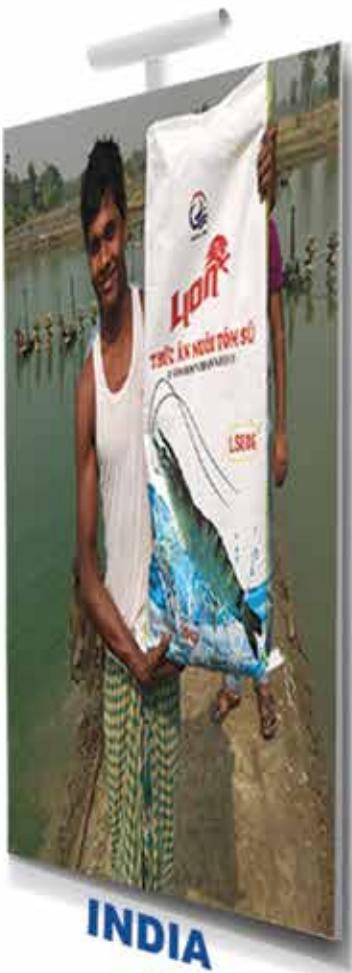
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# How does rainfall affect shrimp pond water parameters?

By Soraphat Panakorn and Erin Tan

Problems in shrimp farming usually occur during severe drought or heavy rainfall. Observations confirm major losses occur mainly during periods of rainfall.

In the last two years, we have had droughts brought about by El Niño. The US Climate Prediction Center and the International Research Institute for Climate and Society have issued an announcement that there is a 60% chance of La Niña developing in the last quarter of 2016. In contrast to El Niño, with La Niña we will witness prolonged storms, heavy rainfall, heavier monsoons and severe winds resulting in more hurricanes and tropical storms. What does it mean and how will it affect shrimp culture in South East Asia?

The most dangerous phenomenon that can affect shrimp culture can be attributed to rain. In general when farmers recalled when they encountered problems, it was more often during the monsoon seasons. Major losses occur mainly during the rainy season. In 2016, we had hot weather for the first 6-7 months and now the rainy season is coming. The La Niña effect can usually last for 2-3 years. How will excessive rainfall affect shrimp pond water parameters?

Rain has very serious effects on shrimp culture. Effects on shrimp include cramping, loss of appetite and reduced feed consumption, shrimp parking at the side of bunds (2-3 days after the rains) and black gills or dirty shrimp. From some observations and records, in south Thailand, shrimp mortality may range from only 2-3% to 50%. We gathered statistics and correlated the data to weather reports. There is no doubt that heavy rainfall can cause huge mortalities. However, the signs of impending mortality are usually minimal unless the farmer knows what to look for.

It is important that the farmer is aware of several direct and indirect effects of rain on water parameters in shrimp ponds. In this article, we discuss various direct and indirect effects of severe rainfall on shrimp culture (in no particular order) and elaborate in detail key points on how rainfall affects shrimp culture.

## Direct and indirect effects

The direct effects on pond water are reduced temperature, oxygen, pH, alkalinity and salinity. Sound and wave disturbances increase, and rainwater flows from the bund into the pond.

The indirect effects are phytoplankton crash and organic material accumulation at pond bottom. There will be a sudden bloom in bacterial population after the water temperature returns back to normal. The agitation of the sludge layer exposes the anaerobic layer (black soil) and shrimp will be exposed to toxic hydrogen sulphide ( $H_2S$ ) gases

The results of these direct and indirect effects of rainfall are:

- Once all the above occur, oxygen is depleted and toxic gases such as  $H_2S$  are released
- Recently moulted shrimp, which are weak become exposed to toxic gases and pathogens and succumb to infections
- Mortality may occur 2-3 days after a severe rainfall.



Adding probiotics in a pond at DOC 118

## Temperature

During severe or prolonged rainfall and cloudy days, there will be less sunlight reaching the pond surface. Wind blowing across the surface of the pond can cause pond water temperature to drop by 2-3°C. The optimal pond water temperature should range between 30-31°C. When temperatures drop 1°C, feed uptake by shrimp typically drops 5-10%. Thus, a drop of 3°C can cause feed uptake to drop up to 30%. When water temperatures drop, feed becomes less palatable and shrimp being cold blooded are affected by external water temperatures.

Shrimp activity also slows down. They will move less and tend to gather at the pond bottom. This will drastically increase shrimp density at the pond bottom. When this happens, being naturally competitive, shrimp will experience more stress as they compete for limited oxygen and space.

As the water surface is cooler following the rains, shrimp will move towards the warmer areas in the pond which unfortunately is usually the sludge area. Here the shrimp become exposed to toxic  $H_2S$  gas and pathogenic bacteria. In these areas, oxygen levels are normally low, but during a rainy period, oxygen levels may drop to zero.

During normal temperature fluctuations, microbial activity increases with increased temperature which accordingly reduces the organic load. Once there is a sudden drop in temperature, microbes also reduce their activity. This leads to the accumulation of more organic material in the pond. When temperatures rise again after a few days, there will be a sudden massive bacterial bloom as there is a lot of organic material for the microorganisms to feed on. This will also take up more oxygen as the organic material is degraded in an already low oxygen situation.



Healthy monodon shrimp at DOC173 after pond treatment (see box)

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## Reduction in immunity

Heavy rainfall can cause pond water pH which usually is around pH 8, to drop. The pH of rain is usually around pH 6.5-7.0. Rain will directly drop pH by 0.3-1.5 in a very short period of time. This causes an immediate decrease in phytoplankton activity.

When pH drops, this causes the toxicity of  $H_2S$  to increase.  $H_2S$  is highly toxic at low pH. Shrimp will also be stimulated to moult under adverse conditions of low oxygen, increased density on pond bottom, increased  $H_2S$  toxicity, low salinity and alkalinity. All these conditions combined increase the chances of moulted shrimp dying within 2-3 days after heavy rainfall. However, often this level of mortality is not noticed because the soft shelled dead shrimp are eaten by other shrimp.

Indirectly, farmers will only notice this occurrence when the average daily growth (ADG) is not improving. What is the key sign of this condition? When the feed uptake drops for 1-2 days after heavy rain, cannibalism occurs. Finally, the effect of the sudden pH shock results in lowered shrimp immunity.

## Low dissolved oxygen

In a pond, there are usually two sources of dissolved oxygen (DO): from the aerators and from phytoplankton. During prolonged rainfall, plankton activity will slow down as there is less sunlight available. This is undesirable; even though shrimp activity decreases due to the changes in temperature, its oxygen requirement is still high or as per normal. DO is supplied by aerators and if the water is not mixed properly, pond water stratification/stagnation will occur. The layer of freshwater (stratification) on the surface of the pond makes it difficult for oxygen to dissolve into the rest of the water body. DO levels can drop from 4 ppm to 2 ppm and then to 1.5 ppm in half an hour if action is not taken immediately.

## Salinity and alkalinity

With dilution of pond water with rainwater, both salinity and alkalinity levels drop. In order for shrimp to harden their shell, it needs sufficient minerals (alkalinity) in the water to do so. When salinity drops very quickly, the moulted shrimp will not harden their shell in the usual amount of time. Cannibalism will occur leading to infection of the weakened shrimp.

The plankton population will also drop due to the low light intensity, low salinity and low pH. These changes impact on the microbial population in the pond; beneficial bacteria tend to die off allowing pathogenic bacteria to flourish. Also once alkalinity drops, pH will start to fluctuate when the buffering capacity in the pond is reduced.



Adding probiotics in the pond at DOC 118 in the case study

## Sounds

The sound of raindrops tapping onto the surface of the water seems loud to us; imagine how deafening it is to the shrimp in the pond as water tends to amplify sounds. This causes a lot of stress to the shrimp. The shrimp will try to hide from the loud noises and retreat to the pond bottom. They are then exposed to low oxygen conditions, high densities, toxic gases and cold temperatures.

## Waves caused by wind action

The sludge layer is covered by a thin oxygenated grey layer. Strong winds create waves which disturb this grey layer. This then exposes the anaerobic black sludge which releases various toxic gases such as  $H_2S$ , ammonia, nitrite and methane. Water running off from the bund into the pond and flowing down to the pond bottom will also disturb areas with sludge accumulation and release toxic gases. On exposure to these toxic gases, shrimp become weaker and are prone to infections and diseases.

## Plankton crash

When temperature, light, salinity, pH and alkalinity change suddenly, plankton activity will reduce and may lead to a plankton crash usually within two days. The thicker the bloom, the faster the plankton will crash. We can observe this via changes in water colour and pH, or when the afternoon pH is lower or the same as the morning pH. This means that plankton is crashing or is in the process of crashing, even if the water is still green in colour. Dead plankton is still green and may still provide some green colour in the pond.

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*Feed in the check tray is easily accessible by bigger and stronger shrimp.*

Dead phytoplankton brings about low DO as there is no oxygen production and oxygen is used for bacterial action. This means that if DO in the afternoon is 6-7 ppm it may drop to only 2-3 ppm. When the dead phytoplankton of which 90% will accumulate at the pond bottom starts to decompose, they will start to compete for oxygen. If the farmer sees cloudy water, foam at the pond surface, bubbles with a long trail and plankton flocculating, this means that the plankton has crashed.

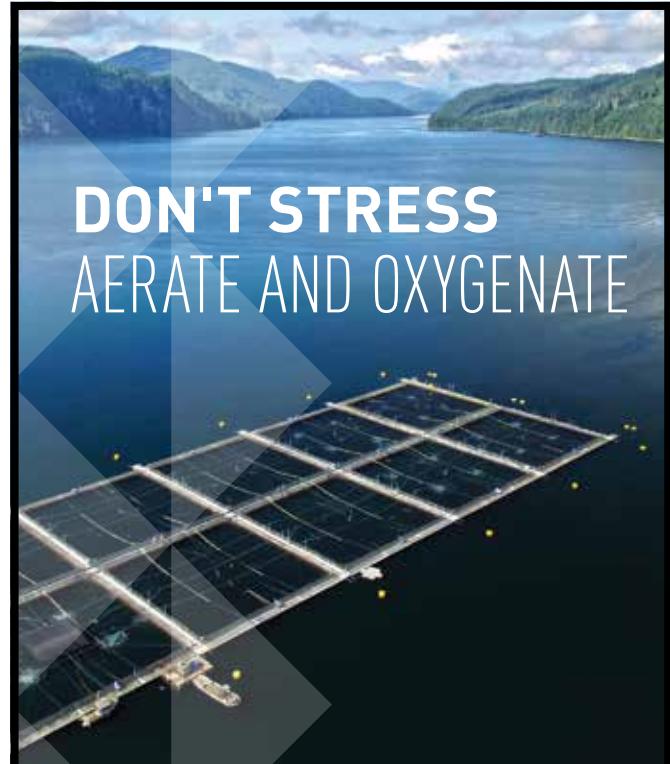
### Shrimp moulting

Rain causes pH to drop drastically, as the pH of rainwater is usually lower than the pond water; slowing of plankton activity also causes the pH to drop. Under such conditions moulting occurs. When moulting, shrimp need more space, twice as much oxygen and increased mineral levels. However, conditions during the rains are not favourable for moulting; moulting shrimp have soft shell, and succumb easily to infection and mortality. Moreover, cannibalism of dead shrimp makes it difficult for the farmer to detect the dead shrimp. What we will observe is a reduction in feed and lower ADG.

### Accumulation of organic matter

During rainy periods, shrimp will not feed normally, but the farmer continues to feed the usual amount of feed thus leading to overfeeding. Phytoplankton activity will also drop as discussed previously. Bacterial action will also slow down, allowing organic matter to accumulate on the pond bottom. This means that a time bomb is ticking as the bacterial population will suddenly bloom when the temperature rises as there is excess organic load in the pond. Usually the pathogenic bacteria will be the ones which bloom because they are usually hardier and can withstand harsher conditions. They also tend to grow much faster than beneficial bacteria.

Why is there a tendency to overfeed? This is because farmers tend to check feed in the check tray only. Feed in the check tray is easily accessible by bigger and stronger shrimp. Normally, bigger shrimp are always being surrounded by other shrimp and the former are not allowed to feed peacefully in the check tray. However, during the rainy period when most of the shrimp do not have good appetite, these bigger shrimp now have an opportunity to eat and finish off all the feed in the check tray. As the shrimp gut is fairly short and open, they are quite capable of eating non-stop until the feed is finished. This will give a false



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Shrimp with a broken rostrum surfacing at DOC 118, possibly a sign of adverse water conditions following rainfall

picture of the current feeding habits of the shrimp in the pond. Farmers will think that they need to increase feed whereas the opposite is true. The bigger shrimp will also tend to eat more and faster because of the strong smell of the feed in the check tray but the rest of the feed that is spread out in the pond will not smell as strong and may not be as attractive to the shrimp. This will lead to the accumulation of excess organic matter in the pond.

## Combined effects

The overall effect of excessive rainfall is shrimp mortality due to H<sub>2</sub>S poisoning, soft shell issues and accumulation of organic matter. The farmer needs to understand the big picture of how rainfall can affect the various parameters in a pond.

## Recommended best practices

Ideally, farmers should use available technology and predictive weather forecasts. Some weather forecast websites are weather.com and accuweather.com. If they learn to predict the weather in the next few days of culture, they will be better prepared for any eventualities. If there is going to be rain in the next two days, pond preparation should include the application of Pond Dtox (Novozymes, USA)- a bacteria product that can neutralise hydrogen sulphide, a day before or just before it starts raining.

Further to this, the following measures are recommended.

- Always make sure that the oxygen levels are 20% more than required. Switch on the aerators. All aerators should be running when it is raining.
- If there is heavy rain, allow the excess rain water to overflow from the surface.
- Assign a worker to apply lime on the bund as a usual practice during good weather. Then when it rains, the lime will leach into the water helping to maintain alkalinity.
- Assign a worker to check the water pH during rainfall. If the pH falls, apply lime.
- Stop feeding during rainy conditions.
- Mix Vitamin C and salt (minerals) with feed before or after the rains. The dosage is 5 g/kg feed. Dilute 17x water (add 5 g of salt to 80 mL of water), mix into feed, allow to air dry, then feed the shrimp. This will allow the shrimp to obtain minerals from the feed if there is a drop in alkalinity in the water.
- Once the rain stops, it is recommended to apply a double dosage of Pond Plus (Novozymes, USA) to allow beneficial bacteria to first colonise and then competitively exclude the pathogenic bacteria.

In summary, our advice to farmers is to be prepared during rainy periods as there are so many factors contributing to problems in the shrimp pond. Being aware and being prepared are the first steps to overcome the problems encountered during the rainy period. There are signs to watch out for and we need to read the signs correctly and take preventive and proactive action to minimise and prevent losses.



Soraphat Panakorn



Erin Tan

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## Case study



Cramped shrimp in the check tray at DOC 118

This is an example of how a monodon shrimp farmer in Malaysia faced problems during the rainy season and how he managed to overcome the adverse situation. This example is from a 0.5 ha pond at 118 days of culture (DOC). The stocking density in this pond was 28 post larvae/m<sup>2</sup>.

With a transparency of less than 10 cm as the pond had a heavy plankton bloom, the farmer observed that shrimp were surfacing and showed cramping in the check tray. In general, shrimp were not very active and were dull in colour. Shrimp had soft shell and loose meat. Feed consumption had dropped to 20 kg/day from 40 kg/day. Previously this pond has had some mortality. There was heavy rainfall two nights prior to the day shrimp were surfacing.

The recommendation was to operate all aerators, a total of 11 HP for 24 hours over 2-3 days. The application of 400 g of Pond Plus and 200 g of Pond Dtox was immediate. This was at 2 pm in the afternoon. Vitamin C was added at 5 g/kg feed and salt was also added into feed at 5 g/kg feed. Potassium at 3 kg/day was added to pond water every day.

The result was that the farmer managed to prolong the culture to DOC 173 before starting to harvest. Shrimp sizes were 38-40/kg and shrimp looked healthy and had bright colours. Shrimp no longer had soft shell or loose meat. Total production was 3.6 tonnes and survival rate was about 50%, because the condition of pond water improved during the last part of the culture period.

# TARS 2016: Shrimp Aquaculture & The New Normal

## Part 2: Towards a sustainable shrimp business in Asia

The plenary at TARs 2016 had four sessions: state of industry and challenges, weak links in the supply chain, living with diseases and finally, building a sustainable shrimp business. Part 1 of this report in issue September/October 2016 covered presentations on the state of the industry and its challenges, particularly in post- IMNV Indonesia, India, as it strives to be a leader in the production of farmed shrimp and on developments in the industry in Latin America. It also covered presentations on what is known on current and emerging diseases, losses due to diseases and some mitigation measures. In this report, we summarise the following presentations.

### Biosecurity, sanitary status and genetics

**Dr Victoria Alday-Sanz** has worked for over 25 years on diverse aspects of shrimp health covering diseases, diagnostics, sanitary legislation, health management, biosecurity and development of SPF shrimp stocks from WSSV tolerant shrimp (SPR/SPT). She is now Director of Biosecurity and Genetics, National Aquaculture Group (NAQUA), Saudi Arabia. Her presentation on the 'Sanitary status and genetics as part of a biosecurity strategy' started by dispersing some confusion in the industry on the concept of biosecurity. Her message is that biosecurity is a tool for sustainability.

"The objective of biosecurity is to reduce the economic impact of diseases. Biosecurity is more than activities in the farm to prevent, control and/or manage disease risks such as PCR, disinfections etc. Biosecurity includes the selection of animals depending on the culture system. We can categorise these for health status or genetic characteristics.

"On health status, we have specific pathogen free (SPF) or pathogen free (PF) of any possible pathogen. PF is difficult to achieve and is not commercially viable. APE means All Pathogen Exposed which is the broodstock coming from ponds exposed to pathogens in Latin America. High Health is a commercial term and is ambiguous. We do not know the biosecurity implemented to grow them or health status. Genetic characteristics are specific pathogen resistance (SPR) and specific pathogen tolerant (SPT).



At a functional feeds breakout roundtable, from left, Joo Min Kim, Sajo DongA One, Korea, Stephen Crisp, BASF East Asia, Singapore, Henrik Aarestrup and Daniela Vera, BioMar Group A/S, Denmark and Chi Man, BASF, Hong Kong.

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**“ While resistance, tolerance, susceptibility or higher productivity is a choice based on the biosecurity risk of the farm that will use them, the sanitary status should not be a choice. Why would anyone want to stock (invest) in infected animals? ” - Victoria Alday-Sanz**



Richard Smullen, Ridley Aquafeed, Australia led a roundtable on functional feeds

SPR means that the animal cannot be infected with a particular pathogen but not with a range of pathogens. SPT means that the animal can get infected but will not develop the disease or will develop a disease to a certain extent depending on environment and culture conditions.

“The message is that when the farm is making a decision on its biosecurity level, it needs to look at health status and genetic characteristics of the animal and to consider history and culture conditions.”

### SPF is a health status

Victoria noted that “SPF refers to the sanitary status of a stock. It is not necessarily free from all pathogens, and not simply PCR negative. SPF stocks are free of certain pathogens regardless of its tolerance, resistance and susceptibility to any pathogen. SPF animals come from a population which has been tested negative for pathogens for at least 2 years with a surveillance program in place, raised in highly biosecure facilities, including enclosed water treated environments, following biosecure management measures, and fed biosecure feeds.

“It is not necessary that SPF animals are pathogen free, more sensitive to pathogens, more resistant or tolerant to pathogens, inbred or have lower genetic diversity and better growth. SPF is not heritable and the offspring loses the SPF status when exposed to lower biosecurity level.”

Victoria added, “We work with SPF because infections are a physiological cost affecting productivity and lower performance of shrimp. We need SPF to be used for genetic improvement programs, research and is fundamental for international trade. Imagine the scenario if we had been moving around non SPF shrimp?”

### Pathogens and SPF

The introduction of SPF stocks has completely changed the industry in Asia. However, there is no consensus on what pathogens defines SPF and it is flexible. It is clear that SPF animals are not free from all pathogens, and not simply PCR negative. Although SPF programs should target all known pathogens, i.e. OIE listed as well as other known pathogens.

“The specific pathogens are defined by the supplier and the client. Some use OIE listed pathogens but OIE is not dynamic enough. It only listed AHPND in 2016 and is yet to look at EHP. DOF Thailand listed only OIE systemic viruses, which includes WSSV, IHHNV, YHV, IMNV and TSV. India requires SPF for all OIE listed pathogens and Egypt, all *Vibrio* bacteria and fungi but no virus.”

This is not all. She gave details on the surveillance program such as techniques (PCR and histology) and frequency, internal and external certification, participation in international PCR lab ring test and latest tests performed. With regard to biosecurity measures and protocols in facilities, information required include water treatment and its validation, movement of personnel, feed of broodstock etc. The findings of an FAO Expert Workshop on SPF, SPR and SPT: A Need for International Technical Guidelines will be released in 2017. These will provide a better understanding for industry.

### Genetic characteristics

“The concepts represented by the acronyms SPF, SPR and SPT have been used in a rather confusing manner over the last few years. SPR and SPT refer to their genetic characteristics that allow them to be resistant to infection to a particular pathogen or tolerant to the development of the disease caused by a particular pathogen.

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<b>Location</b>	: Hong Kong
<b>Duration</b>	: 1 year
<b>Mode of Teaching &amp; Learning</b>	: Full time, face-to-face & thesis research project
<b>Start Date</b>	: September 2017
<b>Programme Details</b>	: <a href="http://www.cityu.edu.hk/svm/links/msapvh.asp">http://www.cityu.edu.hk/svm/links/msapvh.asp</a>





Dr Peter Coutteau, Nutriad, Belgium



Dr Chen Ming-Dang, Charoen Pokphand Foods, Thailand



Dr Fuci Guo, Aquaculture APAC, DSM Nutritional Products, Singapore (right) and Dr Ruchanee Chotikachinda, DSM Nutritional Products, Thailand (middle) and Marc Broadbent, HJ Baker, USA.

These are genetic characteristics regardless of their sanitary status, whether the stocks are infected or not. In other words, stocks can be both SPF and SPR/SPT. SPR/SPT may, in some cases, have the drawback of lower performance when compared to other stocks. While resistance, tolerance, susceptibility or higher productivity is a choice based on the biosecurity risk of the farm that will use them, the sanitary status should not be a choice. Why would anyone want to stock (invest) in infected animals?

### Developing WSSV SPT+SPF

During WSSV outbreaks, some shrimp producers, such as those in Thailand, chose the SPF route and adapted culture conditions with high biosecurity. However, Ecuador and Latin America simply coped with WSSV in low biosecurity ponds and took a longer time to recover.

"In a natural way, WSSV was present in ponds in Latin America for almost 15 years and shrimp developed tolerance against WSSV. But for the future, we need to be ready as the impact will be high if there is an epidemic such as EMS entering vertically into the system. In Latin America, SPF was not adopted because industry associated it to disease susceptibility."

Victoria detailed efforts in Ecuador and Nicaragua in 2010 to clean up WSSV SPT shrimp to be SPF as well. "We started by monitoring pathogens in 23-30 g shrimp from ponds with no biosecurity, over a broad geographical spread for maximum genetic diversity and from ponds with low performance. We then proceeded with nation-wide surveillance using the OIE listed pathogens in 2010 and added in EHP, PvNv, and Streptococcus. Results showed that infections present included WSSV, IHHNV and NHP, but TSV, IMNV, YHV/GAV, BP, PvNv and EHP were not detected. The goal was to exclude these three pathogens in the SPF development.

"Seventy-five shrimp were selected from each pond. These were from ponds with good productivity, low disease prevalence and good appearance. This was repeated for 3 generations. Individual testing was conducted on shrimp after spawning and stressed at 22-24°C for 48 hours to replicate WSSV. NHP was eradicated with antibiotic therapy of broodstock and antibiotic egg washing. SPF was confirmed by the Department of Infectious Diseases, University of Zaragoza in Spain, an EU recognised pathology laboratory.

Does SPF bring advantages to production? "A new term for this process is 'Reverse SPF'. These WSSV SPT/SPR SPF shrimp combine sanitary and genetic characteristics. Assessments on mortality post ablation and during production showed lower mortality rates. In an intensive system, survival was better than SPF shrimp imported from the US. These SPF+WSSV SPT vannamei shrimp were used to recover production in NAQUA in Saudi Arabia which was devastated in 2013 due to WSSV. Production picked up to 22,000 tonnes in 2015, higher than any prior production."

The message was that SPF animals are fundamental to any production unit and genetic characteristics in terms of response to pathogens needs to be suitable to culture conditions.

### A new reality with nurseries

According to **Dr Jesper H. Clausen**, Farm and Feedmill, INVE Aquaculture, Thailand, there is a move towards nurseries due to the increased occurrence of diseases in shrimp farming today. "Diseases are here to stay, and we, the industry, have to manage production to minimize the impact from these diseases. This is the new reality and industry does not have a choice except to adapt. Shrimp nurseries are not new and used to be common in industry in Latin America and Asia before Asia's shift to white leg shrimp. However, farms then went on to direct stocking from hatchery to grow-out in ponds. Today, the nursery phase is reappearing in Asia.

"Nurseries were used to speed up growth before the grow-out cycle and this remains a valid reason for nurseries in Latin America. In South Korea, nurseries are used to give a head start in shrimp farming with the nursery cycle over the winter months. This emerging trend in Asia is more so because of diseases in the early stages of shrimp growth. Today, we also talk about the need for robustness rather than just fast growth as the latter will not work if shrimp mortality is high during the early stages."

Among the diseases faced by the industry today include *Enterocytozoon hepatopenaei* (EHP), acute hepatopancreatic necrosis disease (EMS/AHPND) and white faeces syndrome. In the case of Vibrio causing AHPND, the use of antimicrobials is now a major concern. According to Jesper, a few years ago, industry had eliminated the use of antimicrobials from many South East Asian countries; but in recent years, there has been a sharp rise in EU rejections and detentions with Japanese and USFDA data also showing similar trends. These were often due to antimicrobial residues in shrimp products from countries with EMS/AHPND outbreaks.

### Changing protocols

"There are no silver bullets against diseases and farms will need to work together to adopt management practices towards an economically sustainable direction," said Jesper. The presentation included descriptions of some nursery systems which have been developed recently as well as some commercial trials. More details are available in his article in issue July/August Aqua Culture Asia Pacific 2016, p. 15-18.

"A benefit which is sometimes forgotten is that nurseries are an extra checkpoint where shrimp can be checked for diseases before stocking into ponds. I advocate that the new normal should be well managed nursery systems using high quality



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**“Moving forward, using a high quality product nursery protocol, it is possible to increase stocking density to 30-35 PL/L. In Vietnam, we show that this can save the farmer 14% in overall cost at the end of the nursery cycle.”**

- Jesper H. Clausen



Dr Manoj M. Sharma, Mayank Aquaculture Private Limited, India (left) with Dr Andy Shinn, Fish Vet Group Asia Limited, Thailand.

diets, feed additives and probiotics for a healthy environment. These include elevated doses of nutraceuticals and specific immunostimulants, vitamins, lipids, pigments and nucleotides to support osmoregulation, growth and other vital processes during normal and stressful conditions,” added Jesper.

With a 15% replacement of quality feed during the PL15-PL27 period, Jesper showed that post larvae growth was faster with higher biomass. Nurseries with low water exchange will require probiotics and the tip given was that farmers should calculate cost based on CFU count in the product and not based on the actual volume of the product.

“With regard to stocking density, traditionally it is 2-5 PL/L and feeding using traditional starter diets similar to during the early days in the ponds. Moving forward, using a high quality product nursery protocol, it is possible to increase stocking density to 30-35 PL/L. In Vietnam, INVE has shown that this can save the farmer 14% in overall cost at the end of the nursery cycle.”

“It is not one size fits all for the nursery protocols and for the investment of the farmer. A tailor made nursery protocol should be used for each situation. Farmers in Thailand’s southern provinces are using the shrimp nursery with success and are shortening the cycle for the nursery phase.”

Concluding with his main message, Jesper noted that, “We as the industry should not forget the importance of support from government and universities. In Vietnam, the government is starting to promote nurseries in shrimp farming to increase production both in small and large scale shrimp farms. We in the industry should focus on supporting farmers with solutions that are sustainable and have a holistic, long term approach.”



Dr Camilo Pohlenz, BioMar Americas, Costa Rica (left) with Kenneth Dirst, BioMar Group A/S, China.

## Addressing feed ingredient excellence for a stable industry

“Along the supply chain, there are several expectations. Farmers want healthy shrimp, fast growth and excellent growth performance through standardized feed and stable feed prices. Because marine ingredients are high, upstream in the supply chain, any weakness will effect production. The inclusion rate of fish meal is now lower, but as shrimp farmers regard fish meal as the gold standard in feeds, it is paramount to deliver their expectations with shrimp diets,” said the SPF-Diana Aquativ team of **Dr Philippe Sourd**, Technical and Sales Director and **Vincent Percier**, General Manager in their joint presentation on the need for feed ingredient excellence in building a stable shrimp farming industry.

“As shrimp aquaculture expands, we see that the weak links are in ingredient quality, standardization and consistency. Beyond the nutritional profiles of the ingredients, there are other issues such as supply, sourcing, logistics, price, quality, specifications, certifications, packaging, physical aspect and seasonality. We need to address all these if we want to build a stable industry. This consistency only can allow predictability in farming performances,” said Philippe.

## Variability with fish meals

Fish meal has played a role in shaping the industry, even though supply is unstable and prices are constantly changing; from USD 1.3/kg to USD 2.3/kg over a 4-year period. “However, achieving the fixed performance standards required by industry may not be possible through marine ingredients, which are extremely diverse in their composition, value and consistency. An industry relying on such raw materials exposes itself to more challenges. Farmers’ expectations of feed performances have become very high and feed formulators must find ingredients that will match this demand for excellence as well as sustainability, traceability and food safety.”

The team discussed findings from a 2015-2016 market survey on fish meals sampled worldwide. The analytical profiles of these ingredients were followed by feed trials. Some 37 fish meals comprising three types of fish meals: super prime, standard grade and co-products from global sources were analysed.

“Are product specifications enough to select an ingredient? As expected the protein and ash content are statistically different among groups of fish meals. The surprise is with soluble proteins and small peptides which prove a lot more variable within and between fish meal grades. Processes drive product specifications. In the case of biogenic amines, which are sometimes used to grade fish meals, we saw that amounts did not differ statistically.”



**“Our belief is that by adding highly standardized raw material into the feed recipe, we will be able to offset any variability found in marine or plant ingredients. ”**  
- Philippe Sourd

Philippe also reported on the variations in protein (69-75%), soluble protein (3-14%) and peptide content between batches of super prime anchovy fish meal from the same origin. He said that the variation is a challenge for feed formulators tasked with delivering the same diet with the same growth performance from this high grade fish meal. More details on this are available in an article published in the July/August Aqua Culture Asia Pacific 2016 issue, p44-47.

### Marine meals in South East Asia

“Results on analyses of shrimp and squid meals indicated that shrimp meal appears to be well standardized but with low digestibility. However, squid meal which shrimp farmers consider as a desirable ingredient in shrimp feeds, vary with different protein levels as well as digestibility. The product with the highest protein did not show the highest digestibility,” said Philippe. “In the case of local fish meals, most have 60% crude protein. Co-product fish meal is frequently used in SEA. Some contain high levels of soluble protein and peptides. Freshness is sometimes an issue with high putrescine levels. Deviations in digestibility are high; hence again the importance of a standardized process.”

### Drivers of standardization

“The salmon silages from Alaska, Australia, Scotland, Denmark and Norway showed different levels of protein and soluble protein contents. All these clearly indicate that product specifications alone do not define a product value. The raw material selection and the process itself are crucial drivers of a product’s profile.

“There is no doubt that for each marine ingredient; processing can influence product standardization. Factors of influence range from species selection (mono or mixed species), tissues (whole fish or viscera or both) and in fish meal, drying temperatures or whether solubles are added into the meal.



From left, Maria Abegail Apostol-Albaladejo, Bureau of Fisheries and Aquatic Resources, Christopher G. Co, Oversea Feeds Corporation and Mary Ann Solis, Spectrum Biosolutions, Philippines.

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**“The source owner and ingredient manufacturers are the beginning of the stability chain and we cannot afford to have gaps. A stable chain allows the industry to have a stronger control of the value chain.”**

- Vincent Percier



During the breakout panel for production technology, Abu Bakar Ibrahim, Blue Archipelago Berhad (left) with Anwar Hasan, Biomin and Don Griffiths, FishVet Group Asia Ltd, Thailand.

“Achieving both standardization and consistency are not impossible. Among 107 batches of a tuna fish hydrolysate, the batch variation was  $22.08 \pm 0.43$  for crude protein, but most importantly, soluble protein and peptide profiles remained exactly the same. Our belief is that by adding such highly standardized raw material into the feed recipe, we will be able to offset any variability found in marine or plant ingredients. The value proposal is that a highly standardized marine ingredient such as marine protein hydrolysate could offset the specifications and quality deviations of other marine dietary components and become a corner stone of the recipe.”

## Feed trials

A series of 8-week feed trials with sea bass allowed the ranking and benchmarking of 18 fish meals (prime, standard and co-product) from Mexico, Denmark, Turkey, Peru, Norway, Mauritius, India, Argentina and Ecuador. These were added into plant meal diets and scored versus a positive control (100% prime fish meal diet) and a negative control (100% plant meal diet).

In another group of 1.5-month feed trials, two fish meals (one super prime and one co-product) were blended and used in several recipes at inclusions of 25, 20, 15 and 12.5% while a hydrolysate was added at a 1:2.5 proportion.

“From the first series of trials, we concluded that some fish meals can actually bring down growth performance, and that some standard fish meals could perform better than prime grades.

“In the second series of tests we verified that using a low performing co-product fish meal in diets meant that growth performance went down; and the more co-product fish meal in

the diets, the more growth performance deteriorated. However, the addition of hydrolysates could restore growth up to the level of growth obtained in the super prime fish meal fed group. This showed that hydrolysate can truly be a tool to offset performances variations driven by fish meal grades, and provide an efficient solution for formulators who have to compose with their raw material basket,” concluded Philippe.

## Consistent and stable supply

On the challenges for an ingredient producer, Vincent noted, “Working on hydrolysates require probably the highest level of product standards. Our contribution to the supply chain is a guarantee on exactly the same peptide profile for each batch. To deliver a constant supply of a standard product, we need to have the same species and same tissues at a level of unquestionable freshness. Of course our price has to be stable too.”

The next step is working alongside suppliers of raw materials and to maintain stable pricing. “For this, it is essential to have them on board,” said Vincent. “We have learnt that sustaining consistency and stability is a business. Customers working with us realise that we can supply consistent ingredients and have shared values for the ingredient industry. The source owner and ingredient manufacturers are the beginning of the stability chain and we cannot afford to have gaps. A stable chain allows the industry to have a stronger control of the value chain.”

“Also, the shared objective is not enough. We need to communicate on what the industry needs. Then the next step, which may take two or more years, is certification. This is the road map for this industry.”



Jim Collins, SyAqua Group, Thailand



Nguyen Duy Hoa, Cargill Vietnam Ltd.



Rudy Purwono, PT Matahari Sakti, Indonesia



Surapol Pratuangtum, Bang Go Farm, Thailand



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### FEED INTAKE



**“ The new paradigm will be bacteriophages and in the future, we will hear more on the use of bacteriophages against diseases. ” - Kabir Chowdhury**



Ibrahim Bin Ahmad, Blue Archipelago Bhd (left), Ravikumar Yellanki, Vaisakhi Bio-Resources, India (middle) and Dan Fegan, SyAqua Group, Thailand.

## Nutrition & diseases

There is a need to change the perception that shrimp farming is a disease prone industry. Nutritional interventions could possibly help but prior to this, it is important to understand crustacean immunity. In his review on what is available in the scientific domain, **Dr Kabir Chowdhury**, Global Product Manager, Jefo, Canada discussed the unknowns in shrimp immunity followed by some action mechanisms comprising solutions and additives, how and when to use these products as well as the environmental and economical consequences of their use.

“As most pathogens are already prevalent in apparently healthy populations, disease outbreaks are usually a result of massive amplifications following exposure to various forms of environmental and physiological stress. Stressors can include handling, spawning, poor water quality or abrupt changes in temperature and salinity,” explained Kabir.

## Knowing the unknowns

“Shrimp lack a highly evolved adaptive immunity. Therefore, shrimp rely on innate or non-specific response,” said Kabir. “Crustaceans rely on nonspecific immune mechanism to prevent entry and spread of pathogens. When the mechanism fails, crustaceans immediately initiate multiple innate immune responses to defend against the pathogens. Both humoral (involving cell free components of the haemolymph) and cellular (components by haemocytes) components work together in case of a pathogenic outbreak.

“There is a diverse array of humoral immune responses include clotting cascades, antioxidant defence enzymes such as superoxide dismutase, peroxidase, catalase and nitric oxide synthase, defensive enzymes such as lysozyme, acid and alkaline phosphatases, and antimicrobial peptides. The cellular component involves phagocytosis, apoptosis and RNA interference. One of

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the most effective immune mechanisms in invertebrates is the cellular melanotic encapsulation. A lot of excellent papers are describing this prophenoloxidase (proPO) system." said Kabir.

Kabir described how the complex melanisation cascade requires the combination of circulating haemocytes and several associated proteins of the proPO activating system. Whether there is carry-over immunity is still not very clear.

"Recently, a report on the trained immunity in invertebrates during a transgenerational study using *Artemia* as a model was published by Norouzitallab et al. (2016). In this study, the authors exposed successive generations to *Vibrio campbelli* and then exposed all three generations simultaneously to the *Vibrio*. This work suggested that innate immune responses in invertebrates have the capacity to be trained, and epigenetic reprogramming of (selected) innate immune effectors is likely to have central place in the mechanisms leading to trained immunity."

## Feed based solutions

Several feed additive based solutions to prevent disease occurrence or to improve non-specific immune responses are available worldwide. Kabir divided the solutions into inorganics and organics. Organic solutions include but are not limited to pro- and pre-biotics, essential oils, components from macro- and micro-algae or single cell proteins, carotenoids, organic acids and their salts, and enzymes. He explained how metallo-protease work in the pro-po system.

"Inorganic solutions include several divalent metallic compounds and their chelated products with amino acids such as lysine and methionine as well as carotenoids. Lin et al. (2013) looked at how dietary sources such as zinc methionine (ZnMet), zinc lysine (ZnLys), zinc glycine (ZnGly) and zinc sulphate ( $ZnSO_4 \cdot H_2O$ ) affect growth and immune parameters for *Litopenaeus*

*vannamei*. Shrimp fed diets with organic zinc supplementation produced significantly higher growth, survival and immune parameters than  $ZnSO_4$  treatment."

In 2013, Zhang et al. showed that shrimp fed six dietary astaxanthin levels gave higher survival than the control after a low dissolved oxygen stressor. According to Xie et al. (2015), 2.29-2.34% of proline in the low fish meal diet could improve anti-oxidative capacity, immune response,  $NH_3$  stress tolerance of *L. vannamei*, and proline may be a conditionally essential amino acids for the vannamei shrimp.

The potential of membrane active peptides (MAP) was also described. Koh et al. reported a long list of plant extracts (garlic, vanilla, prunes, acacia, oregano, rosemary, thymus, broccoli, curcumin, orange), essential oils (rosemary, tea tree), bioactive metabolites, plant exudates (pea) and fungal extracts, inhibiting quorum sensing of various bacterial species. Heat shock proteins (HSP60) or chaperonin are distinct ring shaped or toroid quaternary structures. These are considered as endogenous stress signalling molecules.

Interest in enzymatic function for protecting against microbial infection has intensified in recent years. Some of these include halogenated furanones (from seaweeds), synthetic auto-inducing peptides and paraoxonase enzymes (PONs). Kabir discussed the research by Song et al. (2016) on the effect of a dietary protease-complex on growth performance, body composition, digestive and immune enzyme activity of *L. vannamei* and its resistance to a pathogenic *Vibrio parahaemolyticus*. A high fish meal diet containing 200 g/kg fish meal was the positive control and a low fish meal diet containing 100 g/kg fish meal, the negative control. For the other treatments, the low fish meal diets were supplemented with graded level of a protease-complex (125, 150 and 175 mg/kg, respectively). Total superoxide dismutase and



The image shows a large-scale aquaculture system using AQUATEC floating fish cages. The cages are made of yellow plastic pipes and are arranged in a circular pattern on a body of water. Several workers in dark clothing and hats are standing on the cages, inspecting the equipment. In the background, there are green hills and mountains under a clear sky. The AQUATEC logo is prominently displayed in the upper left corner of the image area.

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**“ By reducing protein and excess phosphorus, we can reduce the organic loads in pond water. This then leads to less water quality problems, less stress, lower risk of disease outbreak and better performance. ” - Daranee Sookying**



At the breakout roundtable on production technology, from left, Prakan Chiarakhongman, Charoen Pokphand Foods, Thailand, Hervé-Lucien Brun, consultant, France, Dr María Mercè Isern i Subich, Nutriad, Belgium and Ekanant Yuvabenjapol, Thai Union Feeds, Thailand.

polyphenol oxidase contents in both serum and hepatopancreas were higher and serum malondialdehyde content and the cumulative mortality during disease challenge tests were lower for the diets containing the protease-complex than those fed the low fish meal diets ( $P < 0.05$ ), with no difference with those fed the high fish meal diets.

“The new paradigm will be bacteriophages and in the future, we will hear more on the use of bacteriophages against diseases. However, an issue with bacteriophages is that they need to be changed every 2-3 years as they lose efficacy.”

Kabir’s message is that “Blindly choosing just one single approach could be a waste as a combination of approaches may be more beneficial and helpful. We need to have proper management, better genetics and a combination of nutritional solutions for disease prevention and mitigation.”

## More emphasis on waste reduction and vitamins

How can we use our nutritional knowledge and feed management practices to mitigate diseases in shrimp? In her presentation, **Dr Daranee Sookying**, Aquaculture, DSM Nutritional Products Ltd, Thailand discussed options through the eyes of the feed industry and shrimp farmer. She said that farmers have accepted the fact that poor nutrition and poor feeding practices may lead to a reduced immune system response and lower the ability of shrimp to resist disease. However, at the same time, the demand is for reasonable and consistent feed performance in terms of ADG and FCR and good quality harvest at reasonable feed costs.

“We need to optimize feed performance away from just formulation. We need to look at impact of feeds which, we can control such as nutrient optimization. By reducing protein and excess phosphorus, we can reduce the organic load in pond water. This then leads to less water quality problems, less stress, lower risk of disease outbreak and better performance.

“When we replace fish meal with plant meals, we then need to improve feed digestibility, attractability and water stability. Use of enzymes, although more common in fish feeds than in shrimp feeds are options. Phytase increases available phosphorus and reduces environmental impact. Xylanase breaks down cell walls and protease can increase nutrient availability and minimize organic wastes. More-sustainable marine proteins serve as feed stimulants and attractants from sources. The soluble protein requirement is 8% for vannamei shrimp feeds and 10-12% in feeds for the monodon shrimp. Fast growing shrimp requires highly available nutrients.”

According to Daranee, black spot or black gill disease, cramped muscle syndrome, soft-shell syndrome, blue shrimp and red diseases are nutritionally linked. Specific nutrients

such as vitamin C supplementation help with black gill disease. Calcium and phosphorus supplementation help with cramped muscles. “It may be possible that soft-shell syndrome could be due to rancid/low quality feed and high energy feeds and mineral supplementation can help. Blue shrimp disease or blue shell syndrome is caused by low oxygen in ponds or low level of astaxanthin in feed. Astaxanthin improves biological functions and improves survival, growth and stress resistance in shrimp. In all these, the common factor is to maintain good quality water and pond bottom, and apply probiotics if required.

“Vitamins are known to enhance disease resistance. Today, the vitamin levels in feeds are at less than optimal requirement levels. Superior dietary supplementation levels of certain vitamins do provide additional value. Vitamin C supplementation is crucial in farmed shrimp since shrimp are unable to biosynthesize vitamin C and dietary inclusion is required for growth and development, reproduction, resistance to disease, enhanced immune system response, stress reduction, wound healing and enhancement of antioxidant properties. Elevated dietary levels of vitamin C have been shown to improve resistance to diseases, salinity shock and other stresses. In the case of Vitamin E, the recommended level is 100 ppm, but higher amounts of Vitamin E supplementation needed are related to dietary lipid level or in times of stress.”

## Towards a sustainable industry

### Managing EHP and production planning

**Dr Celia R. Lavilla-Pitogo**, iAqua Malaysia, is a scientist with extensive experience on diseases affecting farmed shrimp and fish. Her most recent work focusses on the management of the microsporidia *Enterocytozoon hepatopenaei* (EHP) at a farm in Malaysia. Celia started with an explanation on how the microsporidian infects shrimp.

“The less than 1  $\mu\text{m}$  spore infects the shrimp when the missile-like organelle releases the polar tubule. Once in the host, it replicates. Each infected shrimp in the farm contributes infectious spores into the environment through its faeces. Microsporidian spores are resistant to drying and routine chlorination levels. Disinfection to deactivate spores requires out-of-the-normal biosecurity protocols like exposure to high or low pH.

“The missile-like polar tubule has a single-release mechanism and failure to inject itself into a host subsequently deactivates the spore. We can prevent infections if we can find means to deactivate the missile organelle. Until then, we have to focus on diagnosing the severity of infections and how to manage production around EHP infections,” explained Celia.

### Wet mount microscopy

EHP can be detected by polymerase chain reaction (PCR), the kits of which are now commercially available. However,



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**“There should be timely communication between production staff and the laboratory technicians. This is currently a weak link in our shrimp industry” - Celia R. Lavilla-Pitogo**



**“There is a strong demand for biosecure shrimp production globally. RAS can be part of the new normal with the benefit of biosecurity for hatchery and advanced juvenile systems for the shrimp industry to get the existing pond culture off to a strong and healthy start.” - Robby Mort**

detection of EHP by PCR provides limited information on how best to manage the stocks after detection. “We need to know the severity of infection. I recommend wet mount microscopy of fresh hepatopancreas samples which allow grading of severity of infection. Histology is also a good tool to confirm severity grading and location of affected cells of the hepatopancreas,” said Celia.

In describing the steps for wet mount microscopy, Celia emphasised on the need to include the central part of the hepatopancreas to see spores inside infected cells. Once infected cells are located, the severity of infection can be determined. This diagnosis can be partnered with a real time PCR to validate microscopic grading of severity of infection.

“Under farm conditions the number of infectious spores can be minimised by thorough disinfection of farming premises with the application of high pH 12 using burnt lime or low pH 4 using HCl. The focal points for disinfection can be the seams of pond liners. In hatcheries, prevention of direct contact between eggs and broodstock faeces is a key strategy but can be difficult and laborious, such as using condoms on female broodstock. This was done to prevent transfer of monodon baculovirus (MBV) several years ago.”

## Production planning

“At the farm, infections with EHP cause a wide variation in sizes despite shrimp eating well. We graded the severity of infections; and linked these to critical factors such as the average body weight (ABW), average daily growth (ADG) and feed conversion ratio (FCR). We then made decisions on how to manage stocks in affected ponds: whether to continue, harvest, or abort the crop,” Celia continued. “Usually, when grade 3 severity and above is observed and growth has plateaued, the farm prepares to abort or harvest to hasten pond turn-around instead of waiting for larger shrimp sizes. However, decisions will need to depend on markets too, based on the minimum ABW that has a value. In Malaysia, for example, shrimp below 7 g has no value. Production planning based on the EHP severity and observed abnormalities will be part of the new normal in shrimp farming.”

The take home message was, “There should be timely communication between production staff and the laboratory technicians. This is currently a weak link in our shrimp industry.”

## Controlled production in China

In this presentation, **Robby Mort**, RADAQUA, Australia shared his experiences in running a cost effective managed recirculating aquaculture system (MRAS), which the company designed and constructed in Fujian Province, China. The commercial trial for the production of *Penaeus monodon* ran from December 2015 to harvesting in February 2016.

In his introduction to RAS, Robby listed reasons for such controlled production models. RAS can be located anywhere, close to markets or for food security reasons, in small nations with no resources like Singapore and UAE. The small footprint is an advantage and overcomes competition for land resources. Legislation is also a reason for RAS such as in Australia with environmental compliance regulations limiting open culture systems.

“These are engineered systems where water coming in is filtered and there is continuous water treatment. We can control parameters such as pH and temperature, even to the point of adjusting photoperiod. RAS gives us high unit output per unit of land, and minimises business risk without any production interruption. Biosecurity allows a high degree of control over external risks,” explained Robby.

The system in China uses standard round HDPE 65 m<sup>3</sup> fish culture tanks. The culture period was divided into specific phases. The nursery phase uses post larvae PL25 in 4 m diameter tanks for a duration of 5 weeks. Aeration was heavy and probiotics enhanced algae and bacteria blooms. The grow-out phase of 6 months was spread over the winter season. Robby said that when they were producing without interruption, shrimp farms in the surrounding areas remained fallow over the winter months.

## Uninterrupted production

“We graded shrimp regularly and adjusted biomass to manage stocking densities and aggression. Shrimp were fed 100% commercial diets. As shrimp reached 30 g, we carried out partial harvests. The harvest was planned in February 2016 to get the best prices and shrimp were sold at average prices of 200 RMB/kg (USD 29.5/kg) for live product through niche buyers. The total production was 2 kg/m<sup>2</sup> which was equivalent to 20 tonnes/ha. It helped that the location of this facility was between two tier1 cities. The choice on location was a business decision of the client. Our advantage was that we could produce large monodon shrimp of size U10 at 10-15/kg. We had little market competition within the market place from other monodon shrimp producers due to disease issues associated with production during winter,” explained Robby.

In terms of productivity, culturing shrimp in MRAS has an advantage over traditional farming in open pond systems where productivity is 10 tonnes/ha in Australian shrimp ponds and 5 tonnes/ha in Vietnam.

The limitations are the high capital outlay for sheds and infrastructure. The staff required should have more than the average technical background. Despite relatively low yields, the commercial trial demonstrated that there is potential to use MRAS for the commercial culture of *P. monodon* in China. In a normal scenario for RAS, where the ratio of water: fish is 1:10 the profits should be better.

“There is a strong demand for biosecure shrimp production globally. RAS can be part of the new normal with the benefit of biosecurity for hatchery and advanced juvenile systems for the shrimp industry to get the existing pond culture off to a strong and healthy start.”

## Proactive management to keep disease away

**Soraphat Panakorn**, Novozymes Biologicals, Thailand has visited shrimp farms in the region extensively and has seen how the industry, in particular, Thailand, is suffering with frequent outbreaks of early mortality syndrome and acute hepatopancreatic necrosis (EMS/AHPND) as well as white spot syndrome virus and



**“ The change is moving shrimp farming from an art to science with the implementation of ideas and modern practices. ”**  
- Soraphat Panakorn

white faeces disease. At TARS 2014, he presented on proactive management to keep disease away. However, as diseases persist, Soraphat's current focus is to get farmers to change mindset and farm management.

“Looking to the future, there is the possibility that shrimp farmers will continue to encounter new diseases while dealing with existing ones. Uncertainties and frequent crop losses from diseases are not sustainable for any industry. Following the phrase, 'prevention is better than cure', to survive in this industry, farmers will have to change their perceptions on the farming process.

“Today, the goal is to fight diseases. For this, sometimes the farmer needs to change the mindset. For each crop, he or she may need to think proactively. Farmers must know some basic knowledge in shrimp farming. Being open and to share knowledge among peers and to accept change are critical for success. But as each pond has its own features and conditions, the farmer should not copy outright practices but adapt to his own farm and pond conditions.”

Soraphat categorised target farmers as proactive management (PAM) farmers and listed the actions and practices they should follow. “The list is very long but important. It is only through proactive management that we can manage shrimp and avoid problems. Farmers should work at fine tuning processes along the supply chain and understand that behaviour and physiological needs of the living shrimp will change with environmental conditions. In turn, there is the dynamics of climate, season and other natural conditions, which will impact shrimp farming. In farm management, farmers need to understand the science and learn to effectively use many of the aquaculture inputs such as disinfectants, lime, microorganisms and feed additives. In outdoor ponds, they need to prepare for climate and seasonal changes. Knowing local and global market situations is important for any investor as well as the farmer.”

With regard to PAM practices, Soraphat gave a list of practices to follow along the production chain, at the hatchery and post larvae selection to the grow-out. At the farm, it includes aeration to cover the whole pond without any blind spot with 30% aeration set as spares and the effective use of probiotics. He also warned against using antibiotics or prohibited chemicals. Some reminders were to give more attention on management during the night and to be aware of the negative effects of hydrogen sulphide.

“Efficiency and adapting SOPs are critical and this is influenced by the social well-being of the farm employees. We should not move away from basic practices but continue to innovate and select the most effective techniques as standard protocols to avoid some common problems. The change is moving shrimp farming from an art to science with the implementation of ideas and modern practices.”

**TARS 2017 will focus on Finfish Aquaculture: Strategies for Growth. It will be held in Bali, Indonesia from 16-17 August, 2017. Updates will be available at [www.tarsaquaculture.com](http://www.tarsaquaculture.com)**



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# Study on the effects of dietary methionine + cysteine supplementation on the white shrimp under pond culture conditions

By Alexandros Samartzis, Nathan Felix, Karthik Masagounder and Girish Channarayapatna

This study showed an optimal weight gain of the shrimp at dietary level of 0.80% methionine and 1.23% methionine + cysteine

Global farmed shrimp production quadrupled from 2000 to 2014 reaching 4.58 million tonnes, according to the FAO 2016 report. Asia contributed almost 85% of this production. A number of studies generated recently on the nutritional requirements of the most cultured shrimp species, *Litopenaeus vannamei*, supported the shrimp industry's growth.

Among them, several experiments highlighted the importance of balancing amino acids in shrimp feeds as well as the significant effects of crystalline amino acids supplementation on growth performance, especially in recent formulations where fish meal is constantly replaced by alternative protein sources. There is still a dearth of knowledge on the methionine (Met) and methionine + cysteine (Met+Cys) requirements of *L. vannamei* under pond conditions. In commercial ponds (green water conditions), shrimp have access to natural food sources such as microalgae, zooplankton, benthic fauna and bioflocs. Even though commercial feed plays the major role in providing for the nutritional requirements of shrimp, natural food may contribute partly to their nutrition, including the need for amino acids.

This experiment was conducted in collaboration with the Tamil Nadu Fisheries University. Since 2013, India showed the highest increase in shrimp production at almost 30% to become the fourth largest farmed shrimp producer in the world. Farming practices (i.e. stocking density, salinity level, feeding management etc) among the shrimp producing countries vary significantly, so this trial was designed to imitate several practices in India. The objective of the study was to evaluate the growth performance of juvenile *L. vannamei* fed increasing levels of dietary Met and Met + Cys in a green water system.

## Trials in ponds

A total of six experimental diets were fed to *L. vannamei* with an average body weight of  $5.05 \pm 0.22$  g, for 60 days. A control diet (diet 1) was formulated to meet the essential amino acid requirement but was low in Met and Met + Cys (0.55 % and 0.97%, as-is basis, Table 1). Diets 2-6 had the same composition but supplemented with increasing levels of AQUAVI® Met-Met (Aqua Culture Asia Pacific, July/August 2016, p34-35) at 0.07%, 0.09%, 0.13%, 0.20% and 0.38%, as-is basis constituting total dietary Met+Cys levels of 1.05%, 1.07%, 1.10%, 1.18% and 1.34% respectively (Table 2). Each treatment had 5 replicates in which 35 shrimp were allocated to (1mx1mx1m) cages placed 20 cm above the pond bottom installed in a commercial 1,500 m<sup>2</sup> pond and fed 3 times/day to apparent satiation. Water temperature ranging from 25.3 to 29.1°C, salinity, 0.2-0.5 ppt, dissolved oxygen, 3.7-7.4 mg/L and total ammonia from 0.1-0.9 mg/L were recorded during the experimental period.

Table 1. Ingredient composition of the basal diet

Ingredients	%	Nutrients	Calculated % (as-is basis)	Analysed % (as-is basis)
Soybean meal, 49% CP	39.58	Dry Matter	91.10	91.37
Wheat flour	38.61	Crude Protein	33.50	34.17
Shrimp meal, 62% CP	6.53	Gross Energy, kcal/kg	4,174	-
Fish meal, 60% CP	8.77	Lys	1.90	1.76
Sardine oil	2.00	Met	0.55	0.54
Soy lecithin	2.00	Met+Cys	0.97	0.98
Monocalcium phosphate	1.00	Thr	1.19	1.22
Vitamin premix	0.50	Trp	0.39	-
Mineral premix	0.50	Arg	2.14	2.19
Calcium propionate	0.10	Ile	1.38	1.44
Stay-C 35	0.05	Leu	2.37	2.43
L-Glutamic acid	0.40	Val	1.50	1.55
AQUAVI® Met-Met	0.00	His	0.80	0.78

## Optimum Met + Cys levels

Shrimp fed with increasing levels of Met and Met + Cys (diets 2-6) showed significantly higher feed intake, final body weight, weight gain and lower feed conversion ratio (FCR) compared to the control diet (diet 1) which had no supplementation of Met. Feed conversion ratios (FCR) among the treatments supplemented with Met did not differ significantly (possibly due to the high variation). However, the diets supplemented with Met (diet 2-6) were significantly lower than diet 1 (no Met supplementation), with highest FCR reduction to 1.37 (diet 6) from 1.67 (diet 1). Both final body weight and weight gain showed the same trend where diets with the highest supplementation (diets 5 and 6) had significantly higher values compared with the rest of the treatments (Table 3).

In order to identify the optimum Met level for the shrimp to reach maximum weight gain, we fitted the weight gain data into a quadratic broken line model and obtained an optimal weight gain at the dietary level of 0.80% Met ( $R^2 = 99.1\%$ ) and 1.23% Met + Cys ( $R^2 = 99.4\%$ ) (Figure 1).

Finally, an economic analysis of the six diets was performed to evaluate the income over feed cost (IOFC) (Table 4). In commercial practices, usually the replacement of fish meal with alternative protein sources and supplementation of amino acids results in a more economic feed. In this experiment the formulated diets differ in only one variable parameter, the increasing levels of Met supplementation. As the level of supplementation

Table 2. Content of methionine and cysteine in the experimental diets

Diets		Basal	0.05% MM	0.10% MM	0.15% MM	0.20% MM	0.40% MM
Met %	Calculated (analysed)	0.55 (0.54)	0.60 (0.61)	0.65 (0.63)	0.70 (0.67)	0.95 (0.92)	0.95 (0.92)
Met + Cys %	Calculated (analysed)	0.97 (0.98)	1.02 (1.05)	1.08 (1.07)	1.13 (1.10)	1.38 (1.34)	1.38 (1.34)

Table 3. Growth performances (mean $\pm$  1 SD) of shrimp fed experimental diets for 60 days\*

	Diets	Feed intake (g/shrimp)	Final body weight (g/shrimp)	Weight gain (g/shrimp)	FCR (g/g)
1	Basal	14.84 $\pm$ 0.06 <sup>c</sup>	13.88 $\pm$ 0.06 <sup>e</sup>	8.90 $\pm$ 0.19 <sup>e</sup>	1.67 $\pm$ 0.09 <sup>a</sup>
2	0.05% MM	16.07 $\pm$ 0.92 <sup>b</sup>	15.86 $\pm$ 0.11 <sup>d</sup>	10.94 $\pm$ 0.28 <sup>d</sup>	1.47 $\pm$ 0.09 <sup>bc</sup>
3	0.10% MM	16.56 $\pm$ 0.94 <sup>b</sup>	16.42 $\pm$ 0.48 <sup>cd</sup>	11.44 $\pm$ 0.42 <sup>cd</sup>	1.45 $\pm$ 0.05 <sup>bc</sup>
4	0.15% MM	17.47 $\pm$ 0.63 <sup>ab</sup>	17.30 $\pm$ 0.16 <sup>b</sup>	12.12 $\pm$ 0.30 <sup>b</sup>	1.44 $\pm$ 0.04 <sup>bc</sup>
5	0.20% MM	19.21 $\pm$ 0.55 <sup>a</sup>	18.49 $\pm$ 0.39 <sup>a</sup>	13.45 $\pm$ 0.43 <sup>a</sup>	1.43 $\pm$ 0.05 <sup>bc</sup>
6	0.40% MM	18.23 $\pm$ 0.99 <sup>ab</sup>	18.36 $\pm$ 0.10 <sup>a</sup>	13.28 $\pm$ 0.15 <sup>a</sup>	1.37 $\pm$ 0.09 <sup>c</sup>

\*Values within columns with different superscripts (<sup>a,b,c,d</sup>) are significantly different at P<0.05), ANOVA

Table 4. Economic analysis of the data, expressed as income over feed cost (IOFC)

	Basal	0.05%MM	0.10%MM	0.15%MM	0.20%MM	0.40%MM
Shrimp stocked per ha	350,000	350,000	350,000	350,000	350,000	350,000
Initial weight, g/shrimp	4.98	4.92	4.98	5.18	5.04	5.08
Initial biomass, kg	1,743	1,722	1,743	1,813	1,764	1,778
Survival at 85%	297,500	297,500	297,500	297,500	297,500	297,500
Final weight, g/shrimp	13.88	15.86	16.42	17.30	18.49	18.36
Final biomass, kg	4,129.30	4,717.16	4,883.76	5,147.94	5,500.78	5,462.70
Gross income, USD/ha*	17,160.50	20,141.80	20,932.80	22,113.70	23,975.88	23,757.48
Feed cost, USD/tonne	524.88	528.54	531.24	545.90	546.64	551.04
FCR	1.67	1.47	1.45	1.44	1.43	1.37
Feed intake, kg/ha	3,980.10	4,404.04	4,546.48	4,805.46	5,338.76	5,060.19
Total feed cost, USD/ha	2,089.09	2,327.72	2,415.28	2,623.31	2,918.39	2,788.37
IOFC, USD/ha	15,071.41	17,814.08	18,517.52	19,490.39	21,057.49	20,969.10
Differences in savings relative to the basal diet, USD/ha		2,742.67	3,446.11	4,418.98	5,986.08	5,897.69

\* For initial stock (initial biomass), USD 2/kg was assumed, and for final biomass, USD 5/kg was assumed

Initial biomass = Initial weight x shrimp stocked per ha

Final biomass = Calculated survival at 85% (ranging from 81.14 $\pm$ 3.26 to 90.29 $\pm$ 4.33) x final weight

Gross income (USD/ha) = (Final biomass x 5) - (Initial biomass x 2)

Total feed cost (USD/ha) = Feed cost (USD/tonne) x Feed intake (kg/ha)

IOFC (USD/ha) = Gross income - Total feed cost (USD/ha)

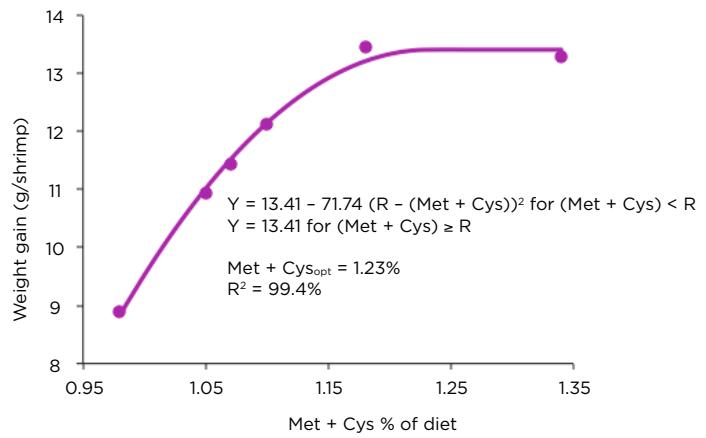
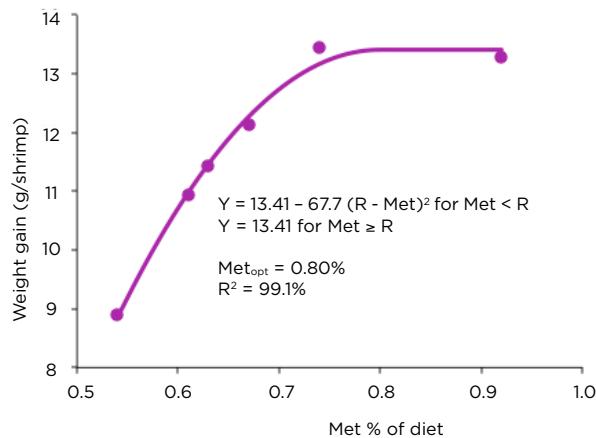


Figure 1. Weight gain of shrimp to increasing levels of dietary Met and Met+Cys with supplemental AQUAVI® Met-Met. Weight gain was optimized at 0.80% Met (0.88% on 100% dry matter basis) and 1.23% Met+Cys (1.35% on 100% dry matter basis).



Cages in the experimental pond

increased, feed cost also increased. However, the gross income of the farm as well as IOFC increased as the AQUAVI® Met-Met supplementation increased until diet 5 which produced higher growth performance of the shrimp. An interesting observation is the differences in savings relative to the basal diet (Table 4).

Overall, the findings of this study indicate that white shrimp fed diet 5 showed significantly higher final body weight and weight gain as well as significantly lower FCR relative to the control un-supplemented diet. The quadratic broken line regression analysis identified the optimum total Met level at 0.80% (as is) for maximum weight gain, which translates to 0.54% of Met derived from the raw ingredient and 0.26 from AQUAVI® Met-Met supplementation. This level also offers the highest IOFC to the shrimp farmer.



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# The fish meal dilemma: Shrimp performance with plant-based protein diets

By Anwar Hasan and Rui Goncalves

Research demonstrate that plant proteins may replace fish meal in shrimp feeds but mycotoxin contamination, single and as well as co-contamination at various degrees can have negative effects on shrimp performance.

The fishmeal dilemma is a big issue in aquaculture due to cost and sustainability. Nutritionists have the mission to optimise formulation costs and growth performance while facing challenges on raw material prices and availability such as for fish meal. Are we on the right track in solving the fish meal dilemma?

There are many studies on alternative raw materials to reduce or replace fish meal as a major protein source in shrimp diets, but little have been achieved. However, non-fish meal protein sources are common today, in particular for fish feed. These are plant proteins, by-products from agriculture or fisheries and from terrestrial animal production. Tacon and Metian (2008) reported results from a global survey on the use of fish meal in compound aqua feeds. It showed the reduction in the use of fish meal in aqua feed in several aqua species (shrimp, marine fish, salmon, trout and chinese carp) by 2020.

## Plant protein as fish meal replacement

Non-fish meal alternative ingredients may contain crude protein content comparable to fish meal. They may be less digestible and imbalance in terms of essential amino acids (EAAs). They may also have higher carbohydrate and fibre content. In feeds, they can lead to inefficient nutrient use, resulting in increased feed usage, greater susceptibility to disease and higher ammonia emissions.

In a study conducted by Soares et al. (2015), plant protein (SPC or soybean protein concentrate) was evaluated as replacement for fish meal in shrimp *Litopenaeus vannamei* feeds. The study concluded that fish meal can be replaced by up to 75% of SPC, without affecting the white shrimp in terms of growth and survival. Another study done by Oujifard et al. (2012), showed the potential of rice protein concentrate (RPC) as fish meal replacement of up to 50% protein in white shrimp diets.

However, a well-designed nutritional formula can contain hidden surprises that disrupt diet performance, affecting gut health directly or indirectly. There are several strategies to optimise performance of diets with plant-based protein for white shrimp, such as using nutrient-based protein and supplementing diets with crystalline amino acids (CAAs), or phytogenics, and managing mycotoxins.

## Nutrient based formulation

Plant proteins such as soybean-based protein (SPC and soybean meal), corn-based protein and rice protein concentrate (RPC) are widely available in the market. Compared with fish

meal, SPC is deficient in methionine (Drew et al., 2007), while the limiting factor of corn-based protein could be lysine (Nunes et al., 2014).

Presently, aqua feed mills often adopt the nutrient-based approach by supplementing formulas with CAAs, mainly methionine and lysine, because these are the two main deficient essential amino acids (EAAs) in low-fishmeal diets (Nunes et al., 2014).

Using the nutrient-based formulation approach, rapid dietary adjustments can be performed through CAA supplementations with minimum changes in the dietary levels. The method uses low supplementation levels of CAAs to effectively reach targeted dietary EAA concentrations through a least cost exercise.

## Phylogenetic feed additives

Phylogenetic feed additives, consisting of herbs, spices, essential oils and extracts have gained considerable attention as an answer to low fish meal diets. The active ingredients, such as phenols and flavonoids, can exert multiple effects in animals, including improvement of feed conversion ratio (FCR), digestibility, growth rate, reduction of nitrogen excretion and improvement of the gut microbiota and health status. Phylogenetics may stimulate digestive secretions, increase villi length and density, and increase mucous production through an increase in the number of goblet cells.

The positive effect of phylogenetic (Biomin Digestarom PEP MGE) on growth performance was tested (Figure 1 & 2). Without changing fish meal levels, the addition of this phylogenetic at an inclusion level of 200 g/tonne of feed, improved FCR and growth rate. However, the treatment diet, fish meal (19%) + phylogenetic performed better than the only fish meal (22%) treatment diet, in terms of FCR and growth rate.

## Managing mycotoxins risks

Despite efforts and the general improvements in nutrition, mainly on strategies to replace fish meal, there are still hidden surprises that disrupt diet performance. Mycotoxins are one of them.

Mycotoxins are found in many agricultural commodities and are produced at various stages e.g. before or after harvest, during transportation or during storage. Reducing fish meal and replacing plant protein in feeds may raise risks of mycotoxin contamination.

Researchers have identified over 400 mycotoxins worldwide. Most focus on the main occurring metabolites, i.e., aflatoxins (AFLA), deoxynivalenol (DON), zearalenone (ZEN), ochratoxin A (OTA) and fumonisins (FUM). Raw materials with the possibility of mycotoxin contamination and adverse effect on aqua species are shown in Table 1.

The effect of AFLA in *L. vannamei* is known. Feed contaminated with 60 µg/kg (ppb) of AFLA had negative effect on weight gain and promote higher FCR. AFLA at 120 µg/kg affected feed intake and a higher dosage (1000 µg/kg) reduced survival rate (Tapia-Salazar et al., 2012). Trigo-Stocki et al. (2000) reported that *L. vannamei* fed wheat contaminated at 0.2, 0.5, and 1 mg/kg (ppm) DON had significantly reduced growth.

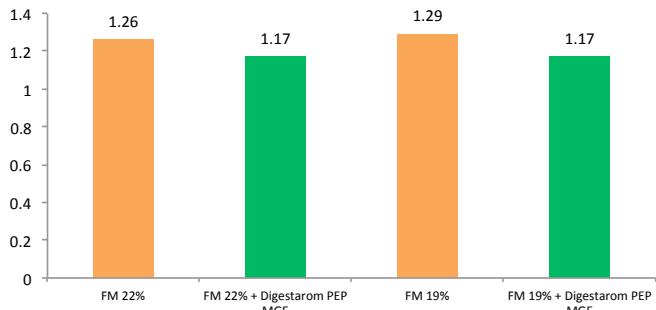


Figure 1. Feed conversion ratio of shrimp fed diets with different levels of fishmeal, with and without Digestarom® supplementation. (Source: Biomin trials, 2012).

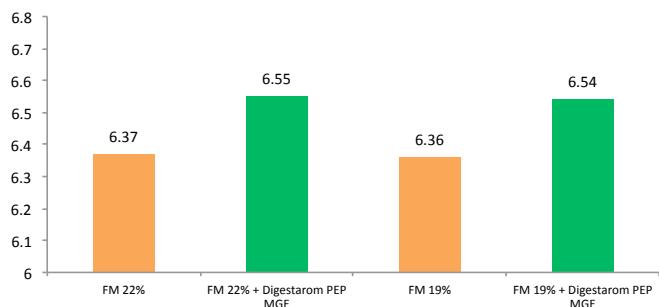


Figure 2. Specific growth rate (SGR, %/day) of shrimp fed diets with different levels of fishmeal, with and without Digestarom® supplementation. (Source: Biomin trials, 2012)

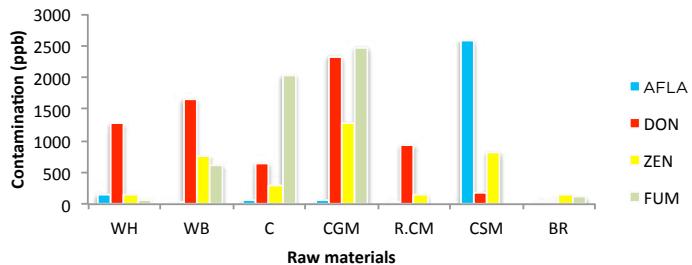


Figure 3. Average of mycotoxin contamination level (µg/kg) of positive samples in raw materials for aqua feeds (Biomin survey 2015). Wheat (WH), Wheat Bran (WB), Corn (C), Corn Gluten Meal (CGM), Rapeseed/Canola Meal (R/CM), Cotton See Meal (CSN) and Broken Rice (BR).

Feed contaminated with 0.5 mg/kg of FUM (FB1) leads to necrosis in hepatopancreas, reduced haemocyte count and phenol-oxidase activity (Mexia-Salazar et al., 2008), while exposure of 0.6 mg/kg FB1 reduced shrimp growth (Garcia-Morales et al., 2013). From the survey results, we found that contamination of AFLA, DON and FUM was more than 1,000 µg/kg on positive samples of raw materials (Figure 3).

### The risk of co-contamination

Co-contamination with two or more mycotoxins in feed or feed raw material is especially harmful to aquaculture species. Compound feeds usually contain a mixture of several raw materials, each of them with a unique mycotoxin contamination pattern and already with mycotoxin co-occurrence (Figure 3). Added to this, mycotoxigenic fungi are usually capable of

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Table 1. Mycotoxins in raw material (Source: Goncalves et al., 2016), and effects on some aquaculture species.

Mycotoxins	Raw materials	Species affected	Source
Aflatoxins	Corn, corn gluten, cotton seed, rice bran, groundnut, cassava, wheat, soybean meal.	Tilapia Yellow Catfish Vannamei shrimp Rohu	- Deng et al., 2010 - Wang et al., 2016 - Tapia-Salazar et al., 2012 - Sahoo & Mukherjee, 2001
Deoxynivalenol	Wheat, wheat bran, canola meal, rice bran, corn.	Vannamei Carp Trout	- Trigo-Stockli et al., 2000 - Pietsch et al., 2014 - Hooft et al., 2011
Zearalenone	Wheat bran, corn, corn gluten, cotton seed, rice bran, groundnut.	Tilapia	- Tola et al., 2015)*
Fumonisins (FB1)	Wheat bran, corn, corn gluten, rice bran.	Vannamei Salmon	- García-Morales et al., 2013 - Garcia, 2013

\* co-contaminated with DON.

producing more than one mycotoxin and it is expected that the occurrence of more than one mycotoxin is very high. Goncalves et al. (2016) observed that 76% of finished samples collected had two or more mycotoxins.

It is also well known that mycotoxins can have synergistic effects. This has not been reported in aquaculture species but we would expect that possibly some mycotoxins would act synergistically also in fish and shrimp. This means, for example, that sensitive levels for reported species in the survey would decrease when in the presence of more than one mycotoxin.

It is important to emphasise that the effects of mycotoxins on farmed species are probably underestimated. This is because of three major factors. The number of studies conducted per species, the variety of farmed species raised in very distinct environments and with distinct characteristics, makes it almost impossible to transpose results from one species to another, even if they are quite close phylogenetically.

In addition, most research looks at the effect of a single mycotoxin, whereas hundreds of distinct mycotoxins and metabolites have been identified.



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# Copper-montmorillonite complex as preventive action through gut flora modulation

By Maarten Jay van Schoonhoven, Marie Gallisot and Orapint Jintasataporn

## A clay complex has protective intestinal action by lowering the pathogenic pressure in shrimp.

Preventive measures to deal with potential diseases are becoming more important in aquaculture. One of these measures is implementing good management practises. These practises reduce the incidence of disease outbreaks, which in the past were commonly treated with antimicrobial substances. The rampant use of antibiotics has led to increasing antibiotic resistance in bacteria and thus regulations on its use must be enforced. However, a preventive approach must comply with an easy to use application. Olmix (France) has long specialised in applications of both clays and algae, by finding innovative solutions to allow sustainable production systems.

Aquaculture, as a production driven industry, will push culture practices to the limits of what is manageable and sustainable. It is therefore very easy for rearing conditions to go beyond these limits causing stress and triggering disease outbreaks.

Controlling these conditions through good management practices will include factors such as population densities,

nutritional quality, water quality, waste management and soil quality. In situations that are difficult to manage it is good to have preventive treatments that are easy to apply; these include situations where there is higher sensitivity to pathogenic pressure.

A helping hand is offered through a very large range of additives. Ideally the application of additives should be a simple process without extra efforts or compromises. These include additives that can be included in feed formulations, surviving the harsh extrusion conditions, and free the farm from regular additions of additives to their feeds or ponds.

## Clay complex as a feed additive

Clay has demonstrated its capacity to improve digestive performance in various animals (Cabezas et al., 1991, Habold et al., 2009). There are three existing ways in which clay can improve digestive performance. Firstly, this is through improvement of the digestive transit time. Secondly, the formation of a stable structure between clay and enzymes will protect enzymes from being broken down by e.g. proteolysis and lastly, clay can provide metallic ions which are the inorganic form of co-factors which are essential for enzyme activation.

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Xia et al., (2005) have shown that a Cu-MMT (copper - montmorillonite clay) complex increases feed digestibility and modulates the gut flora positively. When tested against Cu or MMT alone the Cu-MMT complex showed better growth, beneficial gut flora modulation and significant increases of enzymatic activity. This concept was tested by Olmix in shrimp in a trial in Thailand.

A trial was set up in Kasetsart University where MFeed, a Cu-MMT product, was tested for its capacity to improve the zootechnical and health performances in white leg shrimp *Litopenaeus vannamei*. A total of 375 shrimp ( $6.3 \pm 0.2$  g initial weight) were distributed among 15 tanks, each of 500 L, and with a density of 25 shrimp per tank. The tanks were randomly allotted to one of three treatments (5 replicates per treatment). Water quality was monitored throughout the trial period which lasted 67 days. The treatments comprised :

- Control group fed with a standard diet
- Treatment group MFeed 0.2% fed a standard diet supplemented with 0.2% Cu-MMT complex
- Treatment group MFeed 0.4% fed with a standard diet supplemented with 0.4% Cu-MMT complex.

After 60 days, the zootechnical performance was evaluated (Table 1). Treatment groups where shrimp were fed the Cu-MMT supplemented diets with 0.2% and 0.4% of MFeed had significantly increased survival rates (+16.7% and +19% respectively, Figure 1) and higher final weights, which led to a larger biomass production. Feed efficiency was also improved when MFeed was supplemented at 0.2% and 0.4%, as shown by the significantly lower feed conversion ratio (-9.2% and -11.3% respectively, Figure 2).

### Vibrio challenge

After the 60 day growth trial, a bath challenge test was conducted with a *Vibrio harveyi* load of  $1-2 \times 10^7$  CFU/mL. *Vibrio* is a ubiquitous bacterium in shrimp production and therefore likely to be naturally present in the culture water. *Vibrio* concentration in the intestine before the challenge was lower in the Cu-MMT treatment groups (Table 2). This suggests a protective effect in the intestine. These differences remain for 3 and 5 days after the challenge test showing that Cu-MMT is effective over time and under high pathogen pressure.

Consequently, Cu-MMT supplemented groups showed a lower *Vibrio* intestinal colonization (Table 3 and figure 3) and also presented a significantly increased survival rate in a dose dependent manner.

MFeed, a Cu-MMT complex developed by Olmix, has shown an improvement in *L. vannamei* culture in terms of zootechnical performance and protective intestinal action by lowering the pathogenic pressure. Better digestion resulted in higher feeding efficiency and better growth rates (over 7% weight gain). In

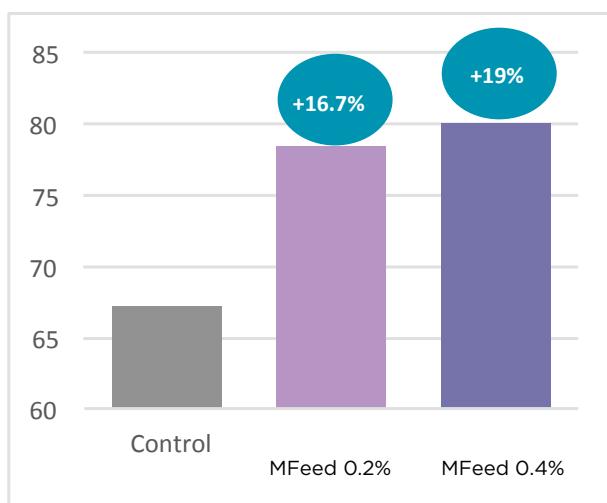


Figure 1. Survival rates (%) after 60 days of culture

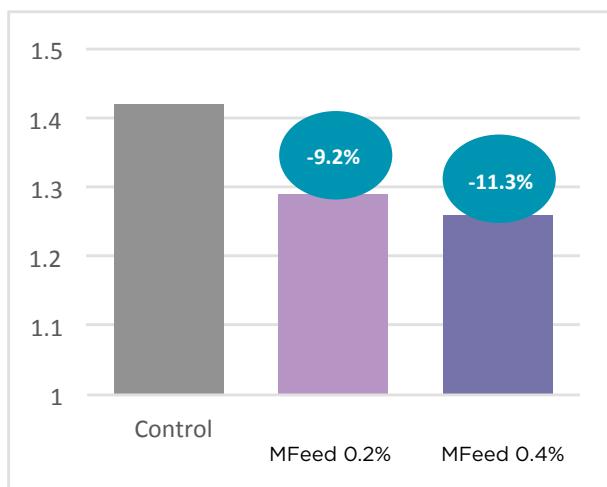


Figure 2. FCR after 60 days of culture

Table 2. *Vibrio* counts in the intestine during the challenge test

Treatment	<i>Vibrio</i> concentration in the intestine ( $\times 10^4$ CFU/g)		
	Before challenge	3 days after challenge	5 days after challenge
Control	1.67 $\pm$ 0.13	193 $\pm$ 32	165 $\pm$ 41
MFeed 0.2%	1.37 $\pm$ 0.34	164 $\pm$ 41	131 $\pm$ 12
MFeed 0.4%	1.31 $\pm$ 0.21	135 $\pm$ 13	130 $\pm$ 17
P-value	0.124	0.055	0.269

Table 1. Zootechnical growth performance after 60 days of culture.

Parameters	Control	MFeed 0.2%	Variation over control	MFeed 0.4%	Variation over control	P-value
Initial weight (g)	6.32	6.34	-	6.33	-	0.1
Final weight (g)	12.46	13.01	+ 4.4%	13.42	+7.7%	0.61
Specific growth rate (%/d)	1.22	1.3	+6.6%	1.34	+9.8%	0.7
Total feed consumption (g/ind.)	8.66	8.5	-	8.65	-	0.95
Feed conversion rate (FCR)	1.42	1.29	-9.2%	1.26	-11.30%	0.06
Survival rate	67.2 <sup>a</sup>	78.4 <sup>b</sup>	+16.7%	80 <sup>b</sup>	+19%	<0.01

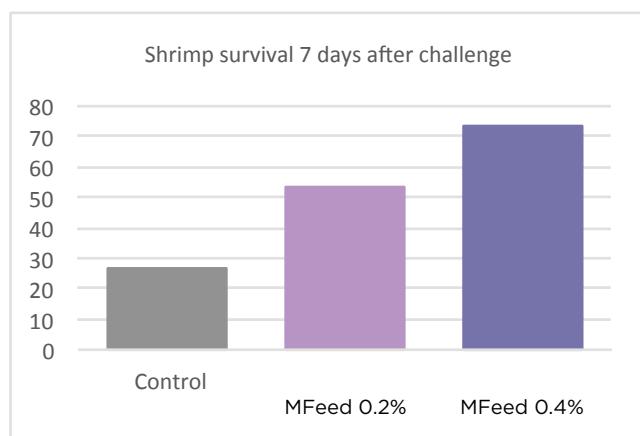
<sup>a,b</sup> Means with different letters within rows are significantly different ( $P<0.05$ )

addition, the improved gut health resulted in higher survival rates during normal conditions and under challenging conditions with high pathogenic pressure. MFeed is an efficient alternative to support gut health and improve zootechnical performance.

Table 3 and Figure 3. Survival rate 7 days after a challenge test with *Vibrio harveyi*

Treatment	Survival rate (%) 7 days after challenge
Control	26.67 <sup>c</sup>
MFeed 0.2%	53.33 <sup>b</sup>
MFeed 0.4%	73.33 <sup>c</sup>
P-value	0.002

<sup>a,b,c</sup> Means with different letters are highly significantly different (P<0.01)



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# Freshwater prawn farming in Thailand: Striving for sustainability

By Krishna R. Salin & Inamul Hassan

Despite increasing competition from white shrimp, Thailand's freshwater prawn farming is however still promising.



Farmer, Noi Sathantoranin at her farm in Suphan Buri province.

Thailand has a long history and tradition of aquaculture which is reflected in the wide diversity of species groups used for aquaculture, and the productive use of the country's water resources, transforming aqua-entrepreneurship into a full-fledged industry. Aquaculture is a way of life for many Thai rural communities and there is a great deal of professionalism in many fronts that have helped the Thai aquaculture industry to dominate in the region over the past several years.

The Department of Fisheries (DoF) of Thailand actively promotes aquaculture by developing and disseminating novel technologies and supporting domestication of new species and their good farming practices suitable to local conditions. Recent estimates by FAO have revealed that the per-capita consumption of fish in Thailand is high, which is around 31.4 kg, ranging from 32.7 kg in the northeast to 41.4 kg in the southern provinces. Of these, 37% of the total fish consumed are from inland waters, 47% from marine, and the remaining 16% from fish-based miscellaneous products from either inland or marine origin.

In Thailand, the giant freshwater prawn (*Macrobrachium rosenbergii*) is a native species found naturally in both freshwater and brackishwater sources especially in the Chao Phraya River Basin, Mae Klong River, Tha Chin River, Bang PaKong River, Pranburi River, and most of their associated canals. In the early years of its farming, juveniles were captured from wild resources. Excessive fishing, deterioration of natural habitats and spawning grounds, as well as various anthropogenic impacts such as pollution and rapid industrialisation, led to the domestication of prawns in Thailand.

Thailand's DoF initiated trials on captive breeding and farming of the giant freshwater prawn in as early as 1956, and these were successful at the Songkhla and Bangkhen Fisheries Stations by 1966 (Singholka et al., 1980). The Chachoengsao DoF Station was established in 1976 to promote freshwater prawn farming in Thailand. In the meantime, small-scale commercial hatcheries had also started producing freshwater prawn seed, resulting in the rapid expansion of freshwater prawn aquaculture in Thailand.

Table 1. Recorded *Macrobrachium* spp in Thailand, their preferred habitat, and economic importance

Species	Source	Economic Importance
<i>M. rosenbergii</i>	Freshwater & brackishwater	High economic importance, most commonly cultured and bred especially in the Central Thailand
<i>M. dienbienphuense</i>	Freshwater	Economically important, wild caught along the Mae Klong, Chi, Moon rivers and their branches in Northeastern Thailand. Has a good potential for farming
<i>M. niphanae</i>	Freshwater	Economically important as an ornamental species, only recorded in waterfalls and streams
<i>M. lanchesteri</i>	Freshwater	Economically important, found in almost all the inland waterbodies in Thailand, poly-cultured with fish in Northeastern Thailand
<i>M. sintangense</i>	Freshwater & brackishwater	Economically important, wild caught along the Mae Klong and Moon rivers in Northeastern Thailand, having good potential for farming
<i>M. amplimanus, M. eriocheirum, M. esculentum, M. hirsutimanus, M. mieni, M. sirindhorn and M. yui</i>	Freshwater	No significant fishery or aquaculture
<i>M. idea, M. equidens, M. lar, M. latidactylus, M. mirabile and M. neglectus</i>	Brackishwater	No significant fishery or aquaculture

Source: Adapted from Uraiwan and Panom, 2004

(New, 1982). Freshwater prawn production had increased from less than 3 tonnes/year in 1976 to 1,200 tonnes in 1982. Production reached a peak of 33,189 tonnes in 2008. Since then there has been a sharp decline in production, particularly because of the introduction of the white shrimp *Litopenaeus vannamei*. However, the value of freshwater prawn has been steadily increasing over the past few years.

About 19 *Macrobrachium* spp belonging to the family *Palaemonidae* and sub-family *Palaemoninae* have been identified and recorded hitherto in Thailand. Among these, five species are considered as economically important for Thailand (Table 1) in Brazil.

## Production

Freshwater prawn production by aquaculture in Thailand is estimated to reach 17,000 tonnes valued THB 5,440 million (USD 157.7 million) in 2016 as per the data provided by DoF. While this means a slight decline in volume by around 1.5% compared to the

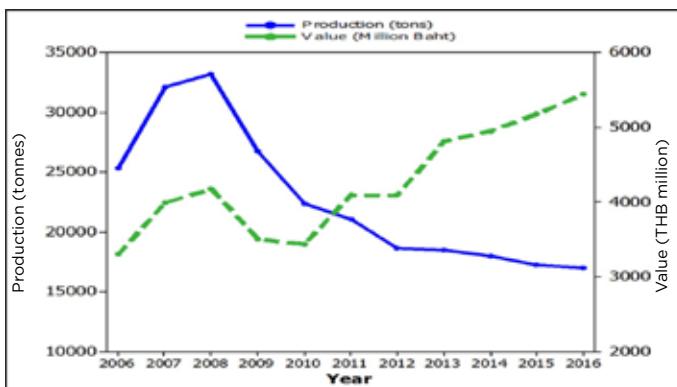


Figure 1. Trends in the production of the freshwater prawn in Thailand

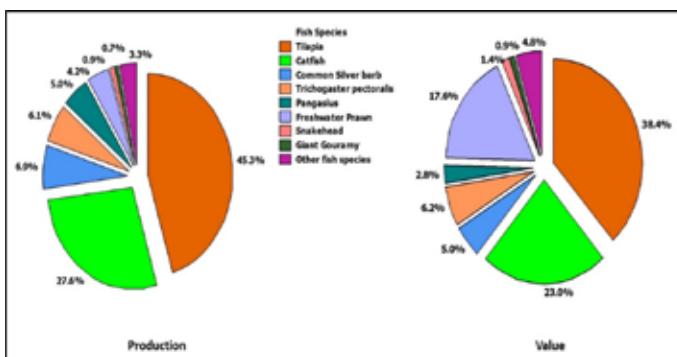


Figure 2. Estimation of freshwater prawn production in comparison with other freshwater species in Thailand in 2016

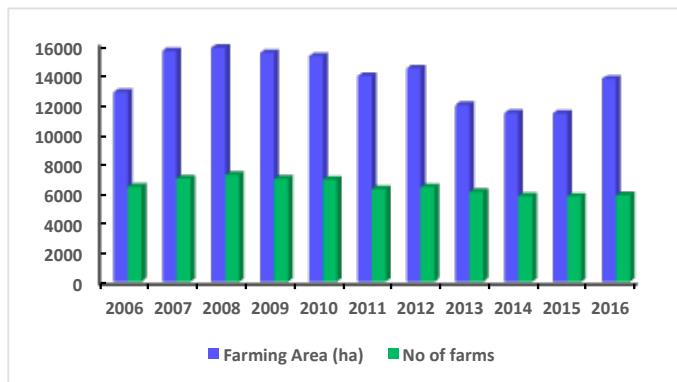


Figure 3. Number of freshwater prawn farms in operation in Thailand in 2016

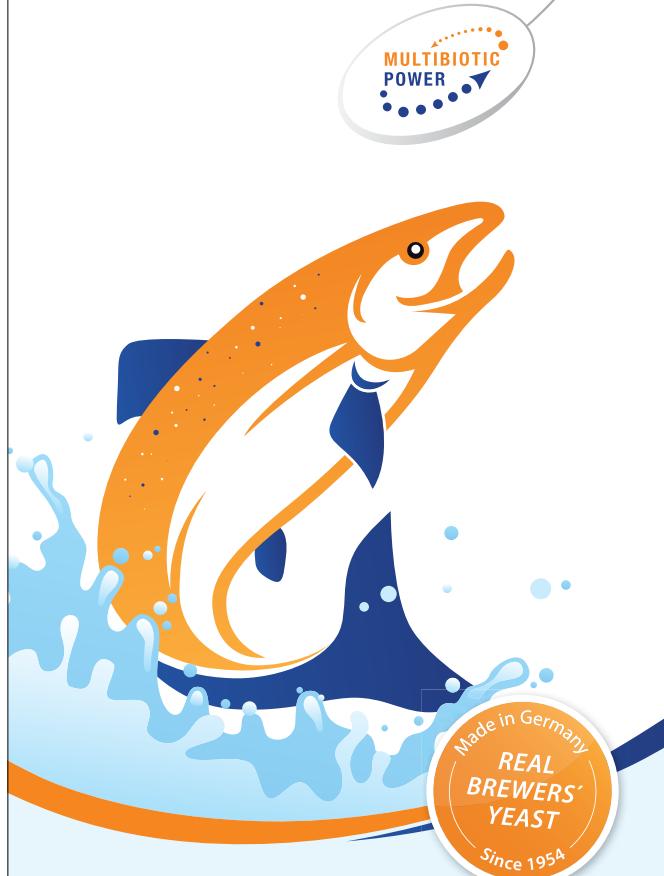
previous year, the value could increase by 8.8%. The contribution of freshwater prawn to the total freshwater fish production of Thailand in 2013 was 4.2%, and the corresponding value share was 17.6% (Figure 2).

Currently, 5,784 freshwater prawn farms are in operation with a total farm area of around 13,600 ha. The number of farms in operation and the total area have also shown a slight decline by 1.5% compared to previous years (Figure 3), presumably due to the conversion to white shrimp farming. A majority of the farms are located in the provinces of Ratchaburi, Suphan Buri and Nakhon Pathom. Over 18% (1,046 farms) out of the 5,784 registered are certified for the Good Aquaculture Practice (GAP) standards by the DoF as of 2016.

## Exports

In the year 2015, 1,557.3 tonnes of freshwater prawn valued at THB 362.8 million were exported. Compared to the previous year, the total exported volume and value decreased by 24.7% and 43.5%, respectively (Table 2). Thailand exports freshwater prawn

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Freshwater prawn hatchery

in the form of frozen, live or chilled, and as value added products. Frozen freshwater prawn was the major form of export, which accounted for almost 99.5% of the total exports in 2015. Frozen prawns were mainly exported to the United States, China and Vietnam, while live or chilled forms to Hong Kong and Japan. Value added products are mainly destined for Japan and Lao PDR (DoF, 2016).

Table 2. The volume and value of exported freshwater prawns from Thailand

Category	2014		2015	
	Volume (tonnes)	Value (THB million)	Volume (tonnes)	Value (THB million)
Frozen	2,046.0	631.9	1,551.0	360.8
Live or chilled	15.6	6.5	4.1	1.3
Processed & flavoured	6.8	3.2	2.2	0.7
Total	2,068.4	641.6	1,557.3	362.8

Source: Department of Fisheries, 2016

Table 3. The total imported freshwater prawn volume and value

Category	2014		2015	
	Volume (tonnes)	Value (THB million)	Volume (tonnes)	Value (THB million)
Frozen	123.6	29.9	270.8	75.2
Live or chilled	25.8	6.3	56.8	13.3
Processed & flavoured	23.7	0.6	-	-
Total	173.1	36.8	327.6	88.5

Source: Department of Fisheries, 2016

## Imports

Thailand imported 327.6 tonnes of freshwater prawns in 2015, valued at THB 85.8 million. Compared to the previous year, this was a significant increase in volume and value by 89.3% and 133.2%, respectively (Table 3). Most of these imports were in the form of frozen (84.4%), and live or chilled (15.6%). The frozen prawns were mainly imported from India (69.3%), Sri Lanka (20.2%) and Bangladesh (10.1%), while live or chilled forms are also from India (47.6%), Sri Lanka (36%) and Myanmar (13.5%) (DoF, 2016). The increasing trend of imported prawns coupled with the declining exports signify the emergence of a well-established domestic market for freshwater prawns in Thailand.

## Market price

Market prices are dependent on size, and the live product fetches a premium price. During the first three months of 2016, the average wholesale market price of live freshwater prawn was THB 529/kg, THB 380/kg and THB 262/kg for 13-14 counts/kg, 15-16 counts/kg and 20 counts/kg, respectively (1 USD = THB 34.5). The average wholesale market price of live freshwater prawn seems to be stable during 2015 and the first quarter of 2016 (DoF, 2016) (Figure 5).

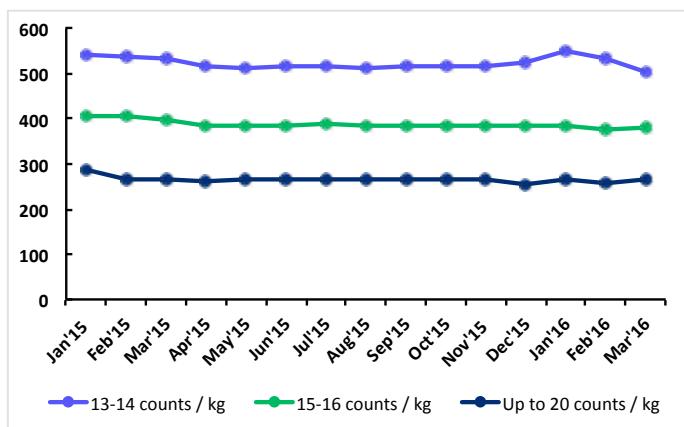


Figure 4. Wholesale prices according to size

## Hatchery systems

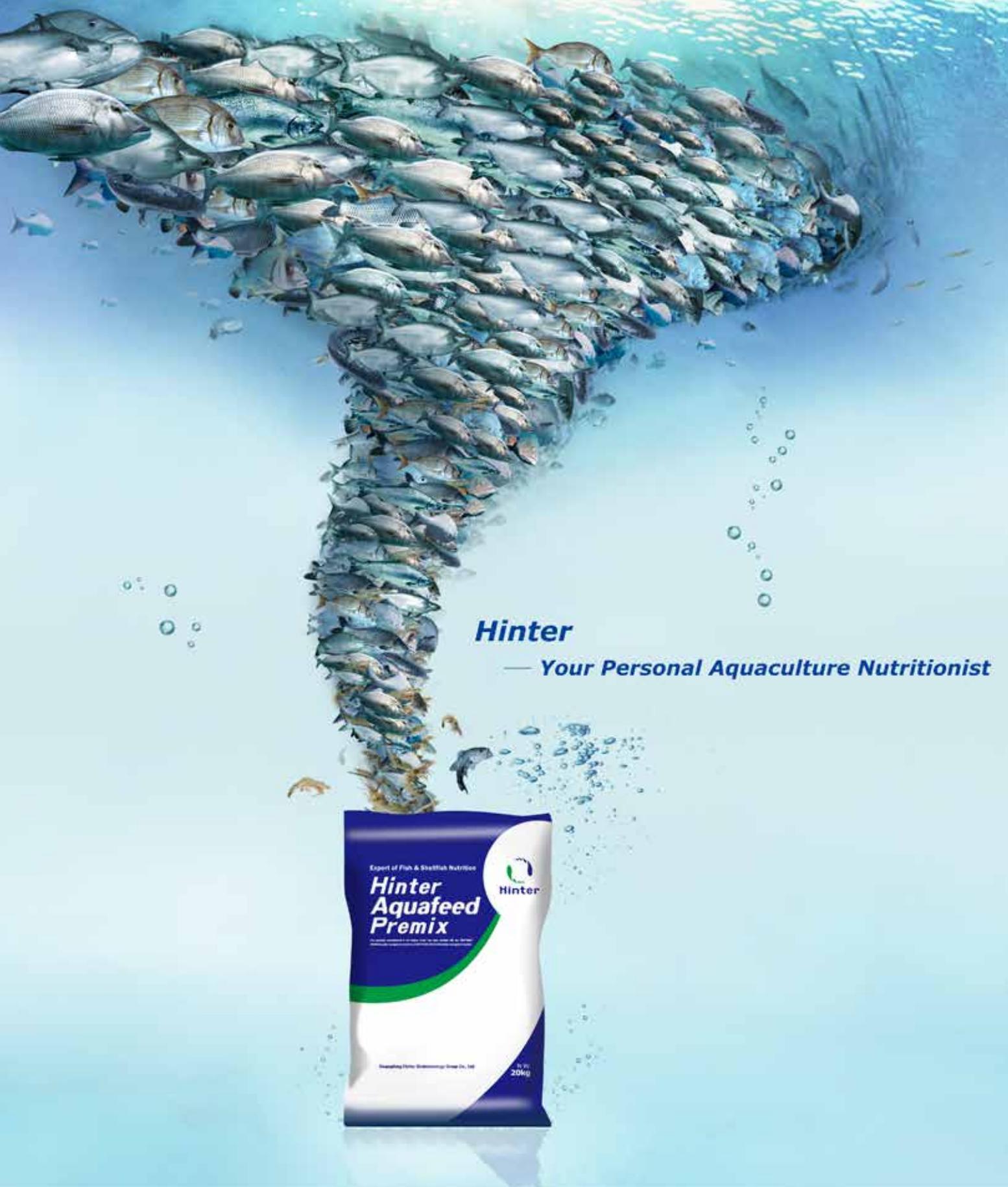
In Thailand, there are two types of freshwater prawn hatcheries; commercial private hatcheries including the private backyard hatcheries developed by DoF staff, and public hatcheries run by DoF. Post larvae (PL) from the DoF hatcheries are produced for stocking in the open waterbodies such as rivers and reservoirs to enhance the culture based fisheries of freshwater prawn as well as for sale to individual farmers. Most of the freshwater prawn hatcheries are located in the central provinces, particularly Suphanburi, Ayutthaya, Pathumthani, Nakhon Pathom and Ratchaburi. The annual production of post larvae produced for aquaculture is about 7,700 million, as estimated by Na-Nakorn & Jintasataporn (2012). This number excludes those produced by DoF for stock enhancement of natural waterbodies.

Several innovative technologies for hatchery production of freshwater prawn have been tried in Thailand. The major hatchery systems include the clear water and green water systems, recirculation system and earthen pond system (Suwannatos, 2003). The clear water system is relatively simple, cost effective and appropriate for backyard hatcheries, while the green water system is more complex and expensive although it is suitable for mass production of post larvae. Recirculation systems are very complex and expensive compared to flow through hatchery production systems and suitable for inland hatcheries located far away from the sea (Uraiwan and Panom, 2004).

The earthen pond system was developed at Phetchaburi Coastal Aquaculture Station of DoF, Thailand. In this system earthen ponds are used to grow freshwater prawn larvae. Larval rearing period is longer in ponds compared to the other systems, but survival rates are high (Tunsutapanich et al., 1994). Some of the major problems faced by freshwater prawn hatcheries in Thailand are poor survival, frequent disease outbreaks, as well as the lack of good quality broodstock and genetically improved strains.

## Grow-out systems

Traditionally, freshwater prawns are cultured in earthen ponds with pond areas ranging from 0.8 – 1.6 ha and water depth of 1 m. In ponds, post larvae are stocked at 75,000 PL/ha to



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Broodstock in tanks



Berried female prawn



Nursery reared prawn

250,000 PL/ha and cultured for 6 – 7 months. While commercial pelleted feed with 30% crude protein are predominantly used, some farmers also supplement with homemade feed that mostly consist of fresh trash fish.

Repeated partial harvests to cull market size prawns are often done until 12 months of the culture period. This method of continuous culture however had problems because of the long grow-out period and associated size variations that negatively affect the price of harvested prawns (Na-Nakorn & Jintasataporn, 2012). All-male prawn farming by batch culture method, in which the post larvae are initially grown for 3 months, followed by the segregation of male and females, was also prevalent in Thailand (Limsuwan and Chantaratchakool, 2004). While the female juveniles are harvested, the males are grown further at low stocking densities for another three months followed by complete drain harvesting. This culture method has been successful in overcoming most of the common issues associated with the traditional practices of prawn farming in Thailand.

## Culture-based fisheries

Culture-based fisheries of freshwater prawn in Thailand dates back to the 1980s when post larvae were stocked into open waterbodies to enhance the natural prawn stocks and their inland fisheries in many parts of the country. Every year approximately 100 million post larvae that are 30 days old and of size 1 cm are stocked at a density of 2,500 PL/ha in natural waterbodies around Thailand. Stocking is done twice every year to coincide with the two major events; first during the Songkran Festival which is the start of rainy season between 12 and 15 April, and the second time on 21 September – the National Fishery Day which marks the end of rainy season (Jutagate and Rattanachai, 2010).

The stocked prawns are harvested at the end of 6 to 8 months when they grow to the size ranging from 100 to 200 g and an average total length of 20 cm. Gillnet, long-lines and specifically designed traps for freshwater prawn are used for harvesting. Even though the recapture rate is poor (often less than 5 %), the economic returns appear to be high and this practice of enhanced fisheries in open water bodies has been found to yield almost 800% profit (Jutagate and Kwangkhang, 2015). Successful enhancement by culture based freshwater prawn fisheries in Pak Mun Reservoir, Rajjaprabha Reservoir, Ubonratana Reservoir, Bangphra Reservoir and the Beung Borapet Natural Lake have been reported.

## Sustainability issues

While prawn farming is currently a mature industry in Thailand, there are several challenges to its sustainability. Occurrence of diseases in hatchery and grow-out farming is a major factor.

These include bacterial diseases, particularly black gill disease, black spot disease, muscle necrosis, Lactococciosis and vibriosis; viral diseases such as white tail disease; protozoan infestation mostly by *Zoothamnium* and *Epistylis* spp.; and some fungal diseases. Other major issues include poor seed quality and low survival rates, size variation which affects the market price, lack of genetically improved varieties, issues with indiscriminate use of chemicals and antibiotics, as well as high input cost particularly that of feed and labour.

The more lucrative white shrimp with shorter culture period and fast growth rate often encourages freshwater prawn farmers to convert their farms for white shrimp. The export market is also affected by the lower meat yield of freshwater prawns compared to shrimp.

## Outlook

The freshwater prawn farming industry in Thailand appears to be very promising particularly because of the fact that it could sustain well despite the increasing dominance of white shrimp. The increasing value of the harvested product is a positive indicator of demand. However, appropriate management measures are necessary to overcome the challenges faced by the prawn industry and sustain its growth.

Genetic improvement programs need to be implemented to produce freshwater prawn strains that have superior performance in terms of fast growth, disease resistance and higher meat yield. Major success seems to have been achieved in this regard by companies such as Charoen Pokphand Foods (CPF). Creation of awareness and better training to farmers to increase adoption of Good Aquaculture Practices (GAPs) are also necessary.



Krishna R Salin



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# Antidumping tariffs for Vietnam's pangasius

By Anh Quynh Nguyen

Vietnam's exports to the US are critically dependent on surrogate country and surrogate value experts.

After the signing of a Bilateral Trade Agreement (BTA) in 2000, trade between Vietnam and USA flourished. High quality Vietnamese goods exported to the US market have benefitted Vietnamese producers as well as US consumers. In the meantime, a litany of US antidumping (AD) cases were filed in order to stymie Vietnamese exports of goods. Notwithstanding, the Vietnamese exports to the USA have largely survived due to the pivotal role played by surrogate value experts.

In AD investigations, Vietnamese goods are alleged to be exported to the US market at less than their fair market value. Since the US Department of Commerce (DOC) treats Vietnam as a non-market economy (NME) country, it rejects all cost and price data reported from Vietnam and determines the fair market value by constructing the cost of goods in a third country, called a surrogate country. As such, the choice of a surrogate country and surrogate value data holds the key to the outcome in the Vietnamese AD proceedings.

## Surrogate country

To illustrate, in the US AD case on pangasius frozen fish fillets from Vietnam, up until the fifth administrative review of the AD Order, Bangladesh was consistently selected as the surrogate country. The fair value based on Bangladesh's surrogate values yielded reasonable AD margins, which was not to the liking of the petitioners, the Catfish Farmers of America (CFA).

Therefore, in the sixth administrative review, CFA argued that the DOC should reject Bangladesh as the surrogate country. In the preliminary results, the DOC preferred the Philippines as the surrogate country, citing its superior fish price data. This switch resulted in very high preliminary AD margins. At this point, Vietnam Association of Seafood Exporters (VASEP)'s surrogate value expert diligently worked in Bangladesh and discovered a new price data source published by the Bangladesh Department of Agricultural Marketing (DAM) to value whole live pangasius fish. He also persuaded DAM to officially release its price data along with several letters to clarify. All of these information was then submitted before the DOC.

In the final results issued in March 2011, a remarkable turnaround happened whereby the DOC switched its surrogate country choice back to Bangladesh, citing the robustness of the DAM data for whole fish. As a result, the AD margins in the sixth review swung back to near zero level and the moribund Vietnamese exports to the US was reinvigorated.

In the preliminary results of the subsequent seventh administrative review, the DOC selected Indonesia as the surrogate country. This time, VASEP's surrogate value expert undertook extensive field trips to Bangladesh and Indonesia. In Bangladesh, he persuaded the government to publish the DAM data online. In Indonesia, he had the then Director General of

Indonesian Aquaculture Statistics (IAS), issue a detailed affidavit, clarifying the IAS data for whole fish.

In the final results issued in March 2012, the Department switched back to Bangladesh. The DOC was persuaded to make this improbable switch solely on the account of new and invaluable information obtained by the surrogate value expert from Bangladesh and Indonesia.

## No future?

A leading Vietnamese exporter, Mr Qui of QVD Aquaculture JSC said, "When the DOC selected the Philippines as the surrogate country in the preliminary results of the sixth review, resulting in very high antidumping duties, we thought that we had no future in the US export market. However, our counsel, GDLSK LLP and its surrogate value specialists, Dharmendra Choudhary, worked tirelessly in Bangladesh over several months to obtain official government pricing data. The DAM fish price data they obtained directly from high levels of the Bangladesh government was instrumental in the selection of Bangladesh as the surrogate country in the final result.

"Based on this surrogate country change, the Department concluded that Vietnamese exporters had not dumped. A similar situation was repeated in the preliminary results of the seventh review, when DOC selected Indonesia as the surrogate country. This time, we felt that the world had come to an end and we had no future in the US market. But based on new information and online DAM data, GDLSK LLP and Mr Choudhary were again able to convince the Department to reverse its surrogate choice from Indonesia to Bangladesh. This change yielded results demonstrating that we had not dumped in US market and again brought down anti-dumping duties to nearly zero level."

Notably, DOC's final results in the sixth and seventh administrative reviews have also been affirmed by the Court of International Trade (CIT). In recent AD proceedings, the DOC has preferred Indonesia over Bangladesh, notwithstanding that Indonesia was not even economically comparable to Vietnam. These decisions are pending litigation. As for future AD proceedings, VASEP's surrogate value expert is engaged in a global research to identify the most suitable surrogate country.

In conclusion, a significant portion of Vietnamese exports to the US market is owed to the excellent work of surrogate value experts.



**Anh Quynh Nguyen** is an international trade expert based in Ho Chi Minh City. He has vast experience in handling anti-dumping cases in Vietnam and several foreign jurisdictions. He is also a frequent speaker at several trade forums. Email: anh.legal@gmail.com

# AD on pangasius from Vietnam



Frozen pangasius fillet

In July 2003, the DOC and ITC first issued antidumping orders for frozen catfish fillet after claims by the Catfish Farmers of America (CFA) of dumping in the US market. The duties ranged from 37% to 64% in 2003. The imposition of bonds to the US Custom and Border Protection followed in 2005 and reduced the US market for Vietnam catfish from 70% to 15-20% of exports. In the following years, there followed several preliminary administrative reviews (POR). The chart below shows trends in rates since 2011 (POR6).

In 2012, POR7 gave zero (for the Vinh Hoan Group, the largest exporter) and several other importers subjected to only USD 0.03/kg tax rate. As catfish exporters enjoyed both volume and value increases on their US shipments, in 2013, new anti-dumping duties were 25 times higher than the previous year's rates. In 2014, DOC imposed duties which were lower than the final result of POR8 but raised them again in 2015. In November 2014, the Vietnamese trade authorities announced that the DOC will continue implementing AD duties for the next five years as revocation of the duties may lead to underselling by 63.88% in the US market (vasep.com.vn).

Administrative reviews	Year of final results	Surrogate country	Anti-dumping duty range for exporters (from VN govt control) in USD/kg	Vietnam wide-rate for exporters (allegedly under VN govt control) in USD/kg
POR6	2011	Bangladesh	0.00 to 0.02	2.11
POR7	2012	Bangladesh	0.00 to 0.03	2.11
POR8	2013	Indonesia	0.19 to 1.34	2.11
POR9	2014	Indonesia	0.03 to 1.20	2.11
POR 10	2015	Indonesia	0.97	2.39
POR 11	2016	Indonesia	0.41 to 0.97	2.39



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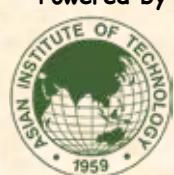
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# From pond to market: Quality shrimp for best prices

By Herve Lucien Brun

It is the wish of every shrimp farm to market the right quality shrimp and achieve higher prices. This two part article guides the farmers through the dos and don'ts at pre- and post-harvest stages and how to keep shrimp in the best condition until at the packing plant.

## Part 1: At the pond side

Quality shrimp is the desire of all shrimp farms, not only for better prices but also to meet customer demands and maintain reputation. However, quality can be interpreted in various ways depending on the markets and consumer cultures. Therefore, it is important to list and clarify with customers the various quality parameter requirements in the most objective and comprehensive way possible. The list and definitions for each parameter must be fully documented and accepted by all parties, to avoid any misunderstanding and commercial implications.

During the decision making process on the quality level, it is important to be aware that even in countries where the local market does not currently seem overly concerned with the quality of the products, consumer expectations may increase or change rapidly in parallel with the rise in their living standards. This is the situation observed in many developing countries for everyday products in general and for shrimp products, in particular. This is happening faster than expected. To address these changes, the producer should be ready to adapt their standard to this increased demand for better quality. It takes time to adapt procedures and train teams at the farm.

The farmer must plan and decide on the quality and shrimp grade to be expected from a grow-out pond prior to harvest. The harvest should not be considered as the final step in the production cycle but a critical stage where the efforts of production teams are optimized. The shrimp farm and packing plant may have invested heavily to harvest and sell very high quality products but unfortunately, bad practices could depreciate the several months of hard work in a few minutes. Two very important factors are time and temperature. Hygiene has an important role not only for food security but also for the quality of the product itself.



Mechanized daytime harvest in New Caledonia. These harvest large amounts of shrimp quickly with a few workers.

## Critical decisions on what and when to harvest

Usually shrimp farmers decide on the harvest date based on the optimal average body weight which in turn depends on market demand and the best price for the selected sizes. However, considering that each market has preferences and requirements, farmers should base their choices not only on the unit prices offered to them but also and especially on net margins (Figure 1). One option is to harvest according to requirements of each market.

Aside from the decision on harvest date, the farmer should then consider the condition of the shrimp. Most farmers carry out preliminary sampling to check on the hardness of the shell and various aspects of shrimp such as colour, flavour, deformities, staining and injuries. In general, the harvest is confirmed if the following criteria are reached:

- Less than 5% of shrimp are molting and less than 10% of shrimp have soft shell,
- Less than 5% of shrimp have defects such as necrosis and dirty gills,
- The desired odour and flavour.

Usually, the information on percent hardness is not good enough when deciding on harvest. The fact that the shrimp stock in a pond has hard shell at the moment of sampling is not enough. It is necessary to determine the intermolt stage. This is to be certain that stress during harvesting will not induce massive molting which would force the farm to stop harvest or carry on but lose quality. Even if the shrimp are not molting, shrimp at intermolt stage will not have a good texture because it contains a lot of water which may induce a loose shell syndrome or a bad yield on cooking.

The determination of the intermolt stage is relatively easy and was described by several authors. (Chan et al, 1988; Loredana Zilli et al, 2003; Jose Renato de Oliveira Cesar et al 2006). The easiest way is to observe the endopodites of the uropods using a binocular microscope with 40X magnification (Figure 2).

The suitable stage for harvest is DO-DI when a very well defined separation is observed between the pigmented tissue zone and the cuticle (Figure 1). Harvest could be decided at stage C but



Draining harvested shrimp prior to weighing them, an example of lost of time during harvest which absolutely must be avoided



Chilling shrimp in crates in Iran. Dipping the 25°C shrimp in this mixture could lower their temperature to 1-2 °C in a few minutes.



Having plenty of ice in a bin does not mean that the shrimp are chilled

the quality would not be optimum because there is still a slight space between the cuticle and the cell matrix which will not give the best texture to the shrimp.

If the harvest starts when the shrimp are at the D2-D3 stage, there is a very high probability that the shrimp will undergo massive molting during harvest. A good method is to collect almost 100 shrimp in various areas of the pond and carry out a binocular observation of the telson to determine the intermolt stage of the population.

To limit stress which could induce molting, the best way is to harvest by draining the pond and collect the shrimp manually or with a harvester when they leave the pond through the exit gate. Harvesting shrimp in the pond using a seine net is a very stressful technique and therefore may result in a significant percentage of soft shrimp.

Once the farm decides to harvest, feeding should be stopped for a few hours (between 4-6 hours but not more) prior to the start of harvesting operations. Several years ago, the practice was to stop feeding at least 48 hours or more before harvesting. This was a mistake as when shrimp are not fed, they dig into the pond sediment in search of food and absorb a large amount of black particles. This gives them an unattractive appearance because the hepatopancreas appears as a black patch.

In Mexico, Brazil, Thailand, Indonesia, Vietnam and Malaysia, buyers take samples to estimate the quality and determine their prices. In the Ecuadorian case, farmers are paid according to

the exact packed quantities per size and per quality. Another advantage of the practice in Ecuador is that the farmers deal directly with the packing plant. There are no middlemen, so the shrimp go directly from the harvest to the packing plant saving a lot of lost time.

This system in Ecuador mandates the farmer to be really concerned on the quality of the final product. The farmers select a packing plant to sell the harvest according to a price list per commercial sizes for HOSO products grade A & B, and HLSO products A&B. The packing plant provides the transportation, ice and all the necessary products for harvest including sodium metabisulfite (if the farmer wants his harvest HOSO or head on shell on processed) and transports the harvested shrimp to the packing plant. The farmer then sends a representative to the packing plant to monitor the packing and he is paid according to the actual packed shrimp per size and quality. This means that the remuneration is dependent on the quality, i.e. whether the product is packed as class A, B and so on. In this case, there is a direct economic interest for the farmers to harvest shrimp of the highest quality possible. This is a very good system; farms are aware of quality and farmers have added incentive to harvest the best product possible.

## Preparations for harvest

Once the harvest date has been decided on, the water level in the pond must be lowered sufficiently to permit a quick and complete harvest. There is no rule on what is the best water depth to start the harvest. This depends of several parameters such as: the biomass in the pond, area of the pond, the speed of the water drainage and the slope of the pond bottom. The farmer must have good knowledge of the pond to determine the optimum water level to initiate harvest. To harvest top quality shrimp, the best way is to collect shrimp in a net at the gate when draining the pond, instead of using a seine net (common in Vietnam) which is stressful for the shrimp.

Ideally a harvest must be concluded within a few hours (4 to 8 according the pond area) to keep the shrimp in good condition. The reduction in water depth must be done carefully so as not to cause stress to shrimp and inevitably induce massive molting. Nevertheless, initiating harvest with a high pond water level could also have dire consequences because the harvest period may be too long which may induce stress and massive molting of the shrimp.

Aside from manual harvesting, today there is mechanical harvesting using different types of harvesters, such as impeller pumps, submersible or not, Archimedes' screw or elevator belt. These harvesters harvest large amounts of shrimp quickly with a few workers. Post harvest operations must be very well organized to avoid loss of time and injury to shrimp due to the accumulation of a huge biomass during the harvesting process.

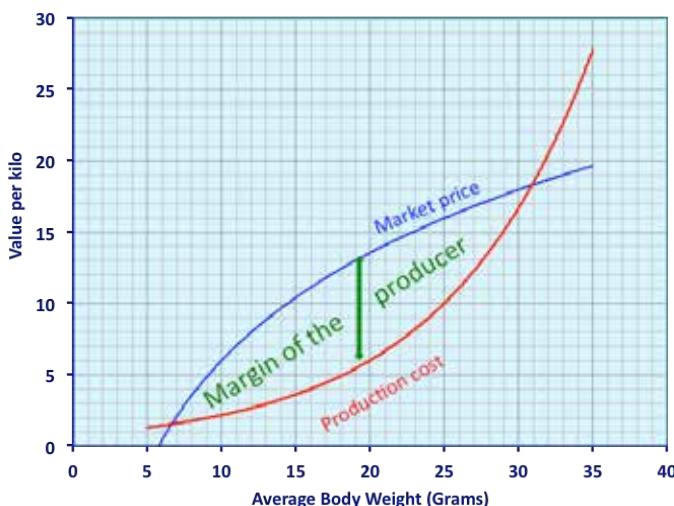


Figure 1. Estimation of the net margins



Mixing SMBS

It is common to harvest at night although early morning is more suitable. The main disadvantage of night harvesting is the lack of control as compared to a day-time harvest. Shrimp can easily be harvested during the day with several precautions. It is most important to shade the post-harvest area by installing a tent to protect the shrimp from the direct impact of the sun. It is also important to avoid time loss between the harvest to chilled transport. An important requirement for daytime harvesting is to have continuous control of the process and on shrimp quality.

Before the start of harvest, the harvesting facilities must be absolutely well organized with respect to the principle of forward movement and avoiding crossing the path of 'clean' and 'dirty' products and/or materials in accordance with HACCP norms. These are important factors and must be considered carefully, particularly when manual harvesting mobilizes many people. It goes without saying that farmers must have absolute control on cleanliness and the sanitary condition of materials before harvesting commences.

Another key requirement for a good harvest is to have well trained staff with experience on the entire harvesting procedure and their individual tasks. It is best if standard operating procedures are written down and that each worker has a copy, reads and understands the procedures. It is also necessary to organize periodic training sessions during which the supervisors check that all employees are familiar with these procedures and understand them perfectly. If necessary, they must be re-explained so that everyone knows the procedures perfectly.

## Harvesting

In harvesting, either manual or mechanized, staff must always keep in mind the importance of both time and temperature. At the same time each task must be done properly.

As soon as they leave the ponds, shrimp must be chilled as soon as possible, usually in a mixture of water and ice. Shrimp are processed and transported in 30 to 40 L crates or in 500 to 1,000 L big bins.

In the case of transfer using crates, chilling is by immersion of perforated crates into tanks containing a mixture of water and ice. Prior to adding shrimp, bins are partially filled with a mixture of ice and water or with slurry ice. The harvested shrimp are dipped in the bin manually from the collecting spot or directly by the harvester.

## Chilling temperature

During this stage, it is critical not to make two mistakes, so as not to compromise on shrimp quality. The temperature of the mixture and of the shrimp must be controlled with a thermometer.

Estimation of the temperature by dipping the hand in the ice mixture should be avoided. Obviously, when the atmospheric temperature is higher than 20°C dipping the hand in a 15°C solution gives a really cold sensation. However, 15°C is not chilling temperature. The temperature at the core of the shrimp must be lowered as quickly as possible to below 2 - 3°C to quickly slow all biochemical degradation processes. Mixing water and ice will only produce a mixture with a temperature of 9 to 15°C. This is not cold enough to drop the shrimp temperature to below 3°C from its temperature of between 20°C and 28°C temperature. Often the inability to control the temperature at the desired range leads inevitably to the 'red head' phenomenon which is bound to bring down product quality.

An easy and inexpensive solution is to add sea salt (sodium chloride) in the mixture of ice and water, so that the mixture of water, ice and salt used to chill the shrimp can reach a temperature lower than -5°C or -8°C. Dipping the 25°C shrimp in this mixture could lower their temperature to 2°C or even 1°C only in a few minutes. Salt is more efficient at lowering temperature and will significantly reduce ice consumption.

For the harvest using crates and tanks on site, it is necessary to follow the progression in temperature change of the bath to attain the desired temperature by adding ice and salt. Here, we need to realize that most of the salt is used when ice melts in the presence of the 'warmer' shrimp. To maintain the same salinity in the cooling tank as at the beginning of the harvest and to keep the desired temperature, the same proportion of salt must be added after each ice addition.

The suitable quantity is to use 600 L of water and ice mixture or slurry ice (50% ice and 50% water) for 400 kg of shrimp. The quantity of salt, which must be added to the slurry, has to be determined empirically by running tests under farm conditions. This quantity will vary in relation with the water composition, the temperature of the harvested shrimp and their size, etc.

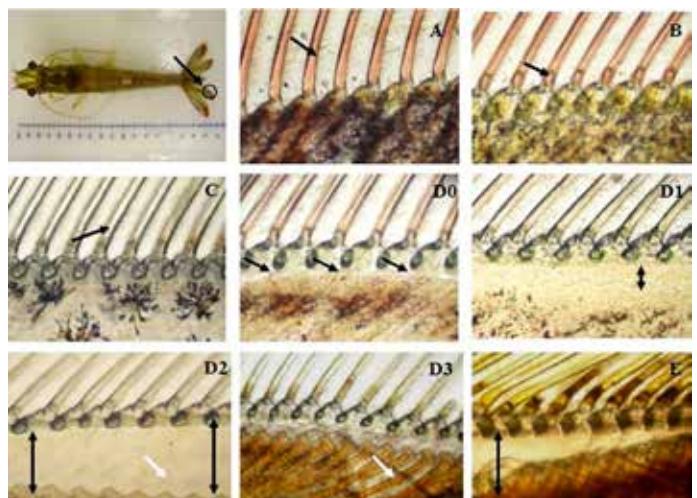


Figure 2. Morphological changes in setogenesis during intermolt cycle (Jose Renato de Oliveira Cesar et al 2006)

The arrow in the top left shrimp picture points the region of the endopodite of the uropod used for setogenesis. From stage A to stage E:

Stage A (early postmolt), arrow points to the setal lumen filled with setal matrix; Stage B (late postmolt), arrow shows retraction of the setal matrix and the beginning of internal cone formation; Stage C (intermolt), arrow reveals empty setal lumen, note chromatophores expanded; Stage D0 (onset of premolt), arrows show the onset of the separation of the cuticle and epidermis; Stage D1 (early premolt), arrow points to the increasing space between the cuticle and epidermis; Stage D2 (intermediate premolt), dark arrows reveal large space between cuticle and epidermis, white arrow shows details of the newly formed setae; Stage D3 (late premolt), arrow features new setae completely formed and folded under the old carapace; Stage E (molt), old carapace shedding revealing the new carapace and new setae.

All images are 40X, from three-month-old animals.

Table 1. Intermolt stages and decision to harvest

Inter molt Stages	Duration	Texture	Decision/ comment
<b>A</b> -Early post-molt	24 hours	Soft	Do not harvest
<b>B</b> Late post-molt	2 days	Semi-hard	Normally not suitable for harvest
<b>C</b> Intermolt	2 days	Semi-hard to hard	Harvest possible
<b>D0-D1</b> Early pre-molt	3 days	Hard	Suitable for harvest
<b>D2-D3</b> Late pre-molt	3-4 days	Hard	Generally not suitable for harvest
<b>E</b> Molt	Few hours	Soft	Do not harvest

For this process to be really efficient, it is absolutely necessary to introduce the shrimp into this mixture until the desired temperature is reached. If the contents of the bin or of the crates are not well mixed, shrimp in contact with chilled water will be cold but shrimp in the centre of the shrimp biomass stay warm even with plenty of ice.

Most of the time, farmers are afraid to shake shrimp vigorously because they erroneously believe that this will damage the shrimp, and shrimp heads will break off. Live shrimp are much stronger than we think. However, they only become fragile when they are dead for some time. Shaking them vigorously when they have just been collected from the pond will not damage them except, of course, if they are crushed against the walls of the tank. This absolutely should not be done. In the crate, the shrimp could be gently mixed by hand until the temperature decreases. In a bin, the best tool to mix is a snow shovel, made from composite plastic material. It is a physically demanding job, requiring manpower working in shifts throughout the entire duration of the harvest.

Once the shrimp is chilled to the right temperature, it is important to drain the bin. Leaving the shrimp in water promotes osmosis. However, if the salinity of the slurry ice is higher than 26 ppt, which is the intracellular salinity of shrimp, the animal loses intracellular water and consequently, weight. On the contrary, if salinity is lower than 26 ppt, the cells of the shrimp would absorb water and so gain weight. Unfortunately, this water will also affect the texture of the flesh and the water in the shrimp will be lost as soon as the shrimp is cooked. In both cases, the consumer will not be pleased and this would negatively impact farm reputation.

The control on the quality and temperature of the shrimp must be carried out regularly throughout the entire harvesting process. This will also help to identify any change of quality such as in the case of massive molting and to decide on whether to stop or continue harvesting. A good routine is to carry out such control for every 500 kg harvested shrimp.

## Antioxidant treatment

Post mortem, oxidation and enzymatic reactions set in immediately, inducing the blackening of the haemolymph, called melanosis. This phenomenon has no impact on taste of the product but the appearance is not pleasing to the consumers (Lucien-Brun, 2005). To prevent melanosis, adding an antioxidant is necessary.

The most common and efficient antioxidant is sodium metabisulfite (SMBS). Nevertheless, the effect of this product is not definitive. The sulfite  $\text{SO}_3^{2-}$  will oxidise to  $\text{SO}_4^{2-}$  but melanosis reoccurs when the transformation to  $\text{SO}_4^{2-}$  is complete. A side

effect is that the accumulation of  $\text{SO}_4^{2-}$  will lower flesh pH, and at certain levels, the taste. However, SMBS is the most efficient product to control melanosis, especially for shrimp intended for the industrial cooking market in Europe. It may have some undesirable side effects, particularly an allergen that can cause severe illness in some people. It is, however, a product widely used in the food industry especially in wine, beer and cider.

For the other markets, there are milder antioxidants such as citrus extract, rosemary extract, 4-hexyl resorcinol etc. Although less efficient, their side effects, if any, require further investigation. It is also important to understand how the antioxidant inhibits the biomechanism producing the melanosis. SMBS has no preservative action to limit development of bacteria.

SMBS is applied following the chilling process. Shrimp is dipped in a solution of SMBS (7 to 8% according to protocols) for 7 to 10 minutes. The problem with this method is how to control the 'real' concentration of the bath as there is dilution with addition of ice. The concentration is also affected by the addition of salt. Most likely, the farm will continue to add SMBS to compensate for this dilution. SMBS is soluble in water at temperatures higher than 25°C but at low temperatures, the crystal salt is in suspension. This can be seen at the end of the harvest when there is a large amount of white sediment (undissolved SMBS) at the bottom of the tank. This was not an issue a few years ago when there was less control by authorities. Today, it is stricter and any batch with excessive residual concentration of SMBS in the flesh will be refused.

The common practice was to add a small quantity of SMBS to bins with the slurry ice and wait for the desired residual concentration. With this method, shrimp has to be kept longer in water. The disadvantage is that flesh texture changes due to osmosis. There is also another disadvantage. As soon as mixing of the shrimp in the bin stops, sedimentation will occur; the ice layer will float to the surface and as the ice melts, it will dilute the SMBS at the surface of the bin. Gradually, a gradient of SMBS concentration occurs in the bin with a higher concentration at the bottom and lower at the surface. The treatment will not be homogeneous for the whole harvest.

The best proposal would be to chill shrimp at the farm during harvest and drain the bin as soon as the temperature of the shrimp reaches below 2 °C. A key factor is to control the temperature. At lower than 2 °C, melanosis development can be stopped for more than 10 hours. Shrimp can then be transported to the packing plant where the SMBS treatment will be applied. In the case of live shrimp, the chilling temperature is below 3°C and chilling should be done immediately after harvest. Shrimp should be kept chilled until they are frozen in order to get a high quality product and avoid the early development of melanosis.

Several years ago, experts believed that for an efficient SMBS treatment, the shrimp should be alive. Later, it was demonstrated that the residual sulphite concentration is much more homogeneous in the flesh when the treated shrimp are dead and chilled (Slattery et al, 1991).

Part 2 of this article in Issue January/February 2017 will cover activities at the processing plant.

**References are available on request**



**Herve Lucien Brun** is an aquaculture consultant based in France. He specialises in shrimp aquaculture: hatchery, farming and post harvest handling and packing and covers shrimp operations around the world. He has worked in Latin America, Asia, Madagascar, Middle East and Oceania for more than 30 years. Email: [hervelb@gmail.com](mailto:hervelb@gmail.com)

# Driving the protein economy

The biennial World Nutrition Forum (WNF) is an opportunity for the global animal production industry to review trends and developments shaping the industry. The theme of WNF 2016, organised by BIOMIN in Vancouver, Canada from 12-15 October, 'Driving the Protein Economy' reflected the need to take stock of current practices, evaluate the current state of scientific understanding and explore the future. WNF 2016 was attended by 800 participants, representing one third of the global animal food production industry. They came from 84 countries from the ruminant, poultry, swine and aquaculture sectors. This year, WNF also celebrated its 12th year; it started in Salzburg, Austria in 2004.

**Dr David Hughes**, Emeritus Professor of Food Marketing, Imperial College, London discussed the challenges and opportunities facing the global food industry. Strong growth is expected for the poultry and beef sectors but volatility in prices will be happening. "In short, businesses should be positive on the future but need to ensure they have the resilience to cope with increasing volatility in international commodity prices."

Hughes said that the developing middle class will bring changes in diet with demand increasing for meat, eggs and dairy but not at the frenetic rates of between 1980 and 2010. He quoted a Rabobank report which gave projections of increases up to 2030 for seafood and beef at 20%, pork, 34% and eggs, 38%. Farmed fish will compensate for wild catch. Contemporary research in UK shows that consumers mainly women and older consumers (more 65 years old) are reducing meat consumption because of health concerns, saving money as well as due to concerns on animal welfare, food safety and the impact on the environment.

"Whatever happens in China will affect global shifts in demand. Pork and seafood dominate consumption and we should keep our eyes on trends. Japan's seafood consumption is declining and by 2030, China's demographics will look like that of present Japan."

Hughes listed the attitudes of Millennials to food according to a survey in the US. This generation skips meals and replaces these with snacks. Plant based protein meals are current and future competition to animal protein.

**Dr Erich Erber**, Biomin's founder and now group Chairman, in his presentation discussed the socio- political and economic challenges since the 18th century to recent economic crises. In terms of demographics, as the baby boomers are leaving the planet, subsequent generations; Gen X, Gen Y, the Millennials and Gen Z will now influence the economy and its future.

"Biomin is in the right industry. The global food industry is growing at 2% per year. The Erber group has the ambitious vision of innovative and sustainable solutions for the safety and quality of feed and food production for the growing world population. Our value proposition for this vision is the 3 S's; science, service and speed," added Erber.

**Adrian Moss**, Focus Business Communications, UK discussed the value and risks of online communities in the social media era. The FoodRisC (Food Risk Communication) is a 4-year research project funded by the European Commission to track perceptions and communications of food risk/benefits across Europe. "Harnessing the new media tools can be an effective way to build and communicate your brand," said Moss. "There is now an explosion of platforms. Online comments remain long after a food crisis is over and the respective company needs to be quick in conveying its message online. We use social media actively to communicate to talk to customers. If we do not get the message on official sites, customers will only see the bad news."

The biennial event includes a two-day scientific conference with mycotoxin and gut performance plenary panels, and species-specific breakout sessions on topics concerning poultry, swine, ruminants, and aquaculture. (The report on the aquaculture session will be in issue January/February 2017).



**“Millennials skips meals and replaces these with snacks, ” - David Hughes**



**“Online comments remain long after a food crisis .. ” - Adrian Moss**

# Biomin aims to be global leader in phytogenics by 2020



At the press conference, Hannes Binder (left), Michael Noonan and Ryan Hines, Communications Manager (middle).

At the press conference prior to WNF 2016, Biomin Managing Director, Dr Hannes Binder outlined the feed additive producer's ambition to become the market leader in the phytogenic feed additive (PFA) segment by 2020. Biomin already ranks among the top three companies in terms of annual PFA sales globally.

"For us, market leadership means having the best science, the most innovative products, prompt customer service and unparalleled technical support. These elements ensure an unmatched customer experience."

This is the ambition and goal for Biomin, currently the global leader in mycotoxin management. "We create value for our customers with phytogenics in all sectors: livestock, ruminant and aquaculture. We see the potential of phytogenics as regulatory policies are determining how we should produce animal proteins. Regulations are having a significant impact on food companies. We also see the shift towards sustainable production methods where there are potential and opportunities for phytogenics," added Binder.

"We maintain close contacts with our customers and address problems they are facing. Phytogenics has a crucial role in their animal production targets; enhancing feed efficiency and increasing profitability of their business amidst changing environments. Proven to improve feed conversion ratios, phytogenics in feeds optimises feed costs; using less resources to produce more."

## Gut health portfolio

Phytogenics is categorised by the degree of complexity and potential from natural single substances (essential oils/extracts) to specialised products (mixtures of essential oils/extracts/plants). According to Michael Noonan, Global Product Line Manager Phytogenics at Biomin, "The market for phytogenics has been showing fast growth in recent years, but it remains fragmented. We feel that there is enough space to take the market leader position. Biomin is ready to make the investment to reach this position in the different regions. We started in the phytogenics field several years ago and now need to accelerate to the next level. Our gut health portfolio is where phytogenics plays an important role. For us the growth has been 24% annually."

Digestarom® was launched in 1989 to support digestion and feed efficiency. In the Digestarom® product portfolio, Biomin provides species-specific phytogenic solutions, as well as multiple-species solutions. "The unique value proposition of this phytogenic product boils down to better feed conversion, deemed 'The Feed Converter'. Improving feed efficiency is a perennial concern among all producers. The benefits are across species. Aquaculture is a growing market," said Noonan.

Feed costs account for anywhere from 50% to 80% of production costs, depending on the livestock species and country. "Particularly in the context of competitive global animal-protein markets, efficiency matters. The feed conversion ratio (FCR) improvement that Digestarom® delivers makes it an indispensable tool for animal performance and profitability," he added.

## Future development

"We have seen significant demand from livestock producers for effective phytogenics for poultry, swine, ruminants and aquaculture species, and the expectation is that this will continue for the foreseeable future. We will leverage our deep knowledge here to advance the science even further and help the industries fully achieve the genetic potential of their animals," said Noonan. Biomin puts considerable investment into scientific research, product development and understanding how Digestarom® works on a molecular level. The Research Center situated in Tulln, Austria and staffed with more than 100 scientists and researchers, conducts a robust in-house R&D programme in cooperation with more than 200 respected laboratories, academic and research institutions worldwide.

Biomin also announced that it is working on a next generation Digestarom® which it plans to launch at VIV Asia in March 2017.

## Phytogenic feed additive market

The global market for botanicals is growing and is valued at USD500 million/year. This market is expected to increase 4 times by 2030. "Looking at numerous scenarios based on feed production trends, evolving consumer demands, changes in livestock production including antibiotic-free and antibiotic reduction strategies, and the growing demand for animal protein products, by 2030 we can expect the PFA market to total between USD 1.7 billion and USD 2 billion," said Noonan.



Participants at WNF 2016 in Vancouver, Canada came from 84 countries covering the ruminant, poultry, swine and aquaculture sectors



**“ Our value proposition for this vision is the 3 S's; science, service and speed, ”**  
- Erich Erber

Roughly 3% of the 1.2 billion tonnes of feed used worldwide today include these plant-based products. PFA inclusion in livestock feed should grow considerably by 2030. This represents growth in global market demand of 8% to 10% per year on average.

“Some of the largest and most sophisticated livestock operations have been early-adopters of phytogenic feed additives, and have continued to use them in light of the benefits that they have achieved,” said Noonan. Antibiotic reduction and

the uptake of novel growth promoters (NGPs) to optimise feed costs, improve efficiency and reduce emissions, should boost demand worldwide for PFAs in the future.

*Pictures credit: Biomin*

## OMICS

In his presentation during the conference, **Dr Franz Waxenecker**, Director of Development, Biomin, Austria said that the future will see the 'Omics' wave. Emerging genomics, transcriptomics, proteomics and metabolomics technologies allow for a deeper insight into the cellular metabolism of live organisms. These next generation sequencing technologies are important to map out the inflammatory processes and mucosal and epithelial integrity to explore the anti-inflammatory gut potential of novel feed additives such as phytogenics. Omics technologies are also used to study antibiotic resistances and effects of novel growth promoters on multi-resistance bacteria.

“With the shift away from antibiotic growth promoters, the focus is turning to holistic approaches on improved farm management and biosecurity. When gut health is compromised by poor nutrition or disease challenges, the animal's immune system kicks in and diverts as much as 10% of nutrients away from growth. Using Omics technologies to study antibiotics, opens up a new way of understanding how feed additives act in the gut and their measurable effect on animal growth and maintenance.”

## Appointments

### New Asia Pacific managing director



BIOMIN has appointed Marc Guinnement as Managing Director Asia Pacific. Marc's career with Biomin began in Singapore in 2007 as Regional Finance Director. He takes over the role from Dr Jan Vanbrabant, who was recently appointed the Director of Executive Board for Operations for ERBER Group, of which Biomin is a part of.

Vanbrabant commented, “I am extremely pleased that Marc has accepted the appointment to lead the

Biomin Asia Pacific business. He has been with the company for over nine years and, during this time, made a tremendous impact. Marc's career to date has afforded him valuable insights into identifying what is required to enable a rapidly-expanding company like Biomin to grow and remain successful. His familiarity with our culture and vision as well as his excellent leadership skills will ensure he also makes a swift impression in the growing region.”

Guinnement said, “We have a strong team of dedicated, hardworking people, and a fantastic culture with deep-set corporate values. I look forward to leading the company to build upon these solid foundations in order to take our business to new heights.”

### New technical managers



Eileen Han



David Bal

Biomin has also appointed two new technical managers to its Asia Pacific team. Eileen Han was appointed as Regional Product Manager - Mycotoxin Risk Management. David Bal recently joined as Regional Technical Manager - Aquaculture.

Both Han and Bal possess over 10 years of experience in the animal health and livestock industry, and hold responsibilities that cover the entire Asia Pacific region. Han will be based at the Asia Pacific headquarters in Singapore. Bal is based in Ho Chi Minh City, Vietnam, where the Biomin has an Aquaculture Center for Applied Nutrition (ACAN). For more information, [www.biomin.net](http://www.biomin.net)

# 2016 New Product Innovation Leadership Award

The Waterbase Limited, a pioneer in India's aquaculture Industry with a focus on driving improvement in shrimp feed manufacturing, farm practices and shrimp processing, has been awarded the "2016 India Shrimp Feed Industry New Product Innovation Leadership Award" by Frost & Sullivan a leading global strategy consulting company.

Frost & Sullivan's Shrimp Feed New Product Innovation Leadership Awards identifies companies that have demonstrated measured excellence in new, innovative products or product lines within their industry. The award ceremony attended by corporate leaders saw The Waterbase Limited take centre stage to receive the award.

"Given its strategic intent to consistently focus on improved end-user experience and enjoy strong consumer acceptance, The Waterbase Limited promises to be a massive technology contributor to the aquaculture industry in India. The Waterbase Limited's advanced pelleting technology equipment coupled with its implementation of stringent quality assurance protocols to ensure that feed quality is maintained to the assured specifications renders an unrivalled competitive edge to the company", said Shruti Jadhav Manager - Best Practice Research. MENASA, Frost & Sullivan

The award was judged on the basis of several parameters, which involved in-depth primary interviews with various industry participants and secondary research conducted by Frost & Sullivan analysts. To incorporate the end-user perspective, the data was then presented to an elite panel of jury members comprising some of the most prominent CXOs from the industry. Frost & Sullivan then presented the award to the company that achieved the number one industry rank.



Ramakanth V Akula (second left) and The Waterbase team receiving the Award.

Speaking on the occasion, Ramakanth V Akula, CEO, The Waterbase Limited, said, "We are honoured and privileged to be recipients of this award from Frost & Sullivan. Our enterprise business growth trajectory is well ahead of industry standards and we are very grateful for this recognition. We strongly believe in being in sync with our customers and offering services which meet their needs and demands. This win clearly shows our strong passion towards aquaculture advancements."

With the introduction of its new generation product, Bay White Enriched, which won the 2016 New Product Innovation leadership award, The Waterbase Limited is promoting sustainable aquaculture development in conjunction with long-term eco-friendly practices. The company plans to double the dealer and farmers network by 100% over the next two to three years. Its processing facilities are FDA and BAP approved, EU Listed and HACCP certified. The company is in the process of setting up a vannamei shrimp hatchery. The company has market presence in the coastal states and is currently focussed on geographical expansion. More information: [www.waterbaseindia.com](http://www.waterbaseindia.com)

## Broad patent cross-licensing agreement

Neptune Technologies & Bioressources Inc. ("Neptune") and Aker BioMarine ("Aker") have jointly announced that they have entered into a broad patent cross-licensing agreement, thus ending all outstanding litigation between both companies. Key elements of the settlement and licensing agreement include an agreement that ends all outstanding litigation, with continued access for Aker to Neptune's composition patents, in consideration of a royalty payment of USD10 million payable over a period of 15 months. Neptune acquires rights to use Aker's select krill oil-related patent portfolio in consideration of a royalty payment of USD 4 million payable over the same 15-month period.

"We are pleased that through this agreement the integrity of each company's Intellectual Property (IP) is recognised and puts an end to all legal challenges. Our collective focus can now

be even more directed to the growth and development of the omega-3 krill oil market," said Jim Hamilton, President and CEO of Neptune.

"Recognition and protection of intellectual property is critical to continue to invest in innovation and R&D, which is key to driving growth in the krill oil industry. This joint patent agreement signifies the importance of respecting IP, further strengthening our position as the leading innovators in the global krill oil market," commented Matts Johansen, CEO, Aker BioMarine.

This agreement should create a lasting patent peace, allowing both companies to focus on growth and business value creation. For more information: [www.akerbiomarine.com/](http://www.akerbiomarine.com/) [www.neptunecorp.com](http://www.neptunecorp.com)



# World Aquaculture 2017

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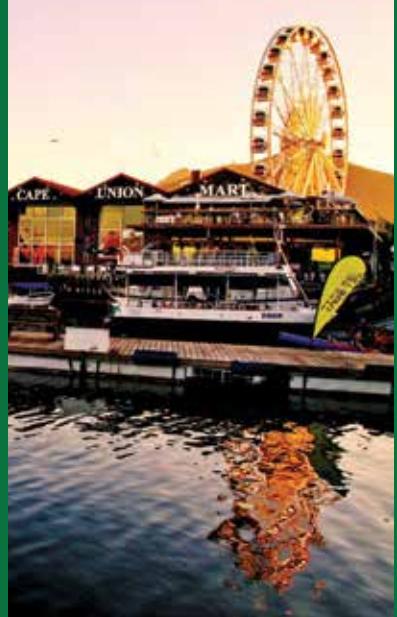
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# A new snakehead breeding project



Xinpin Zhu signed on behalf of PRFRI of Chinese Academy of Fishery Science (left) and Xiewu Jiang on behalf of the Haid Group.

On July 22, 2016, a contract signing ceremony for an all male hybrid snakehead breeding research and extension project between Haid Group and the Pearl River Fisheries Research Institute (PRFRI) was held in the Danzao breeding base of Holdone Aquatic Breeding Company, the subsidiary company of Haid Group. Xiewu Jiang, General Manager of Aquatic Breeding Division and Guangdong Hinter Biotechnology Group signed on behalf of the Haid Group. Both are subsidiary companies of Haid Group. PRFRI was represented by its Vice Director, Xinpin Zhu. The project focuses on selection of snakehead broodstock, breeding of all male hybrid snakehead fish fry and technical extension of new snakehead varieties.

In the mixed-sex culture of snakehead, differences in size and growth rates of male and female have led to high variations in size at harvest and low economic value. However, in the all-male culture, all male individuals achieve higher somatic growth rate and avoid high energy losses associated with gonadal development and reproduction. They also show low variations in size at harvest and reduce the risk of environment impact resulting from escapes of exotic species. This is assuming 100% male progenies.

Super male parents developed using molecular techniques, have the ability to produce all male progeny in snakehead. At present, the group has bred two all male hybrid snakehead. The first hybrid was *Channa maculata* (♀) and *C. argus* (♂) the most common cultured varieties in Guangdong Province, China. Another reciprocal hybrid snakehead *C. argus* (♀) and *C. maculata* (♂) is bred for overwinter farming in South China.

This all-male hybrid snakehead project was planned in 2009 but formally activated in 2011, is in the experimental stage. It will enter into commercial production to market in early 2018. Haid aims to improve techniques for all male hybrid snakehead farming using actual farming conditions in its R&D demonstration ponds. Meanwhile, a professional technical team will be set up to provide integrated solutions for farming to create real value for farmers.

The group is using its many years of experience in aquatic breeding and improved varieties to carry out extension work on breeding technology for customers of Hinter in Southeast Asia. For more information, Email susaquatic@gmail.com(Su Shi, Guangzhou Hinter Biotechnology Group Co., Ltd)

## New location for Aquativ local team in Vietnam

AQUATIV, part of DIANA, member of Symrise group has been present in the South East Asian market for more than 10 years. Its representative office in Vietnam, opened in 2011 and recently moved to a new location in Ho Chi Min City. The opening ceremony took place on September 12, 2016.

"Our office in Vietnam prolongs our Samutsakhon production unit in Thailand. This local deployment and anchorage demonstrates our commitment to actively serve our Vietnamese customers. It is the logic implementation of our company tagline 'The closer-the better', said Paul Seguin, Asia Sales Director.

Aquativ supplies aquafeed manufacturers with competitive and local ingredients in liquids and powders that enhance fish and shrimp feed performances and optimize farm results.

"The strong foothold in Vietnam allows Aquativ to deliver specific solutions and services adapted to the local conditions and species. This local presence facilitates the supply of unique ingredients sourced and produced in our plants in Latin America and Thailand," added Seguin.



Thi Minh Tam Nguyen, Vietnam Office Supervisor and Dung Tien Nguyen, Technical Sales Manager (right).

No less than four new ingredients have been registered locally to meet demands from the industry. Besides secured supply, Aquativ can offer a large extended portfolio of innovative and sustainable solutions that are supported by the presence of its local experts. For more information, [www.aquativ-diana.com](http://www.aquativ-diana.com), [dnguyen@diana-aqua.com](mailto:dnguyen@diana-aqua.com)

# Start of production in Antwerp

At its site in Antwerp (Belgium), Evonik has inaugurated the world's first plant for the production of a new source of methionine specifically designed for shrimp and other crustaceans. The product, sold under the name AQUAVI® Met-Met, is an aquaculture feed additive to make shrimp farming more efficient and sustainable. The plant's modular design allows for increasing production capacity in order to meet customer demand.

"With AQUAVI® Met-Met, we are launching another product for healthy and sustainable animal nutrition. Based on our scientific and technological expertise, we have developed a product innovation that we can now offer to our customers worldwide," said Dr Reiner Beste, Chairman of the Board of Management of Evonik Nutrition & Care GmbH, at the inauguration ceremony. Since shrimp farming is concentrated in warmer seas close to the equator, the main markets for AQUAVI® Met-Met are located in Asia as well as in South and Central America. Evonik is already beginning to supply customers from these regions with the new product as the plant ramps up to capacity.

"We are pleased that Evonik built the first production facility for AQUAVI® Met-Met in Antwerp," said Frank Daman, Evonik site manager in Antwerp. "The new plant affirms our site's key position in Evonik's global production network for methionine." AQUAVI® Met-Met is produced in conjunction with an existing methionine plant in a fully backward-integrated process. The environmentally friendly production process is water-based and uses no organic solvents. The Antwerp site with its harbour is an ideal hub for shipping the product to customers worldwide.



Opening Moment on plant in Antwerp (from left) Bart De Wever, Mayor of the City of Antwerp, Frank Daman, General Manager Evonik Antwerp, Gaëlle Husser, Product Manager AQUAVI® Met-Met, Evonik Nutrition & Care and Dr Reiner Beste, Chairman of the Board of Management, Evonik Nutrition & Care.

AQUAVI® Met-Met, a dipeptide made up of two DL-methionine molecules, achieves the same weight increase in shrimp and crustaceans as conventional methionine sources, but uses only half the active substance. This is mainly due to the fact that the dipeptide must be enzymatically broken down in the digestive system of the shrimp and is therefore available for protein synthesis at the right time. That in turn means that a higher share can be processed. In addition, the product is considerably less water-soluble than other methionine sources and therefore does not leach out of feed as quickly. For more information: [www.evonik.com](http://www.evonik.com)

## Acquisition of Vaki Aquaculture Systems

On November 2, US based Pentair Aquatic Eco-Systems, Inc. (PAES) announced that it has acquired Vaki Aquaculture Systems Ltd., a leading aquaculture equipment manufacturer based in Kópavogur, Iceland. The addition of Vaki is expected to strengthen Pentair Aquatic Eco-Systems' business by broadening its range of systems, products and services in the growing aquaculture market space.

Vaki is focused on the design and manufacture of fish handling, counting and grading solutions for a variety of aquaculture applications. Vaki also develops and offers cutting-edge technology for biomass estimation in aquaculture systems; providing users with accurate information to maximise operational efficiencies, facilitate resource planning and optimise decision-making. Vaki products have widespread global adoption, with utilisation in more than 50 countries.

"As the aquaculture industry continues to experience rapid growth, the addition of Vaki Aquaculture Systems complements our ability to meet the increasing market demand for advanced

solutions, technology and equipment. Vaki also helps to strengthen our position as a comprehensive single source provider," said Karl Frykman, President of Pentair's Aquatic Systems Business Unit.

Pentair Water Quality Systems is a leader in water solutions. Its equipment and solutions are found in swimming pools and spas, aquaculture farms, laboratories, water purification and sanitation systems, foodservice operations, and in other applications. It offers design and consulting services. These advanced water technologies are used across a wide number of industries including industrial, residential, commercial, municipal, aquaponics, aquatic life support systems, irrigation and flood control and wastewater. The company is the largest source of aquatic products and systems worldwide.

PAES offers solutions and expertise to improve growing conditions in any environment from recirculating aquaculture systems to improving water conditions in pens. More information: [www.PentairAES.com](http://www.PentairAES.com)

# Contribution to Aquaculture Chennai 2016



Stéphane Ralite

Lallemand Animal Nutrition, a primary producer and major supplier of probiotics and yeast derivatives, participated at Aquaculture Chennai 2016 held from August 23-24, 2016, in Chennai, India, as a platinum sponsor and invited speaker. The theme of the international conference was 'Reflect & Restore Tempo of Vannamei Shrimp Farming in India'. It was jointly organised by the Asia Pacific Chapter, World Aquaculture Society and Tamilnadu Fisheries University.

Lallemand Animal Nutrition was represented by Goud Dhanunjaya, Technical Sales Manager - South Asia, and Stéphane Ralite, Aquaculture Product Manager. Ralite delivered

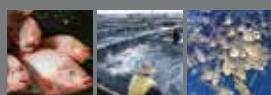
a talk on 'A novel approach in securing aquaculture production with a synergistic association of yeast extracts,' which highlighted challenges of shrimp farm management and the development of innovative microbial based solutions. At a time of increasing health and pathogen challenges in shrimp farming, this presentation attracted much interest from the audience.

Today, shrimp farming is becoming increasingly complex. It is challenged by pathologies such as EMS, EHP and white faeces syndrome, while environmental pressure and food demand are increasing. Ralite compares pond management to a three-legged stool, "It results from a delicate balance between shrimp physiology (immunity, nutrition, oxidative status and more), water and feed management (microbial and nutrients balance) and pathogen pressure." He focused the discussion on the microbial management of the pond, possible through biocontrol or bioremediation strategies, and gut microbial management through the use of beneficial bacteria (probiotics) in feed.

Scientists at Lallemand have developed a synergistic alliance of specific strains of inactivated yeast called YANG. This new solution was shown to contribute to improving binding capacities, immune modulation and mucus production in fish. Regarding shrimp, scientists conducted *in vivo* trials in Vietnam during an AHPND (EMS) challenge.

"Shrimp survival was significantly improved thanks to the yeast derivative. It thus appears that the use of specific microbial solutions in feed, together with environmental management practices and microbial control of the water and pond bottom, can participate to optimize shrimp performance and health during pathogen challenge through the management of microbial ecosystems." added Ralite. For more information: [www.lallemandanimalnutrition.com](http://www.lallemandanimalnutrition.com)

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# Protein for sustainable aqua feeds

By early 2017, US based biotech company Calysta will be putting into the market, its novel FeedKind® protein, a new feed ingredient to reduce the aquaculture industry's use of fish meal. In September, it had the opening ceremony for its market introduction facility in UK, built and operated in partnership with the Centre for Process Innovation (CPI), Teesside. This facility will incorporate Calysta's proprietary, best-in-class gas fermentation technology. CPI staff at the Centre of Excellence will then gain experience in operating the facility under Calysta's supervision. The first output of 6-10kg/hr of FeedKind® Aqua protein will preclude a larger commercial facility in the US in partnership with Cargill, USA scheduled for 2018.

FeedKind® Aqua is produced via methane gas fermentation and is proposed as a traceable, sustainable and cost effective alternative for fish meal. The target initial markets are the global salmon and shrimp farming industries. By replacing fish meal with a nutritious naturally occurring protein, the aquaculture industry can reduce its impact on the environment and on wild fisheries, while offering consumers a more sustainable product. This single cell protein, has been approved for sale in the European Union.

During the opening of this historic facility to an audience of leading UK seafood retailers, global feed and fish producers, scientists, investors and government representatives in the north of England, Dr Alan Shaw, Calysta President and CEO, said, "Calysta's business priority is based on food security. The development of FeedKind® is not only from a technology perspective but economical. We have a gold standard as replacement for fish meal with guaranteed traceability."

The location at Teesside has an economic advantage with its closeness to a supply of methane gas, a by-product from neighbouring industries. The new facility is expected to boost the economy of North East England and support UK's goal to become a world leader in the emerging industrial biotechnology sector by generating game changing technology in gas fermentation and synergistic applications. CPI has an array of skills to help companies move from idea to commercialisation. Calysta's facility will create 40 positions in science, engineering and operations, along with indirect jobs benefits in construction and the supply chain for the region.

The ingredient has an amino acid profile superior to plant sources in terms of lysine, methionine and cysteine, tryptophan, threonine and isoleucine. Lysine is lower than in herring fish meal but levels of tryptophan, threonine and isoleucine are comparatively higher. The level of methionine and cysteine at more than 20 g/kg is relatively close to the amount in herring and white fish meal and is double that in soy protein concentrate. There are possibilities of reducing the moisture content for a 94% dry product, which will depend on the drying process.

Josh Silverman, founder and Chief Product and Innovation Officer, Calysta Inc. said, "The next generation range of protein can be refined to fit the needs for each aquaculture species. The current product is 71% crude protein, 10% fat comprising of short chain fatty acids and 10% NFE. We can elevate omega 3 fatty acids and individual amino acids."



Alan Shaw and the facility in the background

## Views on the need for sustainable feed ingredients

The first focus in the marketing of FeedKind® Aqua protein is the global salmon farming industry. Calysta has conducted feed trials for the salmonids where growth rates were close to 1.6% per day and confirmed its role in the prevention of soybean meal induced enteritis. It is also researching into potential anti-viral and anti-parasitic effects of feeding the protein source.

Led by Jane Bryne, Editor at [feednavigator.com](http://feednavigator.com), a panel of several industry leaders gave their perspectives on the future challenges in fish farming and how this new product fits into their needs for a sustainable feed ingredient. Dr Paul Morris, Director, Nutrition and Formulation at Marine Harvest, the largest producer of salmon in the world, said that although fish meal meets the specifications for fatty acids in salmon feeds, supply is static. Morris needs to look beyond fish meal. Marine Harvest produces 300,000 tonnes of feed at its plant in Norway and finding alternatives to fish meal is on its research agenda. The need is for a supply for a dry raw material which is available and delivered every month and on time. Although, there is room in feed formulations to replace fish meal, replacement requires more than just for protein. For salmon feeds, EPA and DHA are huge issues.

From a retailer's perspective, Ally Dingwall, Aquaculture and Fisheries Manager at Sainsbury's, a leading UK supermarket chain said that 50% of the seafood it sells is farmed and the future growth in supplies will continue to be from aquaculture. When making decisions on its seafood purchasing, the source of fish supply must meet Sainsbury's business values; deliver good value to the customers, be nutritious and be sustainable. Sainsbury's consumers expect the retailer to be responsible and have fully traceable and sustainable seafood on their shelves. In UK, the food standard is two portions of fish, one of which has to be oily fish. When this recommended portion is reached, UK will need an annual supply of 750,000 tonnes of fish.

AquaSpark, an investor in Calysta is an aquaculture investment company with a long term outlook on sustainable feeding and farming technology in aquaculture. Its investments are multi species and with a large geographical spread. Mike Velings, Founder and Managing Partner, AquaSpark said that for the demand of 140 million tonnes of fish, the need is calculated at 300 million tonnes of fish feeds. The use of plant based feed ingredients is a road block in industry development. Soybean meal production although able to supply the plant meal needs of industry uses a large portion of agriculture land and the industry need protein supplies from non-animal and non-plant based sources.



Paul Morris, Marine Harvest presented his views on the need for a sustainable alternative to fish meal. Ally Dingwall (seated) said that Sainsbury's consumers expect the retailer to be responsible and have fully traceable and sustainable seafood on their shelves.

Silverman wants to bring more to the table and not just an ingredient replacing fish meal. He wants to see a pull effect and customers asking for FeedKind® Aqua in the salmon diet instead of just a standard diet. Health benefits are important for customers. As a single cell protein produced using a proprietary fermentation process, it is traceable by the unique carbon marker characteristics.

Based in Menlo Park, California and established in 2011, Calysta brings together experts in biotechnology and product innovation to focus on commercialising disruptive, sustainable technologies. In February 2016 Calysta announced USD 30 million in Series C funding including an investment from Cargill and AquaSpark. To date, the company has raised approximately USD 50 million.



Ribbon cutting by Nigel Perry, CEO, CPI, Anna Turley MP and Alan Shaw.

A photograph of an aquaculture farm with several floating cages in a body of water. Overlaid on the image is the GlobalG.A.P. logo, which is a stylized 'G' composed of various icons, and the text 'GLOBALG.A.P.'.

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# Sustainable aquaculture growth lies in new feed ingredients



At AE2016, Walter Rakitsky, TerraVia, the company that has developed the new algae ingredient, AlgaPrime™ DHA, now utilised by BioMar (left) with Hans Halle-Knutzen, Sales and Marketing Director, BioMar Norway and Vidar Gundersen.

According to BioMar, sustainable growth of aquaculture lies in utilising new feed ingredients that match requirements for a good and healthy growth of the fish and for a stable, high quality of the final product. Exploiting microalgae as a feed ingredient can match these requirements.

BioMar was Gold Sponsor of the Aquaculture Europe conference. The overall theme of the 2016-conference being 'Food for Thought', Vidar Gundersen, Global Sustainability Director of the BioMar Group, expressed his thoughts on how to proceed for developing sustainable aquaculture products.

Gundersen drew attention to the future development of global aquaculture. "Aquaculture is said to become an ever more important source of proteins for human consumption. We must secure that it's growth is sustainable and that the final products provided by our industry, the fish and shrimp that we eat, stay as sound and healthy as they are. For instance by providing a predictable amount of the marine fatty acids in fatty fish species like salmon. Omega-3 fatty acids are proven to have positive health impact on humans and this adds to the a good reputation of the fish as a sound source of proteins for humans."

According to Gundersen it is high time for the aquaculture industry to focus on maintaining or even enhancing the omega-3 fatty acid content in farmed salmon and other farmed fish species. "We need to take care of both the nutritional requirements of the fish and the reputation of farmed fish."

"The omega-3 fatty acids used to be provided to the salmon by the fish oil included in the feed. However, as the global demand for fish oil increases, fish oil suitable for the use in aquafeeds are becoming a scarce raw material. The fish oil that is utilised in the production of aquafeeds nowadays is sourced in a sustainable and responsible way, but the supply is limited," Gundersen added.

## Marine fatty acids from microalgae

Earlier this year, the BioMar Group launched a fish feed in the Norwegian market, containing marine fatty acids from microalgae. Working with global sustainability concerns on a daily basis, Gundersen is thrilled by the fact that today it is possible to utilize microalgae that produce omega-3. "I have no doubt, the future growth of aquaculture lies in exploiting algae as a feed ingredient. At the time being, I consider this particular product to be the most sustainable raw material available for the production of salmon feed," said Gundersen. "BioMar does not intend to discontinue the use of fish oil in its feeds. Utilising marine fatty acids from microalgae simply gives us the possibility to increase or maintain the content of omega-3 in feeds."

## A crucial discussion

There is an increasing public concern regarding marine omega-3 levels in farmed salmon. The question is if the content will decrease even more if fish oil availability is endangered. Gundersen said, "I must say that taking up this discussion is crucial. We simply need to find new sources of the right omega-3 fatty acids, EPA and DHA. Farmed salmon is more than just proteins, and it is highly important to secure the fatty acid content of the fish."

More information: [vidar.gundersen@biomar.no](mailto:vidar.gundersen@biomar.no) (Vidar Gundersen)/  
[hans.halle-knutzen@biomar.no](mailto:hans.halle-knutzen@biomar.no) (Hans Halle Knutzen).



## NEXT ISSUE

**January/February 2017**

**Issue focus: Microbial Management**

**Industry review: Marine Shrimp**

**Feed/Production Technology:** Fish Meal & Marine Protein Replacements/  
Feed Enzymes/ SPF, SPT, SPR shrimp farming.

**Show preview:** VIV ASIA 2017, March 15-17, Bangkok, Thailand

**Deadlines:** Articles – November 15, Adverts – November 23

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## Most successful event to date



Once again, Aquaculture Europe 2016 confirms its position as the European aquaculture event. Aquaculture Europe 2016, held in Edinburgh during the 40th anniversary of the European Aquaculture Society (EAS), was the most successful Aquaculture Europe event to date, with 1,700 participants from 65 countries in attendance.

It was organised by EAS in cooperation with the Marine Alliance for Science and Technology for Scotland (MASTS) and generously supported by Marine Scotland, part of the Scottish Government, AE2016 Gold Sponsor BioMar, Silver Sponsor DSM, session sponsors, President Reception sponsors and media partners. AE2016 was held at the Edinburgh International Conference Centre from September 20-23, 2016. Attendance surpassed previous AE event participation in 2014 San Sebastian (1,450), 2015 Rotterdam (1,087) and 2011 Rhodes (1,029).

The event opened with welcome addresses from EAS President 2014-2016 Sachi Kaushik, Sigi Gruber, Head of the Marine Resources Unit in the Directorate General for Research and Innovation of the European Commission, and the Scottish Government Cabinet Secretary for Rural Economy and Connectivity, Fergus Ewing. Kaushik presented the EAS Award for Distinguished Service to Selina Stead, Professor of Marine Governance and Environmental Science at Newcastle University and Chair of the AE2016 Steering Committee, for her long-term commitment and contributions to the objectives and activities of the Society.

The theme of the event was "Food for Thought" and this was addressed by three plenary sessions that paved the way for the 32 parallel sessions of oral and poster presentations derived from a record submission of 714 abstracts. The AE2016 programme co-chairs Alicia Estevez (IRTA, Spain) and Andrew Davie (Stirling, UK) orchestrated the session chairs that often had difficult choices in selecting abstracts for their sessions.

The first day kicked off with Scottish pupils' perspectives on aquaculture, with a showcase plenary organised as part of the Seafood in Schools initiative. The Seafood in Schools project has worked with pupils from Glen Urquhart and Balfron high schools to help them gain in-depth knowledge about the Scottish aquaculture industry. Their findings were presented by pupils in "Showcase Scottish Aquaculture" to AE2016 delegates and they had to answer questions from the comperes Nicki Holmyard and John Joyce.

In addition to these visual presentations, pupils from each school delighted the audience with their mastery of cookery skills, preparing and cooking a recipe dish of their own devising using Scottish aquaculture species. The seafood dishes were judged by an international panel (EAS incoming President Bjorn Myrseth, food writer and columnist Cate Devine and Fraser Dryburgh of the Scottish Government Food, Drink and Industry

Growth Team) and supervised by Chef Alan Frost. The winning pupils from Glen Urquhart High School - were crowned "Young Scottish aquaculture chefs of the year"!

The cooking was followed by a celebration of the 40 years of EAS, featuring a film made by Yves Harache and the EAS secretariat. Sixteen of the 19 EAS Past Presidents were asked to come onstage and were each presented with a commemorative plaque and an EAS 40 cooking apron.

The plenary session on day two was a retailer perspective on the future of fish by Ally Dingwall, Aquaculture and Fisheries Manager at Sainsbury's Supermarkets Ltd. He provided an excellent insight into Sainsbury's current position in relation to farmed fish sales and challenges and opportunities in delivering sustainable growth in consumption, both in terms of production and the consumer, to fill the gap between FAO predictions on consumption needs and current supply. The future growth will be from farmed fish. In its supermarkets, 49.7% of its seafood products are farmed and the leading fish is farmed salmon. "This is because there is an assurance on quality and safety," said Dingwall.

"Food safety and sustainable is a 'given' at Sainsbury's and we will not buy non sustainable fish. We give customers what they want and answer their questions. We also encourage customers to broaden their seafood repertoire and encourage them to eat more fish. Sainsbury's has developed responsibly sourced farmed salmon with a message that it provides long chain fatty acids, DHA and EPA. Customers trust retailers to source on their behalf. The expectation is that we are doing the right thing,"

The final plenary was from Anne McColl, Board Chair of the Scottish Salmon Producers Organisation. McColl highlighted Scottish salmon farming by addressing key issues that enshrine its success - notably innovation in the evolution of the sector, using research to increase aquaculture production, exporting expertise and knowledge transfer and the future of salmon farming in Scotland.

The AE2016 trade event was also well attended, with a record 92 booths for exhibitors showing their latest products and services. More than 60 Industry Forums and other meetings were organised during AE2016 and included workshops, discussion forums and panels organised by the EAS Thematic Group on "Best Practice in Percid Fish Aquaculture"; EAS/EATiP on "Development versus. Stagnation: Defining issues and identifying needs"; the use of cleaner fish, growing fish in large RAS systems, selective breeding and by IUCN on "Aquaculture and Marine Protected Areas". Other meetings, including the General Assembly of the British Trout Association and a workshop by the Association of Scottish Shellfish Growers were also organised within AE2016, confirming its status as THE European aquaculture event.

## Small revolution for marine fry and fingerlings



At AE2016, From left to right: Stéphane Ralite, John Thinsley, Senior Researcher, BioMar R&D and Michel Autin.

At the Aquaculture Europe 2016 conference, Gold Sponsor BioMar presented a new generation of starter and transfer diets for marine species containing B-WYSE, a promising new yeast based functional ingredient, developed by BioMar's cooperation partner Lallemand Animal Nutrition.

Michel Autin, Technical Director for BioMar's EMEA Division, said, "The aim of the new feed range is to boost the performance parameters and keep the health status of the fish at the highest standard, even after the difficult period of transfer from hatchery to the cages. Transfer feeds are already commonly used in salmon farming.

"In Mediterranean fish farming, the transfer of sea bass, sea bream and meagre from the protected hatchery environment to the harsh environment in the sea cages has always had the risk of losses. Improving the health status of the fragile fry and improving their resistance against diseases prior to transfer to cages is of great concern, and we now are ready to offer a transfer feed range that brings a small revolution to Mediterranean fish farming," added Autin.

The new generation of BioMar marine starter and transfer feed types, named INICIO Plus M and INTRO Plus MT, are formulated with the inclusion of the two functional ingredients B-WYSE™ and Bactocell®, for reduced deformities, an improved gut health, a better resistance to bacterial attacks (*Vibrio* spp.) via synergistic

immune stimulation and increased mucous production. Furthermore, the new feeds present a higher digestible energy/digestible protein ratio without compromising performance parameters while lipid deposits are decreased and the health status of the liver is enhanced.

Stéphane Ralite, Aquaculture Product Manager at Lallemand Animal Nutrition in his presentation, said that B-WYSE™, the promising new biologically active product is extracted from selected marine yeast by utilising an innovative production process. For the last 15 years, BioMar has partnered with Lallemand for the development of this innovative product and various trials have shown its positive effects on the health status of both shrimp and fish, including sea bass and sea bream.

"The inclusion of B-WYSE™ in the new transfer diets is combined with the inclusion of Bactocell®, a prebiotic ingredient that BioMar has applied in its feeds since 2010. This functional ingredient is well-documented for reducing deformities and improving gut health across fish species. Bactocell® was also developed in a cooperation between BioMar and Lallemand and it is still the only probiotic ingredient approved by the EU authorities for the use in fish feed.

"Various test show that the combination of B-WYSE™ and Bactocell® have clear positive impacts on health parameters and by this is perfectly suited to strengthen the fragile marine fry and prepare it for transfer to the harsh environment in sea cages, Autin added.

John Thinsley, Senior Researcher, BioMar R&D, explained how the new combination of functional ingredients impact on the fish. "The first barrier of the fish against external pathogens is the mucus. Strengthening the mucosal barriers in intestines, skin and gills by functional ingredients has a strong influence on its resistance to diseases and parasites. The B-WYSE™ formulation provides not only mucus boosting in terms of quantity and quality but also in terms of enhanced immunomodulating and pathogen binding activities. By this, the external barriers of the fish are boosted against environmental threats."

"We are confident that our customers soon will experience the positive effects of this revolutionary new concept as we expect that our new marine fry and transfer feeds considerably will improve survival rates and the health status the fragile young fish and protect them against some of the very common diseases in Mediterranean fish farming," concluded Autin. More information: [michel.autin@biomar.fr](mailto:michel.autin@biomar.fr) (Michel Autin)



At the Aquaculture Europe 2016 plenary session, pupils from each school showcased their cooking skills by preparing and cooking a dish of their choice using Scottish aquaculture species.



## Spotlight on Africa at World Aquaculture 2017



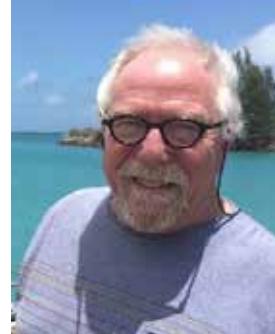
Rohana Subasinghe



Sloans Chimatiro



Gorjan Nikolik



Tom Hecht

The World Aquaculture Society takes its annual conference to Africa for the first time in 2017 – turning the spotlight on the potential of aquaculture production to support economic development and investment opportunities in the world's second-fastest growing regional economy.

Aquaculture is increasingly important as an environmentally sustainable way to meet global demand for fisheries products, while Sub-Saharan Africa's vast inland waters and coastlines – home to a small but rapidly growing aquaculture sector – present a largely untapped opportunity to contribute to the nutrition and socio-economic development needs of the region.

World Aquaculture 2017 with the theme '**Sustainable Aquaculture - New Frontiers for Economic Growth - Spotlight on Africa**', will bring together some 3,000 industry, academic and government delegates from the 100 member countries of the World Aquaculture Society (WAS) and its chapters, to Cape Town, South Africa, from June 26-30, 2017. The conference is hosted by the Aquaculture Association of Southern Africa and the South African Department of Agriculture, Forestry and Fisheries.

Representing the coming of age of African aquaculture and a significant milestone for the global aquaculture community, WAS plans to launch its Africa Chapter at the conference, whereby the continent will join the United States, Korea, Asia-Pacific and Latin-American-Caribbean as fully affiliated chapters of WAS.

The conference will balance global and African perspectives in aquaculture. The theme will be captured in the keynote addresses. Leading sustainable aquaculture advocate **Dr Rohana Subasinghe**, who retired as Chief of the Aquaculture Branch of the Food & Agriculture Organisation (FAO) of the United Nations in 2015, will present '*Feeding the Nine Billion: The Role of Aquaculture*'. **Dr Sloans Chimatiro**, Programme Manager-Fish Trade at the World Fish Centre, Zambia will set the tone for the conference by highlighting the value of aquaculture in global food security with his presentation '*African Perspectives on Aquaculture*'.

Conference Co-Chair and former WAS President, Dr Kevan Maine said Dr Subasinghe is the ideal person to lead conference discussions, especially given his role in spearheading the development of the FAO's Global Aquaculture Advancement

Partnership (GAAP), which addresses the need for a concerted effort to ensure future aquaculture development will become increasingly socially acceptable, environmentally sustainable, and responsibly managed.

Dr Chimatiro has been instrumental in raising 'the African voice' in international fisheries and aquaculture forums, and building African research institutions and networks in support of fisheries and aquaculture development. He played a leading role in formulating fisheries and aquaculture policy and governance programmes for the African Union, including coordination of the development of the Comprehensive African Fisheries Reform Strategy (CAFRS).

Financing and investment in the aquaculture industry will be highlighted in the keynote address '*The global seafood industry from a banker's perspective*' by **Gorjan Nikolik**, Senior Industry Analyst for Food and Agri-business Research and Advisory at Rabobank International, the Netherlands-based cooperative bank. Nikolik is a leading industry analyst, speaker and researcher focusing on the global seafood sector, including aquaculture, wild-catch, seafood trade and processing. In his primary role, he provides research and advice on the sector to support Rabobank in areas such as mergers and acquisitions, leveraged finance, venture capital, and credit risk management.

Focusing on farm to plate, aquaculture development and commercialisation expert **Professor Tom Hecht**, a former board member of the WAS, will speak on '*Establishing aquaculture value chains*'. Prof Hecht has played a lead role in the development of aquaculture in southern Africa with a career spanning research, policy, development and commercial involvement. He is an Emeritus Professor of Rhodes University where he played a lead role in establishing the Department of Ichthyology and Fisheries Science as a regional centre of excellence in aquaculture. In addition to pioneering research on African catfish and abalone culture, he has made extensive contributions to African aquaculture development including small farmer development in Malawi, a landmark review of African aquaculture for the FAO, and the establishment of the Aquaculture Association of Southern Africa. His current work includes establishing a trout farm in the Lesotho Highlands and facilitating the formulation of a Marine Aquaculture Masterplan for the Seychelles.

World Aquaculture Society (WAS) President Juan Pablo Lazo said, "The time is right for the world aquaculture community to focus on Africa. Rapid urbanisation, economic growth and a rising consumer class will only increase demand for fish over the next two decades and aquaculture presents a solution for production of affordable, fresh fish for the region."

"The opportunities for investment and technology development to realise the growth potential of marine and freshwater aquaculture in Africa make the continent the logical choice for World Aquaculture 2017," he said.

WAS Conference Programme co-chair, Professor Peter Britz said, "The continent is seeing a boom in infrastructure and logistics development, there is a growing population to sustain consumer demand and support employment creation, and Africa is endowed with vast natural resources to support aquaculture."

He added that traditional small-subsistence aquaculture in Africa was rapidly transforming and becoming integrated into

the continent's food systems as African governments increasingly adopt policies to support commercial-scale production and encourage investment in the sector.

The conference caters to the broad range of interests in aquaculture, providing a learning, information-sharing and networking opportunity for entrepreneurs, business, scientists, technical specialists, educators, students, policy-makers and public officials.

The technical and scientific programme and diverse parallel sessions will be complemented by a major international trade show, while the AquaForum provides an opportunity for an active participation of Africa's producer and aquaculture association as well as producers from around the world to share information on challenges, techniques and new developments.

Cape Town, recently voted one of the best cities in the world, and the Cape Town International Convention Centre provide an outstanding setting and venue for the first WAS meeting in Africa.

#### Conference details:

- Venue:** Cape Town International Convention Centre, Cape Town, South Africa • **Dates:** June 26-30, 2017.
- **Registration:** Register online at [www.was.org](http://www.was.org). • Early bird deadline is 26 April, 2017.
- **Abstract submissions:** Online at [www.was.org](http://www.was.org), by **1 December, 2016**.
- **Exhibition and trade show:** Register online at [www.was.org](http://www.was.org), or contact [mario@marevent.com](mailto:mario@marevent.com).

## What to look forward to in **Aqua Culture Asia Pacific in 2017**

In 2017, we will cover what is trending and technologies for the next step in aquaculture in Asia Pacific. Our topics are most relevant to the industry to help companies reach marketing targets.

### Volume 13 2017

Number	1 – January/February	2 – March/April	3 – May/June	4 – July/August	5 – September/October	6 – November/December
<b>Issue focus</b> <i>Recent developments and challenges for the next step</i>	Microbial Management	Hatchery & Nursery Technology	Sustainable & Responsible Aquaculture	Revisiting Shrimp Nutrition	Biosecurity & Disease Management	E-aquaculture & commerce
<b>Industry Review</b> <i>Trends and outlook, demand &amp; supply</i>	Marine Shrimp	Marine Fish	Aqua Feed Production	Tilapia	Catfish	Genetics
<b>Feeds &amp; Processing Technology</b> <i>Technical contributions from feed industry</i>	Fish Meal & Marine Protein Replacements Feed Enzymes	Novel Ingredients Micro Feeds Feed Additives	Lipids & Minerals Performance Feeds for Intensification	Extrusion & Processing Feed Additives	Sustainable Feeds Feed Safety and Hygiene	Functional Feeds for Health
<b>Production Technology</b> <i>Technical information and ideas</i>	SPF/SPR/SPT shrimp	Cage Culture Automation	Controlled systems/RAS	Disease Mitigation	Finfish Industrialisation	Aeration Technology & Waste Treatment
<b>Aqua business</b> <i>Feature articles</i>	Experiences from industry and opinion article covering role models, benchmarking, health management, SOPs, social investments, CSR, ancillary services etc					
Markets	Developments in markets (live fish, product development, market access, certifications, branding, food safety etc)					
Company/Product news	News from industry including local and regional trade shows					
<b>Deadlines for Technical articles</b>	November 16, 2016	January 16	March 13	May 15	July 17	September 18
<b>Deadlines for Advert Booking</b>	November 23, 2016	January 23	March 20	May 22	July 24	September 25
<b>Show Issue &amp; Distribution at these events as well as local and regional meetings</b>	<b>VIV ASIA 2017</b> March 15-17 Bangkok, Thailand	<b>Giant Prawn 2017</b> March 20-24 Bangkok, Thailand	<b>Seafood Global Expo</b> April 25-27 Brussels, Belgium	<b>*World Aquaculture 2017</b> June 26-30 Cape Town, South Africa	<b>*Asian Pacific Aquaculture 2017</b> July 24-27 Kuala Lumpur, Malaysia	
<b>*Show preview</b>					<b>The Aquaculture RoundTable Series, (TARS 2017)</b> August 16-17 Bali, Indonesia	
					<b>Vietfish 2017</b> August 29-31 Ho Chi Minh City, Vietnam	

# Practical Short Course on Feeds & Pet Food Extrusion

January 29 - February 3, 2017

Texas A&M, USA

A one week Practical Short Course on Feeds & Pet Food Extrusion will be conducted from January 29 - February 3, 2017 at Texas A&M University by staff, industry representatives, and consultants.

The program will cover information on designing new feed mills and selecting conveying, drying, grinding, conditioning and feed mixing equipment. Current practices for production of pet foods, preparing full-fat soy meal; recycling fisheries by-products, raw animal products, and secondary resources; extrusion of floating, sinking, and high fat feeds; spraying and coating fats, digestes and preservatives; use of encapsulated ingredients and

preparation of premixes, and least cost formulation are reviewed. Practical demonstration of pet food, vacuum coating, and several others are demonstrated on four major types of extruders - (dry, interrupted flights, single and twin screw), using various shaping dies.

Reservations are accepted on a first-come basis. More information and application forms; Mian N. Riaz, PhD, Director, Process Engineering R& D Center (Formerly, Food Protein R&D Center), Email: mnriaz@tamu.edu; <http://foodprotein.tamu.edu>; <http://foodprotein.tamu.edu/extrusion>

# 2016

Details on the events below are available online at <http://www.aquaasiapac.com/news.php>  
To have your event included in this section, email details to [zuridah@aquaasiapac.com](mailto:zuridah@aquaasiapac.com)

## November 9-11

**Taiwan International Fisheries and Seafood Show  
Kaohsiung**

Email: [taiwanfishery@taitra.org.tw](mailto:taiwanfishery@taitra.org.tw) / [stelen\\_yonardi@myexhibition.com.tw](mailto:stelen_yonardi@myexhibition.com.tw)  
Web: [www.taiwanfishery.com](http://www.taiwanfishery.com)

## November 21-25

**Certificate in Aqua Feed Milling  
Bangkok, Thailand**  
Email: [agriscchools@progressus.asia](mailto:agriscchools@progressus.asia)  
Web: [www.progressus.asia](http://www.progressus.asia)

## November 21-24

**FENACAM'16 - Brazilian Farmed Shrimp Fair  
Fortaleza, Brazil**  
Web: [fenacam.com.br](http://fenacam.com.br)

## November 28-December 1

**LAQUA 2016  
Latin American & Caribbean Aquaculture 2016  
Lima, Peru**  
Web: [www.was.org/www.marevent.com](http://www.was.org/www.marevent.com)  
(for exhibition)

## December 14-17

**Profit-on-Aquaculture 2016  
Bhimavaram, Andhra Pradesh, India**  
Web: [www.profitonaquaculture.in](http://www.profitonaquaculture.in)

# 2017

## February 8-10

**2nd International Ornamental Fish Trade and Technical Conference  
Colombo, Sri Lanka**  
Email: [info@infofish.org](mailto:info@infofish.org)  
Web: [www.infofish.org](http://www.infofish.org)

## February 19-22

**Aquaculture America 2017  
San Antonio, USA**  
Web: [www.was.org](http://www.was.org)

## March 15-17

**VIV Asia 2017  
Bangkok, Thailand**  
Web: [www.vivasia.nl](http://www.vivasia.nl)

## March 14-15

**International Conference on Marine Science & Aquaculture 2017  
Kota Kinabalu, Sabah, Malaysia**  
Web: [www.ums.edu.my/ipmbv2/icomsa/](http://www.ums.edu.my/ipmbv2/icomsa/)

## March 20-24

**Giant Prawn 2017  
Bangkok, Thailand**  
Email: [salinkr@ait.asia](mailto:salinkr@ait.asia) / [new.macrobrachium@yahoo.co.uk](mailto:new.macrobrachium@yahoo.co.uk)

## April 4-6

**International seminar on Advances in Fish Health  
Putrajaya, Malaysia**  
Email: [isafe@upm.edu.my](mailto:isafe@upm.edu.my)  
Web: [www.isafe.my](http://www.isafe.my)

## April 25-27

**Seafood Global Expo  
Brussels, Belgium**  
Web: [www.seafoodexpo.com](http://www.seafoodexpo.com)

## May 31- June 4

**5th International Trade Exhibition for the Seafood Industry in Asia  
Bangkok, Thailand**  
Web: [www.worldofseafood.com](http://www.worldofseafood.com)

## June 27-30

**World Aquaculture 2017  
Cape Town, South Africa**  
Web: [www.was.org](http://www.was.org)

## July 25-27

**Asia Pacific Aquaculture 2017  
Kuala Lumpur, Malaysia**  
Web: [www.was.org](http://www.was.org)

## August 16 -17

**TARS 2017: Finfish Aquaculture  
Bali, Indonesia**  
Email: [conference@tarsaquaculture.com](mailto:conference@tarsaquaculture.com)  
Web: [www.tarsaquaculture.com](http://www.tarsaquaculture.com)



## August 29-31

**Vietfish 2017  
Ho Chin Minh City, Vietnam**  
Email: [namphuong@vasep.com.vn](mailto:namphuong@vasep.com.vn)  
Web: [www.en.vietfish.com.vn](http://www.en.vietfish.com.vn)



# VIV ASIA 2017

MARCH 15-17,  
BANGKOK, THAILAND

INTERNATIONAL  
PLATFORM  
FROM FEED  
TO FOOD



[WWW.VIV.NET](http://WWW.VIV.NET)

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asia pacific

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# CREATES THE VALUE OF PRAWN



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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- Tel: +84-650-3737626 - Fax: +84-650-3790819
- Email: aquafeed@upvn.com.vn