

AQUA CULTURE

A s i a P a c i f i c

Commercialising live
nauplii supply

Broodstock multiplication
in India

Microbial management
at farm level

Aqua Feeds in Asia -
A tough 2015

Uppgrade to survive for
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Zuridah Merican

Environment, sustainability, governments & us

In the early days, governments and researchers laid the path for the development of aquaculture in Asia. They looked at the specific water body, inland or coastal, and the number of cages based on carrying capacity considerations. Subsequently, both the government and industry roles bifurcated - with the government taking over the monitoring and regulation and the industry agreeing to maintain the environment to ensure long term sustainability. Leaving a legacy of sound aquaculture practices for the next generation is the responsibility of all stakeholders.

However, especially in the case of cage culture, be it in freshwater or marine environments, we can say that there is lackadaisical development, and this jeopardises environmental sustainability. Who should we blame? It is clear that the industry has done little to mitigate the negative effects. A large impact on pond water and surrounding environment is not only due to density but also to feeding. It is important to realise that for aquaculture activities, we only borrow water. Clean water drawn into rearing environments should be returned as such.

After almost 40 years of continuous growth of aquaculture, it is time to reflect on the effects on the environment. We have examples such as effects of intensive flounder farming on coastal environment in Korea; intensive shrimp farming in Indonesia; marine cage culture in Malaysia and tilapia and carp farming in Cirata and Jatuluhur in Indonesia. The classic pictures of aquaculture versus the environment are marine fish farming in Fujian, China and tilapia farming in Lake Taal in the Philippines.

How do adverse farming conditions impact the future of aquaculture in Asia? One concern is the 'risk factor' of aquaculture viewed by NGOs and consequently consumers and bankers. Another concern is the branding and image of aquaculture in Asia: the crowding of fish/shrimp in a small water body, the destruction of the ecosystem and consequently, the apparent quality of the fish products. Pangasius farming in Vietnam started with a poor image that has partly led to the necessity to launch the product at a low price. Unfortunately, the marketing effort was unable to overcome the preconceived notion, and prices have still not improved. As production is no longer for self-consumption but for international

markets which are becoming more discerning, as an industry, we are all responsible and interconnected.

Today with El Nino causing prolonged droughts, we have heard reports of farmers asking for low pollution feeds. At TARS 2015, there was a discussion on feed standards with minimum protein levels but the latest technological developments in processing and nutrition allows us to do more with less. We could suggest that feed standards include impacts on the environment. 'Fit for purpose' feed standards can go a long way.

When offer prices are close to production costs, farmers opt for high volume low margin economies of scale to sustain their business. Sometimes, without any basis, there are reports of chemicals and antibiotics being used to sustain production. The result is a bad image not only for the species affected but fish/shrimp production of the particular country as well. Then there is the question of 'food safety' for products from Asia. An example is the recent FDA ruling on 100% checks on shrimp imports from Malaysia. Local producers contend that these are shrimp from other countries using Malaysia for transshipment. The message here is that our industry is not 'an island.' What happens in one country or species affects another.

Institutional R&D on the dynamics of ecosystems and associated regulatory functions fall under the role of governments. They need to be proactive in their efforts to prevent greed from taking over. It does take the whole supply chain and support segments to understand the need to regulate; from the hatchery and farms directly discharging into the environment to feed producers producing low quality diets and farmers using farm made feeds.

It is never too late to have rules and processes in place to mitigate risks and elevate the industry to a position to best attract investors. Financial institutions already place a risk premium on aquaculture - let's not add another disincentive to the investment.

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
17-18 August 2016

TARS 2016 will be on Shrimp Aquaculture & the New Normal. It will be held from 17-18 August in Phuket, Thailand. For updates, visit: www.tarsaquaculture.com



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APA 2016: the realm of aquaculture in Indonesia

The largest aquaculture event which focused on aquaculture in Asia and in particular shrimp farming in Indonesia.

Asian Pacific Aquaculture (APA 2016) was held together with two Indonesian aquaculture events, INDOAQUA and FITA as well as with the Eleventh International Symposium on Tilapia in Aquaculture (ISTA). Asian Pacific Aquaculture is the annual conference and trade show of the Asian Pacific Chapter of the World Aquaculture Society (WAS-APC). IndoAqua and FITA (Forum for Innovation and Technology) are annual meetings to encourage information exchange among government, industry and research institutions. ISTA brought together tilapia biologists who review the latest discoveries in tilapia nutrition, physiology, reproductive biology, genetics, ecology, improvements in production systems, and other fields related to tilapia and their use. This large event was held on April 26-29 in Surabaya, the second largest city in Indonesia.

Organisers, WAS-APC and the Ministry of Marine Affairs and Fisheries (MMAF) said that the trade show and conference gathered almost 6,000 participants from 51 countries. The conference comprised 11 concurrent sessions with 465 oral and 254 poster presentations. The exhibition had 241 booths from 22 countries. Some 89 booths were dedicated to Indonesian research institutions, regional and provincial aquaculture centres displaying their R&D outputs and development achievements (field trials for new species, culture systems, product development and fish fry supply).

In welcoming participants to APA 2016, IndoAqua and FITA, Slamet Soebjakto, Director General Aquaculture, MMAF, said, "This is a gathering to promote sustainable aquaculture. It is also aimed at attracting investments both within and outside Indonesia to ensure continuity of the aquaculture business. There are various forms of incentives: income tax incentives in selected business areas, incentive tax on raw materials for feeds and tax incentives in freshwater and marine aquaculture. The potential for aquaculture development is large while the utilisation of potential areas is relatively low. For example with brackish water areas for aquaculture, the potential is 2.9 million ha but the utilisation is only 22% and in marine fish aquaculture, the potential covers 12.9 million ha and only 1.4% of this area is being used."



Endhay Kusnendar Kontara presented on developments in Indonesian aquaculture

There was a large contingent of shrimp farmers attending the industry session and the trade show. Most are members of the Shrimp Club Indonesia (SCI). Iwan Sutanto, President said, "SCI has been very supportive of this meeting and we are glad that we have contributed to its success. Surabaya is ideal as most of aquaculture is centred around it. The shrimp industry session was very useful for our members. SCI has been organising several events to update members on the latest in culture practices. We hope that our support of this event will translate to more shrimp farmers joining SCI."

Blue technology

Two plenary presentations focused on the theme of 'Profitability, Sustainability, and Responsibility for the Future.' **Dr Patrick Sorgeloos**, Ghent University, Belgium looked at "Aquaculture: the Blue Technology of the future." He said that there is a need to move from an empirical to a science based aquaculture. There are areas where basic science is very relevant, such as with microbial management in hatcheries and in culture ponds. "We do not pay enough attention on ecological aspects and what regulates the



Slamet Soebjakto (centre, left) at an Indonesian booth, picture courtesy of MMAF



Iwan Sutanto, right, with Denny D. Indradjaja, Head of Aqua Feed Division GPMT (Indonesian Feedmills Association)



Dr Hasanuddin Atjo, Head of SCl in Sulawesi (second left) with officials from central Sulawesi. Atjo developed the SII technology for 'supra' intensive farming of vannamei shrimp.



Puspita Dewi Prijadi, President Director, PT Matahari Sakti with her team, Rudy Purwono (right) and Teddy Ngoto.

microbial community. By 'disinfecting' water and then providing more nutrients through live or formulated feeds, we are actually favouring opportunistic bacteria. We need to revisit microbial management not only in water but also in the gut of the animal."

He asked whether protocols used nowadays to combat bacterial infections such the early mortality syndrome or EMS in ponds actually work. Sorgeloos said that 'disinfection' in the pond effectively removes all the bacteria and even primary pathogens are eliminated. Microbial diversity and stability are compromised. If the farmer waits, it is possible to have a proper, stable and mature bacteria population. Unfortunately, the farmer does not want to delay stocking. Stocking is usually at the time of stabilisation. To emphasise on what is happening with the microbiota, Sorgeloos detailed the characteristics of r-strategists and k-strategists bacteria. Effectively, the latter group is harmless in fish and shrimp ponds but have low growth rate. Some empirical observations of the strategy of microbial matured water includes using algal rich greenwater systems, probiotics, tilapia co culture, biofloc systems and recirculation systems.

Blue economy: Industrial aquaculture

The second plenary described how Indonesia's aquaculture is geared towards profitability, sustainability and responsibility for the future. **Dr. Endhay Kusnendar Kontara**, Research and Development Centre for Aquaculture, MMAF and the new president of WAS-APC, demonstrated the vastness of the archipelago with a population of 250 million. "Aquaculture and fisheries are extremely important for the national economy. Seafood exports totaled IDR 127 trillion (USD 9.5 billion) and there are 3.8 million people involved in aquaculture. Aquaculture



Ediwarman (standing, second left) and the team at Sungai Gelam Freshwater Aquaculture Centre's booth.

production was 14.16 million tonnes in 2014, including seaweeds, which accounted for 10 million tonnes. The ministry's role is industrialising aquaculture in the blue economy and for food security.

"While output in capture fisheries has levelled off, aquaculture production continues to increase. The major species are the shrimp (now the vannamei shrimp), tilapia, catfish and milkfish." Endhay said that in 2014, Indonesia had a production of almost 1 million tonnes of tilapia, 679,000 tonnes of Clarias catfish and 639,000 tonnes of both vannamei and monodon shrimp.

"However, we are not without problems which include inadequate and unreliable good quality seed supply, disease outbreaks, high feed prices and market access. We have national broodstock centres or NBC for freshwater species, tilapia, catfish, carp, gouramy, *Macrobrachium* prawn and for marine fish such as the milkfish, groupers and pompano. There is a national genetic improvement centre for seaweeds and for the two species of the marine shrimp, we have nucleus breeding and broodstock multiplication centres. In the breeding of new strains, these centres have made tremendous progress. We now have seven improved strains of tilapia including the Srikandi, which is a saline tilapia strain.

"The total carp production was almost 434,000 tonnes in 2014 and resistance to koi herpes virus is important to us. So, among the new strains of carps, Mantap and Mustika are resistant to this virus. With the pangasius catfish, we have developed the Pasopati, a hybrid of *Pangasius hypothalamus* with the local *P. jambal*. There are now two improved strains of the *Macrobrachium* and locally development broodstock of the vannamei shrimp (Vaname Nusantara -1 and Global Gen).

"Furthermore, our researchers have succeeded with the production of specific pathogen resistant shrimp strains with higher resistance by 24.5% against white spot syndrome virus (WSSV) and 67% against vibriosis. We have been carrying out selection of fast growing monodon shrimp, using DNA markers. We increased growth rate by 35.2% and survival at 84-90% during grow-out. The low natural mating rate is the main constraint in domestication of the monodon shrimp. Work on artificial insemination have produced fertilised eggs around 62%. This can be applied in breeding the domesticated monodon shrimp."

Indonesia has a large marine fish culture industry. It produced 631,125 tonnes of the milkfish and close to 20,000 tonnes of seabass and groupers in 2014. However, its main contribution to the region's aquaculture is fry of various aquaculture species produced by small-scale hatcheries. It is the major supplier of milkfish fry.

Growth in revenue for Thai Union

Thailand's Thai Union aims to nearly double revenue from its shrimp business to more than THB 80 billion by 2020. Rittirong Boonmechote, President of TU's global shrimp business unit said the group's revenues from the shrimp business were expected to grow from USD1.4 billion in 2015 to USD1.5 billion this year and to USD 2.6 billion by 2020. With expansion overseas, revenues from its businesses in Thailand are expected to drop 30% by 2020. At present, shrimp contributes about 27% of TU's total revenues. The growth plan for the shrimp business is in line with the global seafood group's goal to double its total revenue to USD 8 billion by 2020. In April, TU announced a deal to acquire a 40% interest in Avanti Feeds' wholly owned shrimp-processing unit Avanti Frozen Foods Private Ltd in India. It is studying possibilities to expand to Indonesia, Bangladesh and other countries. Following the completion of its new factory this June, Avanti expects to boost its total shrimp processing capacity from the current 30-40 tonnes/day to 80-100 tonnes/day in 2016, making the company one of the top three shrimp processors in India.

Geelen Counterflow signs Paris Pledge for Action

Geelen Counterflow designs, manufactures and services counterflow dryers and coolers for feed and food products. In March, it signed the Paris Pledge for Action (L'Appel de Paris). "We signed this pledge because man-made global warming is an urgent threat to the world we leave to our children to, and because the feed and food industry that we are active in can and must play an important role in resolving this problem. The pledge includes also includes companies such as Mars, Nestlé, Unilever, Kellogg, Arla, Danone, Coca Cola, DSM, BASF,

Tesco, Carrefour, etc.," said Sander Geelen, Managing Director of Geelen Counterflow.

The Paris Pledge for Action is an opportunity for non-state actors to welcome the Paris Agreement on climate change and commit to implement it. The pledge demonstrates that non-state actors are ready to play their part to support the objectives of the Paris Agreement. By joining the pledge, businesses, cities, civil society groups, investors, regions, trade unions and other signatories promise to ensure that the ambition set out by the Paris Agreement is met or exceeded to limit global temperature rise to less than 2 degrees Celsius.

Four-Star BAP tilapia from China goes to the US

Four-star Best Aquaculture Practices (BAP) tilapia from China will soon be available to consumers in the US. The Fishin' Company is bringing the first consignment to retail outlets across the country. Four-star BAP product means the product originates from BAP-certified processing plants, farms, hatcheries and feed mills. This is the highest designation in BAP standards developed by the Global Aquaculture Alliance. These standards encompass environmental responsibility, social responsibility, animal health and welfare, food safety and traceability. US based The Fishin' Company sponsored the BAP certification of the two hatcheries and one feed mill, from which it sources fingerlings and feed.

"This is a groundbreaking day for tilapia. We are ecstatic to be able to deliver this totally comprehensive benchmark of food safety, traceability and sustainability to the retail arena, and applaud our supply chain for their partnership in this endeavour," said Manish Kumar, CEO of The Fishin' Company. "We must all strive to make four-star BAP tilapia the norm, not the exception. This journey is just beginning, and we will continue to work passionately with GAA to bring this goal to fruition."

continued from p5.



Dr Victor Talavera, shrimp consultant, Peru (left) with some of the team from Areca, Guatemala. Also in the picture, Dr Daranee Sookying (middle) and Dr Fuci Guo (right), DSM

"We are the only supplier of fry for the humpback grouper *Cromileptes altivelis* for the region. Others are the brown-marbled grouper *Epinephelus fuscoguttatus* and leopard coral grouper *Plectropomus leopardus*."

After outbreaks of infectious myonecrosis (IMNV), surveillance and monitoring for shrimp disease are important aspects of the directorate's program. "In shrimp, the main diseases are IMNV, WSSV and Taura virus syndrome. In finfish it is KHV, megalocytivirus, viral nervous necrosis or VNN. We have a

pilot project of active surveillance on IMNV and WSSV which is compartment based in West Java, Banten and Lampung Provinces. We also have a public-private partnership to prevent EMS in Indonesia."

The global shrimp aquaculture fraternity is curious on the super intensive farming of the vannamei shrimp and Endhay described recent practices. "The ponds are small (<1000 m²) and stocking density is high at more than 500 post larvae/m². Production is high at 9-10 tonnes/1000m². Waste water treatment is integrated with shrimp culture and the volume for waste water treatment pond is about 70% of the total volume of rearing pond. Ponds are fully concrete and water depth during culture is more than 2 m. One important feature is the waste discharge using a submersible pump through a unique drainage system. Water quality monitoring is online."

On the side lines of this event, several companies with feeds, feed additives and aquaculture solutions organised pre conference seminars as well as press conferences to announce developments. Nutriad organised a seminar on "Functional feed additives to boost the blue revolution". Trouw Nutreco and Skretting's seminar was on 'Blending knowledge with performance for trusted aqua feed additives'. Inve Aquaculture's seminar was on 'Growing shrimp in challenging times'. It also held a press conference to launch its 'Care for Growth' approach in Asia. Evonik launched its new product AQUAVI® Met-Met at this show.



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Broodstock multiplication in Visakhapatnam

By Zuridah Merican

Home-grown SPF vannamei shrimp broodstock at lower prices meets the demand of smaller hatcheries throughout India.

In 2012, the Rajiv Gandhi Centre for Aquaculture (RGCA), the R&D arm of the Marine Products Export Development Authority (MPEDA) took a bold move to develop a vannamei shrimp broodstock multiplication centre (LvMC) in Mangamaripeta, Visakhapatnam, Andhra Pradesh, India. It did this in association with the Oceanic Institute (OI), which supplies the post larvae from its nucleus breeding centre (NBC) in Hawaii.

Today, after more than three years in operation, RGCA is able to claim that it has contributed to the expansion of the vannamei shrimp industry, otherwise dependent on supplies of specific pathogen free (SPF) broodstock, mainly from Florida and Hawaii. The Indian shrimp farming industry is highly regulated by the Coastal Aquaculture Authority (CAA) with registered hatcheries required to apply for an annual import quota of broodstock. In 2015, there were 254 vannamei shrimp hatcheries and according to CAA, in January 2016, there were 70 hatcheries pending registration.



Broodstock are packed in 8-10 L of water containing four broodstock per bag for less than 8 hours journeys and three broodstock per bag for longer trips.

Mandate to supply locally bred SPF broodstock

“Hatcheries often lament the high shipping cost and transit loss due to mortality; however, supply issues are only a partial explanation,” said Dinesh Kumar, Project Manager of the LvMC. “There is a large demand for broodstock from hatcheries in the country. During 2015-2016 period, CAA had issued letters of permit to 254 hatcheries for importing 560,000 broodstock for the production of post larvae required for stocking approved vannamei shrimp farms in India.

“LvMC has the capacity to supply from 45,000 to 60,000 broodstock yearly. To date we have delivered 160 consignments of 90,014 broodstock. Information from the Aquatic Quarantine Facility (AQF) in Neelankarai, Chennai showed that in the period 2015-2016 (up to January 27), hatcheries in India imported close to 181,148 broodstock. Some 90% of imports are from SIS in Florida, USA.

Dinesh Kumar added, “It is not only the rising costs of imports but also the difficulty with planning for supplies and booking spaces at AQF that deters small hatcheries from using imported broodstock. As such, many resorted to pond-reared broodstock, which ultimately results in the production of poor quality post larvae and subsequent crop losses to farmers.

“Our mandate is to supply these smaller hatcheries. However, we also supply large hatchery groups to benchmark our broodstock with imported broodstock such as those from SIS and Kona Bay.”

Lowering cost of post larvae

Another aim of this home bred supply of broodstock is to reduce the cost of post larvae. Currently, the cost of post larvae (PL10) produced from imported broodstock is INR 0.5 to INR 0.8/PL (USD 7.5 to 12/1000PL), depending on the demand from farmers. The lowest price is INR 0.4/PL (USD 6/1000PL). In contrast, the selling price for post larvae from pond reared broodstock is only INR 0.15/PL (USD 2.2/1000PL).

“The higher cost of imported broodstock is transferred to shrimp farmers buying post larvae at high prices,” said P. Jayagopal, Senior Project Manager for Shrimp Breeding, RGCA. “About 80% of the shrimp farmers are marginal and small scale farmers with 0.5 to 5 ha pond area and the success of the crop largely depends on the quality of seed supplied to the farmers.

Imports of SPF vannamei shrimp broodstock into India and contribution from LvMC					
year	Broodstock imports	RGCA LvMC broodstock	Total	No of vannamei shrimp hatcheries operating	Total post larvae produced (billion)
2013*	91,314	30,320	121,634	117	18
2014*	179,282	14,274	193,556	183	26.5
2015*	161,648	30,820	192,468	250	31.7
2016 (up to Jan 27)**	19,500	14,600	34,100	254	na

*adapted from Ravi Kumar Yellanki (2016), presented at AqualIndia 2016
 ** additional information provided by RGCA



Jayagopal (left) and Anand Kumar at Phase 1, LvMC. These 8 tanks are ready to receive the next batch of post larvae.

From the hatchery to the ponds...



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Anand Kumar and bags ready for delivery

Hence for sustaining the productivity and profitability of shrimp farmers, it is essential that quality post larvae are provided to farmers at reasonable costs.”

Two phase broodstock culture

In preparation for this program, RGCA retrofitted the Andhra Pradesh Shrimp Seed Production, Supply and Research Centre. Using a complete recirculation aquaculture system, water exchange is limited to 10% per day. Effluent water is treated prior to being discharged. Tank dimensions simulated OI's facility in Hawaii. The 40 m² rectangular post larvae rearing tanks have been designed for commercial purposes, that is, to hold 1,000 broodstock which are all harvested for distribution. Broodstock are packed with 8-10 L of water containing four broodstock per bag for less than 8 hours journeys and three broodstock per bag for longer trips. Prior to transport, each batch is chilled to 20°C.

“The farthest we have sent to are hatcheries in Gujarat which is a long journey by air to Mumbai and by road to the hatchery. During this long journey of more than 30 hours, no mortality was reported. Our largest consignment was 2000 broodstock which we dispatched in two lots,” said Dr A Anand Kumar, assistant project manager, LvMC who is charge of Second Phase Operation and Packing.

LvMC receives SPF post larvae produced from selected families at OI's nucleus breeding program in Hawaii. Prior to acceptance, RGCA obtained a confirmation on the health status of the batch from a third party laboratory, the Aquatic Pathology Laboratory at the University of Arizona, USA. RGCA is also required to get an import permit from the Ministry of Agriculture, Government of India for each consignment. Since 2013, it has received eight batches from OI. On average, the survival rates from PL10 to broodstock is 65%.

There is a two phase culture system at this centre. In Phase 1, the post larvae are reared at a density of 100 PL/m² until they reach 15-20 g. This takes 2 months. In Phase 2, shrimp are stocked at 25 juveniles/m² and cultured for another 3 months until they reach broodstock sizes of 45±10 g. The culture temperature is maintained at 26°C as higher temperatures affect the spawning performance of male broodstock. Shrimp are fed with broodstock feeds from Zeigler, USA. No live feeds are used. All inputs are screened for bacteria and other disease pathogens.

“A critical standard operating procedure is the testing for diseases. At 1-2 g sizes, we have to test for diseases and provide this information to the Ministry of Agriculture for the issuance of a permit to use this stock. Then during the second phase



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we screen for the 11 diseases with histology and PCR," said Jayagopal. Each batch of broodstock passes through stringent multi-level disease test certified by the Aquatic Pathology Laboratory, Arizona University as well as RGCA's Central Pathology Laboratory. The list of pathogens are white spot syndrome virus (WSSV), taura syndrome virus (TSV), yellowhead virus (YHV), infectious hypodermal and hematopoietic necrosis virus (IHHNV), infectious myonecrosis virus (IMNV), monodon baculovirus (MBV), baculovirus penaei (BP), hepatopancreatic parvo-like virus (HPV), morbillivirus (MoV) and necrotising hepatopancreatitis (NHP).

Reducing costs for hatcheries

"RGCA's target is to produce 225,000 broodstock over 5 years, starting from 2013. It has a five year contract with OI for post larvae supply. The primary objective of this initiative by RGCA is to produce selectively bred vannamei shrimp broodstock that exhibit good hatchery performance for producing high quality post larvae. These should exhibit fast growth and high survival in commercial shrimp farms in India. We evaluate the growth performance of each family in nine cages in ponds at the Vaisakhi Bio-marine farm. Our shrimp farming industry is fast developing and we need to ensure that supply keeps up with demand for broodstock. Our aim is also to reduce the cost of post larvae production by providing lower cost broodstock," said Jayagopal. "In 2015, the cost of imported broodstock rose to USD75/broodstock. In contrast, LVMC sells its broodstock at INR2,000/broodstock or USD30-35 each."

In the future

A nucleus breeding centre

At present, the availability of quality SPF vannamei shrimp broodstock is a major limiting factor for increasing farmed shrimp production. As such, it is essential to have a National Breeding Program and a Genetic Nucleus Centre to sustain the supply of SPF vannamei shrimp broodstock to hatchery operators in India. OI has agreed to collaborate in the setting up of the Breeding Program with a Genetic Nucleus Centre in India which will help RGCA to produce genetically improved SPF broodstock with suitable characteristics for Indian climatic conditions. The site identified is at Rajakamangalam, Kanyakumari District in Tamil Nadu state.

Capacity building in Andhra Pradesh

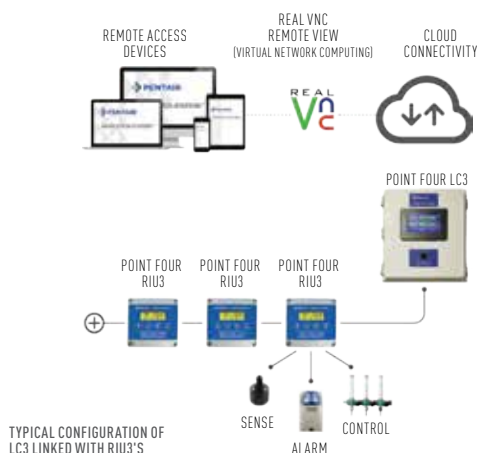
There is a huge demand of SPF vannamei shrimp broodstock in hatcheries in Andhra Pradesh (AP), the state which produces almost 70% of the annual vannamei shrimp production. The AP government has requested RGCA to increase broodstock production. Aside from increasing capacity to 60,000 broodstock at the LVMC, RGCA has proposed the setting up of an additional multiplication centre in AP with an annual capacity of at least 100,000 broodstock by utilising the grandparent stock produced at the proposed nucleus breeding centre. Meanwhile the AP government has allotted a 30-acre or 12 ha site at Bangarammapeta, Gurupudi Revenue Village, Nakkapalli Mandal in Visakhapatnam district for this project.



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Commercialising the daily supply of live *Artemia* nauplii to hatcheries

I&V BIO has expanded live nauplii production to Phang-nga and looks ahead to become the 'shop on wheels' for the hatchery industry.

Following the set-up of its initial hatchery in Chonburi, Thailand in 2013, I&V BIO has expanded and moved production to Phang-nga, Phuket. This expansion has allowed the company to provide live nauplii and fresh decapsulated cysts to hatcheries in eastern and southern Thailand. I&V Bio was founded in 2013 by Luk Van Nieuwenhove, Frank Indigne and Patipon Srianeek (Khun Kob.)

I&V Bio just finished construction of a new facility in India together with an Indian partner, Reddy Krishna from Neeva Aro Solutions. It is also in the process of setting up a nauplii centre in Indonesia and is looking for partners in Vietnam and in other aquaculture countries.

At the Artemia Nauplii Centre in Phang-nga, **Luk Van Nieuwenhove**, Director and Co-owner tells AAP the story behind the company. Luk is not new to the hatchery industry and Asia, as he has been involved in the *Artemia* business for more than 20 years. He was previously operations manager and member of the board at INVE Aquaculture.

"I recognise the problems hatcheries face on a daily basis. They need clean instar1 *Artemia* nauplii. I wanted to relieve hatcheries of the burden of hatching *Artemia* cysts. Often *Artemia* cysts of unreliable quality (and without labels) are sold in the market. During hatching, temperature, light and bacterial contamination have important impacts on the hatching rate and quality of the nauplii. I wanted to develop a system which is able to produce *Artemia* nauplii on a commercial scale and at the same time guarantees the hatchery manager a steady supply of live nauplii ready for use," said Luk.

Concept to commercialisation

"First, we need to convince the shrimp hatchery manager that we can produce quality *Artemia* nauplii consistently. For this, we have integrated many back-up systems in this centre in Phang-nga such as generators, extra pumps, air compressors, liquid oxygen and 24-hour surveillance. We developed a software to record and monitor every step in the production. We train young people who work and live at the centre.

"Our dedicated team is managed by Preecha Chotiya and Prapatsorn Rattanukul. They have both proven that they can manage the people and protocols. From this experience in Phang-nga we were able to fine tune our concept and translate this into blue prints which can be implemented easily in other countries," added Luk.

"Today, 90% of the hatcheries in Phuket are using our quality *Artemia* products. Our instar1 live nauplii has set a new standard in the shrimp hatchery industry. Our products enable hatcheries to follow strict bio-secure protocols and at the same time relieve them from the burden of dealing with inferior *Artemia* cysts quality and sub-optimal hatching conditions. This allows them to focus more on the demands for quality post larvae for grow-out."

I&V Bio has three products for the shrimp hatchery industry. InstART 1 is pure instar1 *Artemia* nauplii, with no impurities, no damaged animals and no *Vibrio*. InstART E is *Artemia* nauplii for hatcheries, nurseries and grow-out, enriched via a three-step process; enrichment with high quality DHA (docosahexanoic acid), SELCO and plant extracts high in amino acids and carotenoids, and finally ELVAN a blend of herb extracts with proven anti-*Vibrio* effect and prebiotic properties. The aim of this three-step process is to have a product that promotes gut and animal health as well as enhance immunity.



Luk Van Nieuwenhove (right) with his team at the Artemia Nauplii Centre in Phang-nga



A 800 g tray of InstART. On delivery, the hatchery operator will just scoop out the paste of InstART1, add this to water and soon will be able to see only actively swimming nauplii.

The fresh decapsulated M-Bryo is a product of a proprietary decapsulation method which uses a combination of two non-toxic chemicals. This is an ecologically friendly method. Furthermore, the outer membrane is softened for easier intake and digestion.

“M-Bryo surpasses those dried decapsulated cysts or shell free cysts which are of inferior quality as the decapsulation process uses hypochlorite. The subsequent drying process to ensure a longer shelf life damages the outer membrane and once introduced into the shrimp/fish tanks, there will be contamination of water and increased risk of bacterial blooms,” said Luk.

“ Being able to feed clean *Artemia* nauplii is in my opinion a new milestone in the hatchery business. ”

A guarantee to deliver

“The key to our success is our guarantee to supply customers with daily live, fresh, clean and disinfected (*Vibrio*-free) products,” said Luk. “This differentiates us from our competitors who are selling just dry *Artemia* cysts and leave the burden of risky hatching conditions to the customer. Shrimp hatchery managers are very capable in controlling their water quality, monitoring the feeding and health of the shrimp larvae but all their efforts can be jeopardised by feeding contaminated *Artemia* nauplii. Being able to feed clean *Artemia* nauplii is, in my opinion, a new milestone in the hatchery business.

“We add value to any hatchery business by supplying ready to use live *Artemia* nauplii paste in 800 g trays. Each tray is equivalent to one can of cysts with 70% hatching,” said Luk.



Inside the centre in Phang-nga, the team produce instar1 nauplii under controlled conditions (aeration, temperature, light and disinfection)



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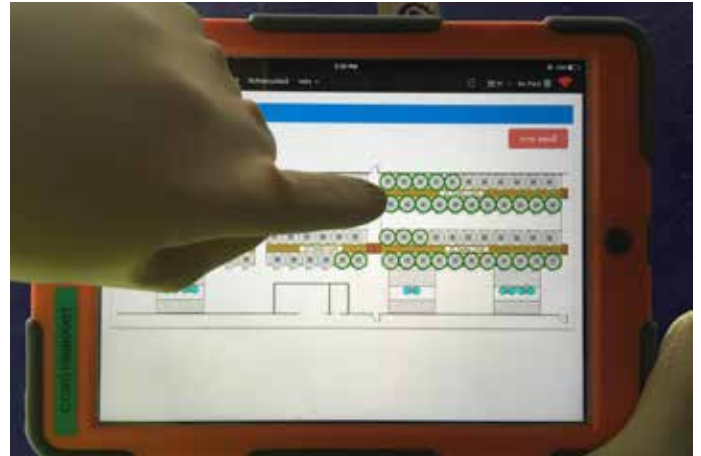
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I&V Bio has developed software to record and monitor every step in the production

“Today, everybody believes that the market is dominated by large multinationals and that there is little or no space for small companies. However, we show that there is still space for a small company willing to think out of the box and meet the real needs of the industry.

“The key to our future growth will depend on our ability to set-up similar *Artemia* nauplii centres in other locations and at the same time use our daily contact with the hatchery managers to introduce other products such as high quality diets and probiotics. We want to become the ‘shop on wheels’ for all hatchery products. We also have plans to use similar concepts for nursery and grow-out.”

In the making

By mid 2016, I&V Bio will offer a range of state-of-the-art artificial dry diets to ensure that besides the clean and fresh nauplii,

their customers can feed shrimp larvae with high quality diets produced with a new technology to ensure better performance.

“We are currently developing a fresh diet for shrimp brood stock and a fresh booster diet for the nursery phase. We believe that through fresh diets we can achieve nutritional conditions not possible with conventional dry feeds.

“Our goal is to be the preferred supplier of high technology products that are easy to use and delivered on a daily basis directly to the end-user. We want to be present in all main shrimp and fish farming areas and markets world-wide through the establishment of local facilities with local partners,” said Luk.



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Vibrio in shrimp gut: challenge and control strategy

Is *Vibrio* spp killing your shrimp? Anwar Hasan discusses why and how to prevent such infections.

After *Litopenaeus vannamei* was introduced in Asia, world shrimp production increased from 2 million tonnes (45% *L. vannamei*) in 2003 to almost 4 million tonnes (71% *L. vannamei*) in 2011. Unfortunately, disease occurrences has followed the growth of shrimp production, particularly since 2008. Infectious myonecrosis disease (IMNV), white spot syndrome virus (WSSV), white faeces and early mortality syndrome/acute hepatopancreatic necrosis disease (EMS/AHPND) have each hit shrimp production in Asia.

Viral diseases remain a big challenge. However, now the industry must be more cautious towards non-viral diseases, particularly bacterial disease caused by *Vibrio* spp. *Vibrio* has been well-known as a major bacterial pathogen in shrimp since the 1990s, but it was more common to post larvae stage in the hatchery. However, there have been some reports of *Vibriosis* during the grow-out phase. Now, diseases related to *Vibrio* affect shrimp production.

Vibrio and diseases

Vibrio plays a role in primary and secondary infections. As primary infection, *Vibrio* has become an even greater cause of concern after Tran et al. (2013) reported *Vibrio parahaemolyticus* as causative agent of AHPND. Interestingly a researcher in Vietnam found virulence genes of *V. parahaemolyticus* in *Vibrio harveyi*. In recent years, the concern on virulent gene (in plasmid) transference not only among *V. parahaemolyticus* strains but also to different *Vibrio* species has grown.

On secondary infection, Phuoc et al. (2009) showed that there was significant increase of *Vibrio campbellii* in shrimp haemolymph in co-infection with WSSV; increasing to 10⁵ CFU/mL, from *V. campbellii* single infection of only 10² CFU/mL. There was no difference in infected cells by WSSV with or without *V. campbellii* co-infection implying that co-infection with *V. campbellii* was not affected by WSSV virulence. However, co-infection of WSSV and *V. campbellii* or *V. harveyi* caused higher and faster mortality during normal WSSV infection.

Moreover, Manilal et al. (2010) reported that non-pathogenic *Vibrio alginolyticus* became virulent after a WSSV outbreak in the pond. In some cases, *V. alginolyticus* has a known probiotic role to compete with *V. harveyi*.



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Monitoring *Vibrio* in shrimp

Based on the role of *Vibrio* in diseases, farmers should monitor the *Vibrio* level in pond water as well as in shrimp. Monitoring of *Vibrio* in pond water is already quite common. Many farms have *Vibrio* monitoring in pond water as a standard operating procedure (SOP), but not many farms today monitor *Vibrio* in shrimp body. As a further precaution, it is recommended that farmers collect samples to monitor *Vibrio* level in shrimp tissues such as haemolymph, hepatopancreas and gut.

The case of white faeces disease (WFD) in Chanthaburi, reported by Somboon et al. (2012) showed us how important it is to know *Vibrio* levels in shrimp tissues (haemolymph and the gut). The report showed different total composition of *Vibrio* in haemolymph and gut in shrimp collected from normal pond and pond with an outbreak of WFD (Table 1). *Vibrio* is normal flora in the shrimp pond ecosystem. It is present in water and also in shrimp. Controlling *Vibrio* at a normal level is important to keep shrimp in a desirable condition. Letting *Vibrio* growth exceed the normal range will lead to a higher susceptibility to diseases.

Table 1. The number of *Vibrio* spp. in the haemolymph and gut of the normal and white faeces infected ponds in Chanthaburi. (Source: Somboon et al., 2012).

Pond	<i>Vibrio</i> spp. in shrimp			
	Haemolymph (CFU/mL)		Gut (CFU/g)	
	Normal	Infected with white faeces	Normal	Infected with white faeces
1	4.446 × 10 ³	7.978 × 10 ⁴	3.448 × 10 ⁶	3.853 × 10 ⁷
2	6.183 × 10 ³	18.955 × 10 ⁴	4.441 × 10 ⁶	3.956 × 10 ⁷
3	8.811 × 10 ³	3.078 × 10 ⁴	4.242 × 10 ⁶	2.049 × 10 ⁷
4	5.915 × 10 ³	12.504 × 10 ⁴	2.918 × 10 ⁶	3.923 × 10 ⁷
5	5.817 × 10 ³	3.822 × 10 ⁴	3.302 × 10 ⁶	3.638 × 10 ⁷
6	6.855 × 10 ³	4.692 × 10 ⁴	2.573 × 10 ⁶	3.628 × 10 ⁷
Mean±SD	6.338 ± 1.444 × 10 ^{3a}	8.505 ± 6.187 × 10 ^{4b}	3.487 ± 0.731 × 10 ⁶	3.508 ± 0.728 × 10 ⁷

Additives to control *Vibrio* in shrimp gut

In the past, many farms applied antibiotics to control *Vibrio*, particularly during the hatchery phase. This led to many cases where shrimp exports were rejected due to banned antibiotics being detected or allowed antibiotics exceeding permitted levels.

There are specific cases where antibiotics in correct doses in shrimp farming is allowed, although application should always be done under the supervision of a veterinarian. The veterinarian will design an application program that runs over the course of several days to treat sick animals. Importantly, antibiotics are not meant for everyday use for normal and healthy shrimp. Improper use of antibiotics can lead to several problems related to antibiotic resistance.

Antibiotic resistance of bacteria impacts the choice of therapeutic drugs humans and animals can use. Antibiotic residues in food-producing animals pose health concerns in humans. Not to be forgotten is the issue of 'superbugs'-bacteria that are resistant to multiple kinds of antibiotics.

In order to control infectious bacterial diseases in shrimp aquaculture, application of natural, antibacterial additives accompanied with various strategies, such as improvement of both pond water quality and the host health, are recommended.

Organic acids could be one option to control *Vibrio* in shrimp gut. In an *in vitro* test, Adams and Boopathy (2013) reported that a low dose of formic acid has good inhibition effect on five *Vibrio* strains. The effective concentration (EC50) value of the test is shown in Table 2. The relative toxicity of the organic acids coincides with the relative lipophilicity. These growth patterns of five strains of *Vibrio* were in agreement with pH change in the media. The pH value in the completely inhibited treatment was ≤ 5. The pH value of the control remained neutral to slightly alkaline. It is more likely that *V. harveyi* and other *Vibrio* species growth is inhibited when the media pH is below or at 5. When the media pH is above 5, *V. harveyi* is able to adapt to the acidic environment and survive. However, we cannot kill 100% *Vibrio* in the ecosystem.

Table 2. EC50 of formic acid versus 5 *Vibrio* strains. (Source: Adams & Boopathy, 2013).

Organism	EC50
<i>Vibrio harveyi</i>	0.023%
<i>Vibrio alginolyticus</i>	0.026%
<i>Vibrio parahaemolyticus</i>	0.030%
<i>Vibrio vulnificus</i>	0.028%
<i>Vibrio cholerae</i>	0.039%

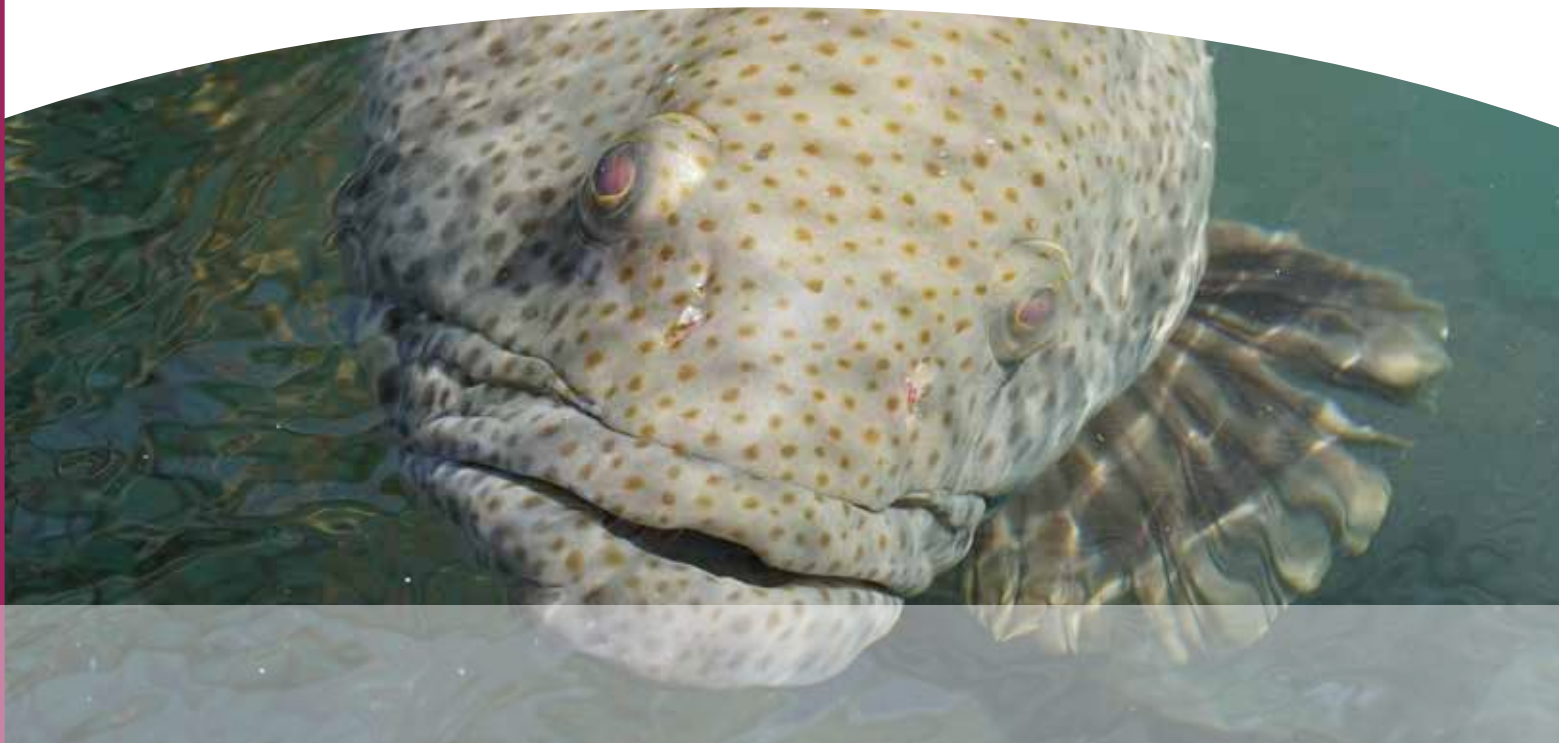
The pH reduction to 5 to kill *Vibrio* could be an issue for organic acids application, due to the slightly basic 7.2-7.4 pH of shrimp gut. Another issue is the effect on feed palatability.

Organic acids, phytochemical, permeabilizing complex

BIOMIN has developed a mix of organic acids blend, a phytochemical compound and a Permeabilizing Complex, known as Biotronic® Top3. Organic acids are blends of formic acid, acetic acid and propionic acid. The three acids have a strong effect on gram-negative bacteria such as *Vibrio*. The phytochemical, cinnamaldehyde, plays a role in inhibiting pathogenic bacteria division (antibacterial action), and keep the bacteria under quorum. Meanwhile, Biomin Permeabilizing Complex makes bacterial membrane permeable allowing acids, phytochemical and other antimicrobial substances to infiltrate easily. With this the dose of acids can be reduced, limiting the negative effect on gut pH.

Several field trials were conducted as *in vivo* test of Biotronic® Top3 to gauge the effect on shrimp growth and capability to control *Vibrio* levels in the gut of *Penaeus monodon* and *L. vannamei*. For *P. monodon*, we conducted the field test on 2 farms. There were 3 selected ponds in each farm as treatment, and 3 ponds each as control. The treatment feed on this field trial was Biotronic® Top3 at inclusion level of 0.8 kg per tonne of feed. In *L. vannamei*, the trial was conducted in one farm where 2 selected ponds were used for the treatment diet and 2 ponds as control.

Figure 1 showed profile of Total *Vibrio* Count (TBC) in shrimp gut until days of culture (DOC 60). Treatment ponds showed similar results. TBC in treatment ponds (Farm A, B and C) declined to levels lower than in the control pond. It was in 10⁴CFU/mL range which is a normal condition, particularly for *P. monodon*.



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Table 3. Harvest data of Farm A, B and C.

Parameter	Farm A (<i>P. monodon</i>)			Farm B (<i>P. monodon</i>)			Farm C (<i>L. vannamei</i>)		
	Control	Treatment	Δ	Control	Treatment	Δ	Control	Treatment	Δ
DOC (days)	133	134		136	137		88	88	
ABW (g)	28.8	31.53	+2.73	31.28	31.72	+0,44	18.34	17.3	-1.04
ADG (g/day)	0.217	0.235	+0.018	0.230	0.232	+0,002	0.21	0.20	-0.01
Biomass/ha (kg)	4863	5388	+525	5194	5345	+151	12201	12138	-63
SR (%)	85.4	86.5	+1,1	86.8	89.9	+3,1	94.15	97.35	+3.2
FCR	1.6	1.6	0	1.53	1.58	-0,05	1.08	1.08	0

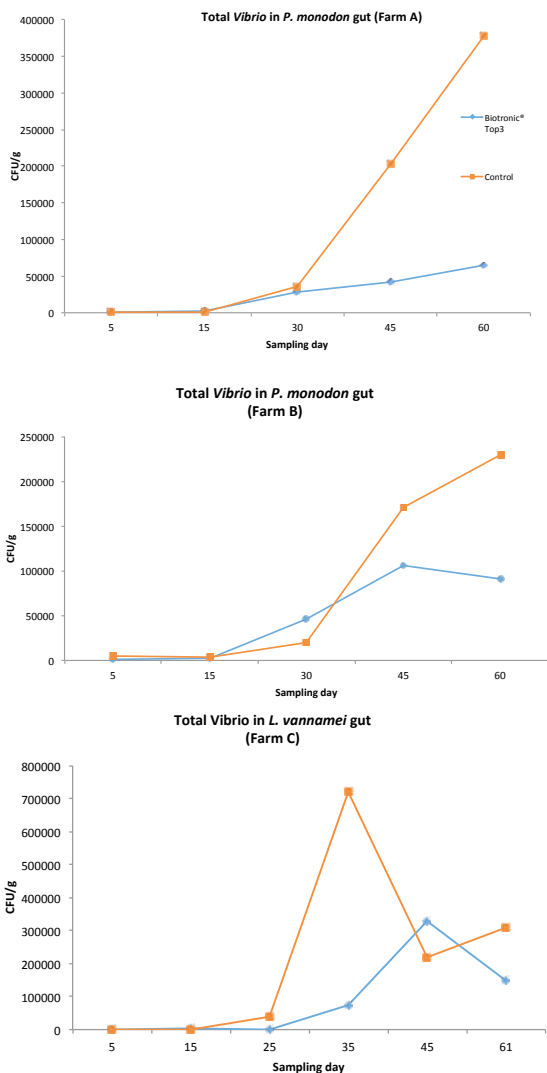


Figure 1. Total *Vibrio* count in the gut of *P. monodon* in Farm A and B; and *L. vannamei* in Farm C.



Figure 2. Checking feeding tray (A) and shrimp in treatment pond Farm A at DOC 110 (B).

Harvest data from three farms is shown in table 3. Results showed that shrimp fed with treatment feed containing Biotronic® Top3 performed better than the control in terms of survival rate, weight, daily growth and biomass. Shrimp survival rate in treatment ponds in all three farms improved in comparison to the control. Importantly, Biotronic® Top3 (containing organic acids blend, phytochemical and Biomin's Permeabilizing Complex) had no negative effect on shrimp growth. The average of daily growth of shrimp in treatment ponds was higher than 0.2 g/day.

Conclusion

It is important to monitor and control the *Vibrio* level in shrimp gut. Additives can be used to control *Vibrio* level. Organic acids (e.g. formic acids) can work to control many strains of *Vibrio*. However, pH reduction will be an issue as when we apply high dose of acids, shrimp growth is affected. A mix of acids blend, phytochemical and Biomin Permeabilizing Complex in Biotronic® Top3 at a very low dose has been proven in a field test (in vivo) with no negative effect on growth.

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Microbial management at farm level

A sharing of recent developments in pond and feed probiotics, scientifically designed and field tested solutions for the shrimp farming industry in India and the rest of Asia.

In March, Lallemand Animal Nutrition (LAN) held its second International Aquaculture Meeting, this time in Chennai, India. A follow-up to the first meeting held in Bangkok in 2012, this meeting confirmed the progress made in the knowledge and science of management of microbial community in the environment and in shrimp gut. This year, 250 participants came from India, Thailand, Malaysia, Vietnam, the Philippines, Indonesia, Iran and Brazil.

The development of new solutions for aquaculture has been associated to Lallemand Aquapharm in Oban, Scotland, the unique library of the Canadian group with over 10,000 marine microorganisms harvested worldwide from unique marine habitats representing the biodiversity of the oceans. Lallemand Aquapharm has the expertise and R&D facilities to select and screen new bacterial and fungi strains for use in aquaculture.

This year speakers from LAN focussed on the latest developments in the field of bioremediation and shrimp intestinal microbiota. They were joined by **Dr Loc Tran**, Aqua Mekong Laboratory, Vietnam who covered current concerns on diseases, including early mortality syndrome (EMS), *Enterocytozoon hepatopenaei* (EHP) and white faeces disease. **Hendrik Aarestrup** shared the philosophy of innovation at the feed company Biomar



Lighting the lamp to start the meeting was led by Dr Baskaran Manimaran, Vice Chancellor, Tamil Nadu Fisheries University (left).

and the use of LAN's EU approved Bactocell (*Pediococcus acidilactici* MA 18/5M) in functional feeds for major European farmed fish and shrimp larval feed.

Werner Jost, Director, Camanor Brazil described an innovative approach to shrimp farming after facing white spot syndrome virus (WSSV) for several years. He recounted the journey for the farm from producing only 50 tonnes of shrimp in 1991 to 500 tonnes annually. In 2013 the farm began to use Aquascience, an



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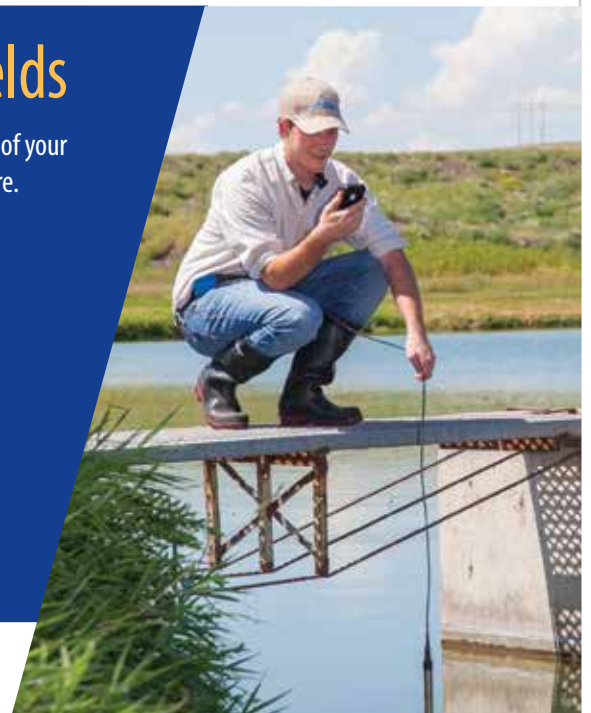
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innovative recirculation system which ensures that parameters are extremely stable for a productivity of 43 tonnes/ha.

Emmanuel Tabert, Commercial Director for LAN eloquently summarised the proceedings for the day. "We try to bring important information to add to current knowledge, as well as highlight what we do at LAN. We bring to you real life solutions, scientifically designed and validated with our partners, research centres, universities and commercial farms. We know that we do not have a silver bullet but at least we can help farmers move one step ahead."

Bioremediation

The basics and control of organic matter, ammonia and nitrite

Dr Mathieu Castex, Research Director, provided the basics of bioremediation in aquaculture and gave insights into how to benefit from microbes present in the pond as well as on external microbes that can be added to modulate the biological processes in the ponds. "It is a natural process and is a part of pond dynamics. However, this is not so straightforward. The difficulty lies in the randomness, the pond to pond variance. Sources of variation range from design, size of pond, location, pond preparation to water management."

On the role of nitrogen as it enters into the pond system, Castex said, "The bacteria component plays a critical role in the recirculation of nitrogen in the pond. There is no single way to manage the pond and we need to understand the microbial ecosystem to better react and adjust practices depending on the situation. We need to know not only the bacteria but also their functions, and use these knowledge as biological tools to better manage ponds."

"Getting a perfect scenario in a pond is not easy with physio-chemical constraints such as the effect of alkalinity on nitrification processes. A basic understanding of microbial



Werner Jost (right) with Luiz Henriques S Peregrino, Technical Supervisor, Camanor

ecology and nitrogen cycling is important to drive microbial bioremediation. For instance we looked at the effect of salinity where we found reduction in nitrification as different microbes are at play affecting assimilation. Different microbial species or even strains from the same species are involved in denitrification and nitrification in seawater and in freshwater. There is no rule of thumb as salinity will change with rainfall and climate and the farmer needs to adjust its practices in order to take benefit from a natural microbial diversity in his ponds or by using specifically selected microbes adapted to various environments."

Castex said, "Our initial work was based on the selection of competitive heterotrophic bacteria adapted to various environments". He detailed the work at Lallemand Aquapharm in screening more than 300 bacteria. His take home message was, "Although nitrogen cycling in shrimp ponds is a complex process, we need to understand what we can achieve through pond management. Using carefully chosen bioremediation solutions and protocols is one tool at farmers reach but it does not replace the need for optimal pond management practices and a basic understanding of pond dynamics. At the same time, farmers should be concerned on the issue of antibiotic resistant genes, and select products with adequate safety documentation. Use of safe and specifically selected microbial consortium is important."

Scientific and practical developments

Stephane Ralite, Aquaculture Product Manager described achievements to date on bringing information to the field and on product development.

"We look at the classical problems in shrimp farming, including uncontrolled algal bloom, black sludge, pathogens development, and ammonia and nitrite concentrations. Bioremediation, in a shrimp pond, is a process aimed to mitigate organic matter and



Mathieu Castex (left) and Loc Tran

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Henrik Aarestrup and Stephane Ralite (right)

nitrogen levels and to control pathogens. The screening of bacteria for bioremediation is achieved through a series of processes such as enzyme activity and *Vibrio* inhibition. The capacity for bacteria to grow in various environmental conditions is also critical, for instance growth at various salinities is particularly crucial in India, where pond water salinities change considerably from close to 0 to 50 ppt. Not only is bacteria species important but also the selection of the strains. The efficacy can be highly variable from strains to strains within the same species. That is why our Lalsea Biorem, marketed in several countries comprises seven strains but less than seven bacteria species.”

The challenge is applying this information at the field level. Ralite described results of some trials in India carried out in partnership with a feed company, Avanti and in Thailand with Kasetsart University. “With Kasetsart, we analyse the ability of Lalsea Biorem to control total organic matter and ammonia from shrimp faeces. We demonstrate the efficacy of Lalsea Biorem with a clear dose effect. However, to adapt to real conditions, and prove the efficacy of bioremediation concept, we developed a model in tank to mimic what happens in a pond.”

Ralite described some effects of bioremediation. “Our metagenomics analysis shows changes in the sludge bacteria population when bioremediation products were added into the tank. We also demonstrated a dose effect of Lalsea Biorem on ammonia, nitrite and nitrate evolution in water and on specific growth rate of vannamei shrimp. We could describe the implementation of the nitrification process which was strongly influenced by heterotrophic bacteria development. Lalsea Biorem, at commercial doses, speed up ammonia assimilation by heterotrophic bacteria, leading to delayed, but also more complete, nitrification.”

The take home message was, “Bioremediation is a multifactorial process with no single solution and bioremediation bacteria have more difficulties in high saline waters. All strains are not alike and multi strains are not always better. Bioremediation concept has been proven efficient at commercial doses”



From left, Sushanth, D. Sambasiva Rao and Natarajan, Avanti Feeds Limited

Gut microbial management

Gut microbiota in the shrimp gut comprises bacteria, yeast, parasites and viruses or bacteriophages. Castex said, “Among them, we know more on bacteria which is highly concentrated at 10^6 to 10^9 CFU/g. Microbe diversity in the shrimp gut is low relative to that in fish. Most of these microbes are transient because they are evacuated with digesta and during molting. This low diversity means that the shrimp is not able to competitively exclude pathogenic bacteria. There is a high variability between individual shrimp, which explains susceptibility to opportunistic pathogens.

“Recent molecular techniques allow us to better characterise the shrimp microbiota as it grows from post larvae (PL15) to adult. A study in Thailand, confirmed not only a low diversity of bacteria but a relatively high abundance of gamma *Proteobacteria* and the *Vibrio* species is within this group. Bacterial diversity in post larval gut is higher than that at the adult stage and is very different, which probably gives the post larvae advantages in terms of competitive exclusion and sensitivity to *Vibrio*.

“In terms of functionality, we know the gut microbiota is strongly linked to disease infection and studies with probiotics have provided most of the information known. The presence of autochthonous bacteria has a positive effect in preventing pathogenic bacteria to develop. Our studies with Bactocell spanning almost 10 years, showed that the rapidness of probiotic bacteria cells to invest the gut and how they are associated with the gut cells. This is essential to get the best value of the probiotic.”

Understanding the link is essential to reduce the risk of opportunistic infections. On feed probiotics to modulate shrimp gut microbiota, Castex said Lallemand studied probiotics and disease mitigation strategies including the use of specific fungal

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fractions in feed. “We observed that feed probiotics can reduce pathogenic *Vibrio* in the haemolymph by 50%. We know that current diseases such as white faeces, acute hepatopancreatic necrosis disease (AHPND) and running mortality syndrome are linked one way or another to what is happening in the gut. Research at Biotec, Thailand showed with white faeces infected shrimp, there is disturbance of microvilli in the gut with gregarine like structures and intestinal damage.”

Castex concluded, “Today, we may not know the full picture of bacteria in the gut but primitive intestinal intervention makes sense because this is the place where a lot of interactions are likely to happen. This continues to be an interesting field of research.”

Control of EHP and EMS/AHPND

At the Aqua Mekong Laboratory in Vietnam, **Dr Loc Tran and colleagues** have been investigating the route to transmission of the microsporidian EHP. Tran called EHP, the new ‘hidden killer’. In Vietnam, farms reported shrimp with stunted growth and without gross signs of EMS or any other viral infections. “We traced back the infection to the hatchery and broodstock. Imported broodstock did not have any EHP infection but when fed live feeds, they were infected after a few days. It is now evident that hatcheries were using live feed collected by fishermen in areas close to shrimp farms. Such locations were incubators for the microsporidian.

“When frozen feeds were fed to broodstock, there was no infection, indicating spores do not survive freezing temperatures. Our co-habitation trials in the laboratory showed that EHP is transmitted to healthy shrimp through faeces. Our co-habitation work with 1-2 g shrimp in cages suspended in tanks showed that after 48 hours SPF shrimp were infected.

“Antifungal or biocidal products work to stop transmission. High doses of formalin destroy spores and DNA is degraded but shrimp survived. We used qPCR to quantify the microsporidian load in a co-habitation model. Even after 15 days the spores continued to increase to $\sim 10^8$ copies/g. We found a feed additive, fed continuously can maintain a load of 10^4 copies/g by the 5th day. This gives us the direction to work on.”

In the case of EMS/AHPND, Tran detailed the risks associated with outbreaks. “Most of the time when the EMS causing bacteria in water is more than 10^5 CFU/mL shrimp mortality occurs. That is why in the ponds mortality continues as healthy shrimp feed on dead shrimp. Therefore, removing dead shrimp and sludge to keep pond bottom clean helped in keeping the disease away. In the hatchery, we found live feed contaminated with *Vibrio* bacteria. Again, the practice of using live feed is dangerous.

“Controlling *V. parahaemolyticus* is a nightmare. In our laboratory, we are carrying out a lot of treatments, with probiotics, phage therapies, acidifiers, essential oils and traditional herbs and others. Some work and some do not. My take home message is that there is no single solution; prevention is critical and we have to return to sustainable shrimp farming methods.”



From left, Celina Donna Bantoc, Technical Manager, Lallemand Animal Nutrition, Philippines, Neil Raphael S Jamon, Hoc Po Feeds Co, Ong Si Mon, Malaysia, Glenn Torres, Farm Manager of Santeh Feeds Corporation and Cesar Policarpio, Nezus Philippines Corporation.



Emmanuel Tabert (left) presented an award to Avanti Feeds Ltd for its six-year partnership with Lallemand Animal Nutrition. C. Ramachandra Rao, Joint Managing Director represented Avanti. Indrakumar Alluri, Chairman and Managing Director delivered a message via a video conference. Also in the picture, from left, Dr Pradipt Linge, Area Manager and Dhanunjaya Goud, Technical & Sales Manager - South and South East Asia (Aquaculture) at Lallemand Animal Nutrition and Dr Mathieu Castex.

Probiotics and yeast fractions work against EMS and white faeces

Ralite followed up with some results of trials conducted by Lallemand Aqua. “A shrimp farm is like a stool and the three legs (representing host health status, environment quality and pathogen pressure) should be strong for farm success. At Lallemand Aquapharm we apply some specific protocol in reducing or controlling the growth of *V. parahaemolyticus* to screen live probiotic strains and yeast fractions.”

The initial selection for the best bacterial candidates involved screening 331 tested strains down to 14 strains showing inhibition of *V. parahaemolyticus* and then a selection of 4 strains after co-culture. In the case of yeast fractions, Ralite said, “Until now, the way to explain yeast functionalities has been done by their composition (1,3 and 1,6 beta glucans, MOS, nucleotides etc). We have gone further using Atomic Force Microscopy to select yeast fractions also based on some physical properties. This led to the development of new yeast product called ‘Yang’ with three properties: pathogen binding, immune modulation and mucus production. The next step was *in vitro* and *in vivo* testing in the laboratory and field validation.”

“Our *in vivo* validation was done in the Aqua Mekong Laboratory. Bactocell and two selected bacterial strains have been tested on survival of shrimp in a 31-day feeding trial. The 10-day immersion challenge was with virulent *V. parahaemolyticus* strain able to induce AHPND at 1.1×10^9 CFU/mL. Bactocell and one selected strain showed resistance against the *V. parahaemolyticus* challenge with survival at 65% and just over 70%, respectively. The Yang yeast fraction showed a clear dose effect with survival at over 70% for the treatment containing 1.2 kg/tonne of feed.” added Ralite.

Farm trials with a combination of Bactocell and Yang demonstrated an effect on white faeces disease. “In Indonesia, Bactocell alone at high dose was able to stop white faeces infection after 5 days of treatment in a pond with 126 PL/m² stocking density. In India, at 50 PL/m², Bactocell and Yang gave a 100% recovery after 10 days compared to 10% recovery with the control diet. In Vietnam, the combination stopped white faeces infection after 7 days of treatment and shrimp density was 60 PL/m².”

Ralite had this message, “Here we show that results are consistent against *V. parahaemolyticus* and can have efficient action with white faeces. But, as these pathologies are multi factorial, there is no magic bullet to solve the problem completely. Even if the *Vibrio* control is quite spectacular in the laboratory, Bactocell and Yang, are only one useful tool to control these pathology in the farm.”

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Preparing for the next generation in shrimp farming

Shrimp pioneer Dr I Chiu Liao, culminates decades of involvement in Asia's shrimp aquaculture research and development with a new book, co-edited with Nai-Hsien Chao, former senior specialist of Taiwan Fisheries Research Institute and now visiting researcher, Institute of Biotechnology, National Cheng Kung University, Taiwan and Dr Eduardo Leaña, Network of Aquaculture Centres (NACA), Thailand.

IC Liao says, "It seems there is no limitation for the development of biotechnology for the next generation to carry on. Today, it is exciting news to all that there have been tremendous breakthroughs on the scientific and applied research on how *Penaeus monodon* has been challenging WSSV, which might lead to a revival of this once booming industry in the Asia Pacific region."

"This book is the result of the dedication and never ending efforts of these three editors. It is also to recognise the efforts of scientists involved in the shrimp and prawn farming industry. For us, it is also the story of the growth of the National Taiwan Ocean University (NTOU) for fisheries, aquaculture and oceanography and ocean engineering management," said Ching Fong Chang, President, National Taiwan Ocean University, in his introduction to the book.

For this 444-page hardcover book with 18 chapters, the editors invited contributions from outstanding experts in shrimp aquaculture. Chapters covered old and new information. The book begins with a chapter on the dawn of the decapod crustacean propagation and culture. It traces the taxonomy of decapods and development. The reader will remember IC Liao's journey in 1968 when he made the breakthrough on the breeding of the grass shrimp, the Taiwanese name for *P. monodon*. This started an industry in Taiwan which quickly spread to other parts of Asia.

In chapter 2, K. Shigueno, summarises the memorable events in the last 50 years in the culture of the kuruma ebi *Penaeus (Marsupenaeus) japonicus*. The most recent innovation in its farming is the use of recirculation technology with stocking at 250 post larvae/m² which, Shigueno says, gives a productivity of ten times that of pond culture and with thermal water 1.5 cycles are possible. In chapter 4, authors describe the development of shrimp aquaculture techniques and facilities in Taiwan. It also includes the contributions of NTOU, other institutions, and universities and the progress covered during those early days before 1969 up to the present. It provides details of developments such as the use of the paddlewheel raceway systems and the sediment removal systems in intensive shrimp ponds. There is also mention on the use of recirculation systems to solve problems with disease and the excessive use of ground water, a practice common in Taiwan. The authors conclude that the conventional intensive model of farming shrimp is unlikely to be adopted again and the domestic demand is unlikely to be met. Despite decades of research and

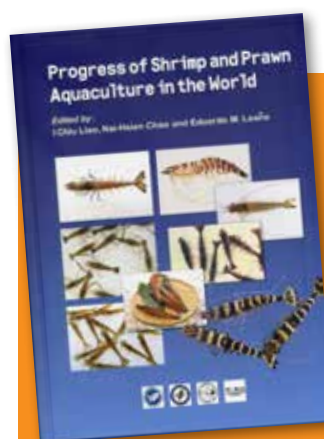


The book is dedicated to IC Liao's late mother, pictured here with Liao and Nai-Hsien Chao (left).

testing, the actual operating cost of indoor recirculation systems remains high and shrimp prices must be above USD 13/kg for the system to be cost effective. Taiwan imports USD 70 million of shrimp annually.

The book has four more chapters on developments in Taiwan and industry reviews on shrimp farming in the Americas, Vietnam, India, Philippines and China. The chapter on shrimp genetics deal with the work on *P. vannamei* in Hawaii and *Fenneropenaeus chinensis* in China. Another interesting chapter by Han-Ching Wang, National Cheng Kung University, Taiwan and collaborators in Taiwan touches on "Science to the Rescue: Interventions that help shrimp in the arms race against white spot syndrome (WSSV)."

The information in the book is useful to all those interested in learning the science of shrimp farming from students, researchers to industry stakeholders and investors. The book will be a useful reference for those interested in venturing into this exciting field of shrimp and prawn farming.



Title: **Progress of Shrimp and Prawn Aquaculture in the World**

Editors: **I Chiu Liao, Nai Hsien Chao and Eduardo M Leaña**

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Publisher: Center of Excellence for the Oceans National Taiwan Ocean University

More information: The book is available at USD 50. Email to order: koanita1225@gmail.com (Hui Yu Ko)

Shrimp nursery technology:

System design and management for cost-effective results

Part 2. Water quality, biofloc technology, feeds and feed management

By Craig Browdy, Peter Van Wyk, Chris Stock, Thomas R. Zeigler and Ramir Lee

Properly designed shrimp nursery systems are high-biosecurity facilities to grow post larvae at high and hyper intensive densities, from 2 mg to as large as 3 g. The aim is to produce healthy, strong and uniform juveniles with significant potential for compensatory growth after their transfer for final grow out. Part 1 of this article in issue March/April (pp 39-43) covered design considerations.

Hyper-intensive shrimp nurseries maximize production efficiencies. At very high stocking densities, high feed inputs demand careful attention to water quality. From initial filling through the production cycle, system management based on a sound fundamental understanding of microbial and water quality dynamics coupled with the use of high quality specialised feeds and precision feeding strategies are essential.

Water quality

Water should be pumped into reservoir tanks from a high quality source and properly treated. Most nursery systems should implement at least some degree of filtration and disinfection of incoming water, including sand filtration, cartridge filtration (5-50 microns; layers of 1-micron, filter bags are highly recommended) and chlorination (20-30 ppm). De-chlorination can be accomplished by aeration or addition of thiosulfate, but the latter approach is discouraged because of possible detrimental effect of the chemical to the animals. Vitamin C addition and natural de-chlorination with aeration are two of the best approaches. Without exception, all nurseries should strive for the highest levels of biosecurity and implement additional post-filtration of incoming water, including the use of ozone or UV sterilisation and final cartridge filtration.

Support equipment for nurseries must include suitably-sized incoming water pump(s), distribution pipes and blowers with sufficient capacity and emergency back-up power. Maintaining oxygen levels and mixing is absolutely critical. Round tanks usually use a single 0.5-1 hp blower for each 100-m³ of tank volume. Rectangular tanks usually use 2-3 hp blowers per

100-m³ of tank volume. Newer designs normally use venturis or air injectors that both aerate and circulate the water without the need for any blowers. The most efficient designs require lower initial capital investments and have lower operating costs while increasing the system's carrying capacity.

Shrimp nurseries operate at very high stocking density and biomass, imposing the need for continuous monitoring of critical water quality and animal health parameters. Aside from the essential equipment for water quality monitoring in a pond and hatchery, ORP meters, power backup systems and backup oxygen supplies are required. Monitoring of ionic balance including calcium, magnesium and potassium levels and their ratios is required when using lower salinity water. Larger and more complex nurseries can also have automated monitoring systems with a variety of sensors and alarms to promptly warn operators of system failures and problems.

Proper aeration is absolutely critical in nursery systems, not only to provide oxygen to shrimp for effective feed utilisation and growth, but just as importantly to oxidise the liquid, solid and gaseous waste of the system. Water aeration, circulation and circular flow are taken care of by various equipment, including spray bars from high pressure pumps, nozzles and/or airlift pumps. Depending on the system, paddle wheels can be used for older juveniles but are discouraged at initial stocking due to potential physical damage to the young shrimp. Systems using both spray bars and airlift pumps have the advantages of redundancy if either the water pumps or air blowers have mechanical failures.

Along with proper water temperature (normally not an issue in indoor systems), DO is the most important water quality parameter. It must be maintained at or above 4ppm, however, 6ppm is recommended to support optimum growth. With high inputs of feed, there is high demand for oxygen by the target crop and by the microbial community in the water. Any change in aeration efficiencies or power failures can quickly become catastrophic. Thus, monitoring of equipment and oxygen levels should be carried out continually or at least 12 times per day. DO levels of less than 4 ppm require prompt measures like water exchange and sludge removal, suspension of feeding, probiotic treatments, and the addition of pure oxygen.



Adequate aeration is absolutely critical in nursery systems as shown in these raceway systems in China (right) and Ecuador (left).



Water aeration include spray bars from blowers (left) and diffuser aeration hoses on bottom of raceways (middle). Paddle wheels as in this raceway in China, can be used for older and larger juveniles (right).

One of the keys to successful operation of intensive nurseries is management of nitrogenous wastes. Ammonia can be quite toxic at high pH and nitrite toxicity can easily cause mortality in these systems if not monitored and properly managed as discussed below. Any settling of organic material in the system allows for anaerobic decomposition producing harmful compounds like H_2S which can quickly compromise the health of the crop.

Biofloc technology

Biofloc technologies are at the core of the design and operation of modern hyper-intensive nursery systems. When managed correctly, a diverse healthy microbial community contributes directly and indirectly to shrimp nutrition and growth while processing excess nitrogen in the system. Once established, the community becomes stable, competitively excluding harmful opportunistic *Vibrios*, improving shrimp health and immune competence before transfer to growout ponds. The key to maximizing these benefits is in understanding and managing the microbial community in the system.

Fundamentally, the microbes can be best understood through three key functional groups: heterotrophic bacteria, nitrifiers, and microalgae. Heterotrophic bacteria take up nitrogen and carbon from the system building more bacterial cells. Feeds which drive the system are high in nitrogen, particularly high protein feeds for young animals. Addition of carbon drives production of heterotrophic bacterial biomass pushing them to higher and higher concentrations as evidenced by increasing floc volume. Nitrifiers cycle ammonia to nitrite and nitrate. They are slow growing, requiring time to become established unless head started through water reuse or direct addition. Once functional, the chemoautotrophic nitrifiers can cycle all excess nitrogen through to nitrate if alkalinity and oxygen levels are maintained. Photoautotrophic algae can grow as long as there is light penetration. Growth of beneficial algae like diatoms have been correlated with higher shrimp growth. The challenge for the grower is to understand and manage these components, balancing functional roles and driving the community to maintain water quality, growth and health.

When ammonia and nitrite levels are problematic, addition of molasses, sugar or other carbon sources provides a short term solution, building more microbial biomass and tying up organic material until the cells die and decompose. Continual addition of carbon results in very high floc volume, and excess organic material which can build up as sludge. Thus, the system should be managed to maximize nitrification. Understanding when and how much carbon addition to use is the first key to successful water quality management. High floc levels cause gill fouling, increase propensity for sludge accumulation and shade light reducing algal productivity. All of these reduce growth and lead to health problems. Thus, the second key to system management is maintaining optimum floc levels. This is achieved through use of settling chambers and foam fractionation in closed systems and/or through strategic collection and flushing of sludge with water exchange or recirculation. On the other hand, too much water exchange can lead to system instability, algal blooms and crashes and pH swings. Thus, managers must actively measure and regulate floc composition and density.

To establish a biofloc, the following procedure is recommended by well-known shrimp farming and biofloc expert Dr Tzachi Samocha. Firstly, add a probiotic such as EZ Bio daily, beginning before the start of the production cycle. Proper use of an effective probiotic can be an important management tool, particularly at startup. Ongoing R&D is providing more empirical data to advance strain selection, dosages and functionality. Secondly, at the start of the production cycle, add sugar in proportion to the amount of feed added (30%) and thirdly, measure all forms of nitrogen (NH_4-N , NO_2-N , NO_3-N) daily. When nitrate appears, gradually decrease the amount of sugar added eventually eliminating carbon addition after 5-7 days. With proper startup and ongoing management, biofloc stability can be achieved and maintained.

Feeds and feed management

In hyper-intensive nursery systems as in all shrimp farming, it is the feed inputs that drive success or failure of the crop. Feeds directly determine shrimp growth and health while indirectly



Filtration include sand and cartridge filters (left) and 1 or 5 microns filter bags (right).

driving key water quality parameters. Flocs can contribute some micronutrients for shrimp and can enhance growth but floc is not a reliable, constant predictable source of food for shrimp. Although the importance of proper feed selection and management is fundamental to successful operation of hyper-intensive nursery systems, feed selection and management strategies vary greatly from producer to producer. Practices typically originate from traditional procedures modified through personal experiences and preferences. A scientific approach to feed selection and management should focus on the evaluation of three key variables. Feed formulation, feed physical characteristics and feeding protocols. The key to success is to strive towards providing each shrimp exactly what they need, exactly when and where they need it. Use of regular pond feeds in hyper-intensive nursery systems significantly compromises performance. Waste feed and undigestible nutrients go directly or indirectly into the water, driving water and bottom quality deterioration, reducing growth and compromising health.

Formulation

During the nursery phase shrimp are growing at an exponential rate. Genetic strains utilized today have significantly higher growth potential requiring adequate nutrients for maximum performance. Specialized nutrient dense nursery feeds are available from Zeigler today to provide 100% of the nutritional requirements with the correct balance of essential nutrients. They have to be highly palatable, and very digestible. The feed should be precisely formulated to support shrimp health, enhance immune system balance and reduce stress during the transfer to the grow-out pond.

Table 1. ZBI feeding program for various stages, animal weights and production biomass.

Prod Stage	Animal Weight	Option 1: Hyper-Intensive Recommended for high biomass conditions			Option 2: Traditional Recommended for low-to-medium biomass conditions		
		Product	Protein /Fat	Particle Size	Product	Protein /Fat	Particle Size
1	2-10 mg	EZ Artemia	52-17*	0.3-0.5 mm	EZ Artemia	52-17*	0.3-0.5 mm
1	2-10 mg	PL Raceway 40-9 w/Vpak	50-15	0.4-0.6 mm	PL Raceway 40-9 w/Vpak	40-9	0.4-0.6 mm
2	10-100 mg	PL Raceway Plus w/Vpak	50-15	0.6-0.85 mm	PL Raceway 40-9 w/Vpak	40-9	0.6-0.85 mm
3	100-400 mg	PL Raceway Plus w/Vpak	50-15	0.85-1.2 mm	PL Raceway 40-9 w/Vpak	40-9	0.85-1.2 mm
4	400 mg-1.5 g	PL Raceway 40-9 w/Vpak	40-9	1.5 mm	PL Raceway 40-9 w/Vpak	40-9	1.5 mm
5	1.5-3.0 g	PL Raceway 40-9 w/Vpak	40-9	2.0 mm	PL Raceway 40-9 w/Vpak	40-9	2.0 mm

*Dry Weight

Physical characteristics

The particle size and uniformity of the feed used depends on shrimp size and its uniformity. Particle sizes and shapes should be optimized for the size range of the shrimp population in the system. Table 1 above includes pertinent information based on our proven Precision Feeding Program (PFP™), for various shrimp stages, weights and production biomass.

If there are animals of different sizes within a tank, then feed particles of various sizes need to be used. Optimally, every shrimp in the tank should have access to a properly sized particle of feed at each feeding. It is the producer's responsibility to check labels for manufacture dates to ensure feed freshness. Good packaging is essential to retain feed quality and nitrogen should be used in the packaging to extend its shelf life and palatability. The feed must have a balance between good water stability to retain nutrients but not be so hard that it loses its attractability and texture.

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Checking feed trays (left) and juveniles with full guts.

Feed application

The goal of a precision feeding program is to provide just enough feed to achieve the desired growth objective. Precise calculation of feeding rates requires accurate prediction of shrimp survival, growth and feed conversion efficiencies for the selected shrimp strain and diet. Optimizing feeding rates can be greatly facilitated using feeding programs that adjust feeding recommendations according to population status and system temperature while allowing operators to make proactive adjustments during the cycle based on sampling data, potential for compensatory growth, and observations of molting, water quality, excess feed etc. For example, our PFP™ program incorporates sophisticated algorithms to adjust for predicted temperature changes and enables daily user input to adjust feeding according to conditions in each nursery unit.

Continuous feeding using automatic feeders is recommended because shrimp are constantly feeding or grazing. The minimum recommended feeding frequency is once every two hours (12 times per day) with equal quantities of feed for each feeding. This is because the nutritional value of aqua feeds begins to decline immediately when placed in water and can lose much of their value after only one hour in water. Constant daily feeding rates enhance conditions for desirable and beneficial steady-state water quality. At each feeding, inputs of organic material are reflected in increased oxygen demand. More frequent application of smaller inputs reduces fluctuations in oxygen demand. This in turn reduces peak aeration requirements and changes in dissolved oxygen levels.

The feed should reach 70% to 80% of the area of the system within several minutes of each feeding. This can be achieved by physically broadcasting the feed across the surface or by allowing the water circulation to distribute it. Excessive buildup of feed in localised areas such as tank corners, can promote low oxygen conditions and produce harmful hydrogen sulfide. Overfeeding must be avoided. The goal is to feed the proper quantity of feed to each shrimp where they can easily access and promptly consume the feed.

Compensatory gain

It is typical that in well managed hyper-intensive nurseries shrimp grow at a rate below their apparent genetic potential at lower densities. Thus, size of shrimp at harvest should be expected to be somewhat smaller than that of animals stocked directly into a pond at the same temperature. However, shrimp have been shown to recover this growth difference in a very short time if the producer adapts initial pond feeding rates to support compensatory gain after the successful transfer of healthy nursed juveniles to grow-out ponds. This is one of the most important tools in pond management, to shorten time in grow-out ponds to market size, reduce disease risk and increase profitability.

Perspectives

Properly designed and operated shrimp nurseries provide proven benefits and allow for much more efficient use of the carrying capacity of ponds with direct stocking of post larvae, while significantly manage risk during the first 20-40 days of the cycle. Shorter pond cycles, daily fixed costs are reduced for each kg of shrimp produced.

The best economic gains from the proper use of nurseries are realised. There is the opportunity to stock larger post larvae in ponds, reduce the total duration of a cycle to market size, hold post larvae when temperatures are too cold for open pond stocking or to have a large quantity of juveniles ready to stock when temperature increase or regulations permit. Producers can also reduce time to harvest by having juveniles ready to re-stock a pond following a harvest, increasing the number of cycles per year or improving the size of shrimp at harvest. An additional benefit is to have juveniles large enough to go directly on to pelleted feeds when stocking where primary productivity is low (oceanic water).

Shrimp farmers continually look for ways to lower risk while increasing operational efficiencies and profitability. Effective implementation of hyper-intensive nursery systems is a fast and cost-effective way to accomplish this. Proper management of water quality and precise specialized feed inputs in shrimp nursery systems are critical prerequisites to success. Adoption (and in some cases re-adoption) of improved nursery systems technologies, is increasingly common in Asia and their growing role for future industry success is evident.



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Continuing tough times in 2015

By Zuridah Merican

In general, aqua feed production was below rated capacity in most countries. El Niño ruled with hot weather, higher salinity and reduced feed demand.

Low shrimp feed volumes for 2015, which were generally below rated capacity in most countries, reflected the difficulties faced by shrimp farmers. Up to the present, the list of disease extends to include the microsporidian *Enterocytozoon hepatopenaei* (EHP). On top of this, El Niño brought on the generally hot weather coupled by prolonged dry season, drought and higher salinity. Shrimp growth was already slow with EHP and the higher salinity further reduced growth rate. Feed sales dropped in Vietnam when farmers reacted to lower offer prices by reducing stocking density.

There was a significant increase in fish feed production in Vietnam, mainly for the pangasius, tilapia and snakehead fish. High temperatures and lack of water reduced feed demand in Indonesia and Thailand. High temperatures affected fish spawning and produced low quality fry and consequently reducing feed sales (MS Bulletin, 2015). While farmers in Thailand pushed the demand for low pollution feeds, containing phytase and/or probiotics, in Malaysia, farmers opted for less feeding and lowered stocking density. Industry estimates showed that China produced less feeds for the freshwater fish, but more feeds for the marine fish in 2015.

Recent developments in aqua feed production for leading producing countries are discussed below. There is a report on the developments in China on pages 40-42.

Vietnam

In 2015, Vietnam's shrimp feed totalled almost 460,000 tonnes, a drastic decline from 680,000 tonnes in 2014 although some feed millers had estimated only a decline of only 20% at the end of 2015. Ma Chin Tien, Uni President Vietnam said that Vietnamese farmers have better control of the early mortality syndrome (EMS), but EHP is a major problem. Farmers reported slow growth such as 10 g after 3 months of culture and with very high



Hernan Lim (right) and Roberto Gatuslao, President, Philippine Shrimp Industry (PHILSHRIMP) at the Hoc Po booth during the 10th Philippines Shrimp Congress in General Santos City.

feed conversion ratios (FCR). Under good conditions, FCR was 1.1 to 1.3 and within 80 days, shrimp reached 16-20 g. Ma also said that farmers shunned premium feeds and even booster feeds because of low offer prices for the shrimp harvested. The top three leaders in shrimp feed production in 2015 were CP Vietnam, Uni President Vietnam and Grobest; together they had 50% of the market share, mainly feeds for the vannamei shrimp.

In contrast, Vietnam's fish feed production continued to rise. Feed for the pangasius dominated at 1.8 million tonnes. Almost half of this production was by Viet Thang and Tay Nam; both are feed milling subsidiaries of Hung Vuong, the leading pangasius integrator. Two independent feed millers, Proconco and Green Feed are also leading players in this feed market. The loss in shrimp feed is compensated with increases in tilapia feeds for Uni President Vietnam which together with Cargill, CJ Vina, CP Vietnam are the leading producers. Tilapia feed production grew from more than 360,000 tonnes in 2014 (David Serene, pers comm.) to almost 450,000 tonnes in 2015. Production of feeds for the snakehead fish increased 30%.

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Haris Muhtadi, CJ Feeds Indonesia (right) and shrimp producers, Sim Ing Jye, Sea Horse Farms, Sarawak, Malaysia (left) and Lee Weng Wah, JCS, Kalimantan, Indonesia, at Asian Pacific Aquaculture (APA2016).

India

The industry estimate for shrimp feed volumes in 2015 was 800,000 tonnes. This was in spite of a lower volume of shrimp produced. "The main diseases in shrimp farming was white spot syndrome virus (WSSV), white faeces disease (WFD), EHP and running mortality syndrome," said S.V. Alavandi and K.K. Vijayan at AqualIndia 2016. They also discussed growth variation and stunted growth of vannamei shrimp. Although production volumes for shrimp feed was well below capacity in India which is 1.8 million tonnes, the industry continues to attract new players. Two shrimp integrators and two livestock feed producers are planning to set up feed milling operations in the next few years. This move may translate to a loss of future feed sales by suppliers of feed to these integrators.

The shrimp feed market is dominated by Avanti Feeds Ltd and CP India, with almost 72% of market share. Growel which started shrimp feed production in 2014 is among the top five shrimp feed millers, which also includes The Waterbase and Godrej. Shrimp feed imports from Sheng Long and Uni President in Vietnam totalled 30,000 tonnes. Sheng Long has begun construction of its feed mill in Tamil Nadu, scheduled to start production in 2017. "By 2017, shrimp feed capacity may reach 2 million tonnes as Avanti Feeds, Growel and CP India expand capacity and a livestock feed miller diversify into shrimp feed production," said Ramesh Gangatharan, Wenger, India. He also expects increases in shrimp production with higher demand for 10 g shrimp in local markets. No growth was reported in the fish feed market which remained dominated by extruded feeds for the pangasius.

A major business constraint for the shrimp feed industry in India and countries such as the Philippines is the seasonal demand for shrimp feed. At AqualIndia 2016, Dr Victor Suresh charted the seasonal variation in feed demand in India which is highest in June and lowest during the coldest months.

Indonesia

According to Denny Indradjaja, GPMT, the fish feed sector in Indonesia did not see any growth in 2015 and remained at 1.2 million tonnes. Adverse conditions due to El Nino reduced and shifted demand. For example, feed production for the Clarias catfish declined to 380,000 tonnes in 2015 in comparison with 500,000 tonnes in 2014 (Trobos Aqua, 2016). However, shrimp feed volumes increased to 336,000 - 380,000 tonnes. This reflected the success with small but intensive farms for the vannamei shrimp and industry-wide practice of waste removal

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in shrimp ponds to manage pond conditions. Without such practices, there would be a 20% decline in shrimp feed sales. Relatively large ponds of 5,000 m² are being converted into smaller 3,000 m² and those of 1,000 m² to only 500 m² ponds for ease of control.

Production capacity for both shrimp and fish feed is expected to increase in 2016 and beyond. Under construction is a new plant in East Java for CJ Feeds to produce 30,000 tonnes per year (tpy) of extruded fish feeds. Operations will start in mid 2016. CJ is a leading shrimp feed producer with two plants producing almost 75,000 tpy. Cargill is expanding shrimp feed production and PT Matahari Sakti (MS) will continue to expand its shrimp feed production in East Java. According to Indradjaja, two leading feed millers from China have expressed interest in integrated operations in Indonesia including setting up feed mills for shrimp and fish feeds. There are imported shrimp feeds from Thailand and Vietnam in the market.

A future impact on the fish feed industry in Indonesia is the government's plan to reduce significantly the number of cages in the freshwater lakes, Cirata and Jatuluhur. Only extruded feeds will be allowed for carp and tilapia farming in these lakes. The government has also asked GPMT to reduce the cost of fish feeds by IDR 1,000/kg. Currently, the retail price for general freshwater fish feeds is IDR 9,000 to IDR 10,000/kg. There is also a program to encourage production of farm made feeds by providing feed equipment. The target is to bring down feed costs to IDR 5,000-6000/kg.

Thailand

Shrimp feed production rose 20% in 2015, reflecting a small improvement in shrimp production. CPF led with 50% of the shrimp feed market share. The other leading players are Thai Union Feedmill (TUF), Grobest, Intecq Feeds and TRF Feeds. As shrimp feed lines are run for only a few days, feed millers compensate with increasing feed production for marine fish, mainly for the seabass.

With a long drought, the focus is to conserve water and reduce pollution in freshwater fish ponds. Farmers have asked for eco-friendly feeds with lower environmental effects such as those with phytase and probiotics. For the snakehead, the shift is to move away from fresh to pelleted feeds. In the last two years, aqua feed producers have shifted focus to fish feeds, such as for the seabass farmed in marine environments and in the land locked north eastern provinces.

Bundling services

Technical and advisory services are part and parcel of the feed business in Asia. Alongside feed supply is the supply of quality post larvae. As it expands sales in India, Sheng Long will have a hatchery. Feed companies continue to work together to improve farm management. In 2015, Uni President Vietnam introduced its photosynthetic bacterial PSB brand Uni-Light to reduce organic matter in water, and to minimise H₂S concentrate at pond bottom. Trials indicated that with improvement in water quality, FCR improved by 0.1 to 0.2 points and survival by 10%. They are encouraging farmers to look at gut health and pond conditions for better production. InVivo NSA, Vietnam proposed a hyper intensive and enclosed nursery system stocking PL10 to PL 30-45 prior to stocking in ponds. It has introduced 'inmyfarm', a user friendly tablet application with daily support to optimise farm management (Raynaud, 2015). In fish farming, De Heus has started a R&D project in Vinh Long to find new ways of optimising and ensuring sound environmental practices to deliver product performance and lower costs (Feed Navigator, 2015).

Table 1. Industry^a estimates on production in 2015 (tonnes) in selected countries in Asia. Arrows indicate increase/decrease versus 2014

	Production 2015		
	Shrimp feeds	Freshwater fish feeds	Marine fish feeds
China	1,400,000↓	13,000,000↓	2,000,000↑
Thailand	400,000↑ ^b	530,000↓	35,000-45,000 ↑
Vietnam	460,000↓	2,800,000↑	20,000*↓
Indonesia	336,000-380,000 ^b ↑	1,080,000↓ ^b	108,000-120,000↓
India	783,000-800,000↑ ^c	500,000↓	-
Malaysia	58,000-60,000↓ ^c	70,000-100,000↓	42,000↓

^aEstimates by industry stakeholders and feed millers.
^bIndonesia -Aquafeed Division, Indonesian Feedmill Association (GPMT)
^c includes imported feed 30% in Malaysia; 30,000 tonnes in India
*includes trash fish

Fish meal and alternatives

Since mid 2015, the pressure was for Thailand's feed millers to avoid fish meal using raw material from unregistered fishing vessels under the IUU (illegal, unregulated, unreported) regulation. "This reduced supply of fish meal by almost 50%," said a feed miller. However, only three feed millers comply with using non IUU fish meal, easing market access for shrimp farmers using their feeds. In Indonesia, Indradjaja said that the pressure is on producers to use more local fish meal to reduce imports. Indonesia imported 60,200 tonnes of fish meal from Peru, China and Vietnam (Trobos Aqua, 2015).

Less fish meal is being used in shrimp feeds. The range is now from 10 to 20% from the previous 30-40%. Three ingredients, wheat flour, soybean meal and fish meal account for 87-90% of raw material costs in shrimp feed production in India. Shrimp feed formulated with 0% fish meal and 20% poultry by product meal can meet the industry standard for an average daily growth rate (ADG) of 0.18-0.21 in Southeast Asia when stocking density is 80-120 post larvae/m² (Suresh, 2016).



Floating feeds for the tilapia and carp from PT Matahari Sakti (PT MS) at APA 2016. The company also developed a lower protein feed for the pangasius stocked at 20-40 fish/m² in cooperation with the research centre in Kerawang, West Java.

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Marketing feeds during Tilapia 2015 in Kuala Lumpur. Malaysian market leader, Star Feedmills' Sean Lai Yoke Wai (centre) and team.

"No fish meal is added for pelleted feeds for the pangasius in India but in Vietnam, despite research indicating that zero fish meal diets are possible, feed millers continue to include fish meal at 3-5%," said Dr Le Thanh Hung at TARS 2015. Several ingredients and additives are available including insect meals to help in fish meal replacement but the constraint is final cost of feeds, particularly with freshwater fish such as the Clarias and pangasius catfish.

Outlook for 2016

The outlook is mixed and is country specific. Aqua feed producers in the Philippines are optimistic that demand for both shrimp and fish feeds will increase in particular in Mindanao in the south which could have 40% market share. Hernan Lim, CEO said that Hoc Po Feeds will double capacity for shrimp feed production and also increase production of feeds for the milkfish and tilapia. CP Foods Philippines, subsidiary of Thailand's Charoen Pokphand Foods Public Company Limited (CPF) is a relatively new entrant in an industry dominated by local producers but it has a significant market share with many of the large farms using its feeds.

Contrary to expectations that demand for shrimp feed is expected to decrease with the multitude of disease outbreaks, such as infectious myonecrosis virus (IMNV) and WFD in Indonesia, the industry there is building up capacity. "I expect to have better shrimp feed sales in 2016 as farmers are coping well with WFD outbreaks. They are cleaning up ponds, reducing stocking density and culturing fish in between cycles," said Puspita Dewi Prijadi, President Director, PT Matahari Sakti. Then there is also demand from the intensification of shrimp farming through the vannamei village project. Each year, more farms are being established.

In Malaysia, while Cargill stopped production of shrimp feeds and relied on imports to service the Malaysian market, in particular starter diets, Grobest from Taiwan will begin operations of its new shrimp feed mill by the end of 2016. When fully operational, this will increase the country's shrimp feed capacity to 180,000 tpy.

Acknowledgement: On behalf of Aqua Culture Asia Pacific, the author thanks feed millers and other stakeholders in the aqua feed industry for their contributions in the preparation of this article. References are available on request.



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A new feed R&D centre using RAS technology

A commitment for better performing fish and shrimp feeds in India

As it expands its aqua feed milling business, Growel Feeds has commissioned a full recirculated aquaculture system for its new indoor R&D centre. The facility expands the current capacity to conduct nutritional research and in the development of new feed formulations. This new centre complements trials in cages in ponds.

Growel Feeds began producing floating fish feeds at its factory in Chevuru village, Krishna district, Andhra Pradesh in 2010. It started with one extrusion line and with new lines to increase capacity it is now among the largest producers of fish feeds in India, mainly for the pangasius and smaller volumes of feeds for the Indian carps (rohu and catla), pacu and tilapia. The production of shrimp feeds began in 2014 and by 2015, Growel has become a significant player in the market.

This new centre demonstrates the management's commitment to R&D. Dr Victor Suresh, Technical Director credited the company's success in India's aqua feed industry to its focus on R&D.

"With this investment, we will have the ability to run more extensive nutritional research, feeding trials on fish and shrimp as well as evaluate new ingredients and feed additives. We can test our new formulations in conditions simulating the pond environment. Our top most priority in R&D is to provide farmers with products, services and tools to be the most productive and profitable. Since most of our directors are farmers themselves, they keep challenging R&D to provide them value for their money."

A unique RAS system

In the development for this new R&D centre, Suresh wanted facilities to carry out nutritional studies and feed trials for fish and shrimp in controlled conditions. Kula Aqua, a reputed aquaculture engineering firm came up with a design for the facility. Anil Ghanekar from Ecosure Systems, who has been setting up various RAS systems in India, executed the design by developing two separate water systems; green water and clear water, each with their own set of 40 tanks. Raw water is treated in two outdoor reservoirs containing fresh and saline water and a third can be used to mix the two waters to produce water of desired salinity. Prior to use, water passes through a series of filters and finally through ozone treatment.



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The system comprises three outdoor water treatment reservoir tanks, two outdoor green water tanks each connected to 20 indoor experimental tanks (top), 40 experimental tanks in RAS (right) and 8 biofilters.



Anil Ghanekar. Each tank has a protein skimmer and venturi tubing for aeration

“This centre fulfils our needs for controlled conditions to run feed experiments. We have one metre deep tanks, coloured brown as we want to simulate the pond environment. Each 600-L tank capacity is designed to accommodate 5 kg fish or shrimp, and each 20-tank section can hold 100 kg of fish or shrimp. We can run each section at different salinities to develop feeds that perform in specific salinities. The sections can also run with either recirculated clear water or recirculated green water or floc allowing us to study the interactive effects of pond environment and feeds” said Suresh.

“The obvious priorities are fishmeal substitution and feeds for extreme low salinity and high salinity systems, but the centre will also prioritise long-term projects like digestibility of common ingredients for shrimp that can eventually lead to accurate prediction of digestibility using Near Infrared Spectroscopy (NIRS).”

Ghanekar explained, “Each of the 20 tanks have their own settling sump for removing wastes. In the case of each of the two clear water systems, water treatment consists of four compact cylindrical biofilters, which have a bio-filtration capacity of 2 kg of pellet feed per day, with a mechanical filtration of about 20 microns. Water goes to UV treatment before returning to the

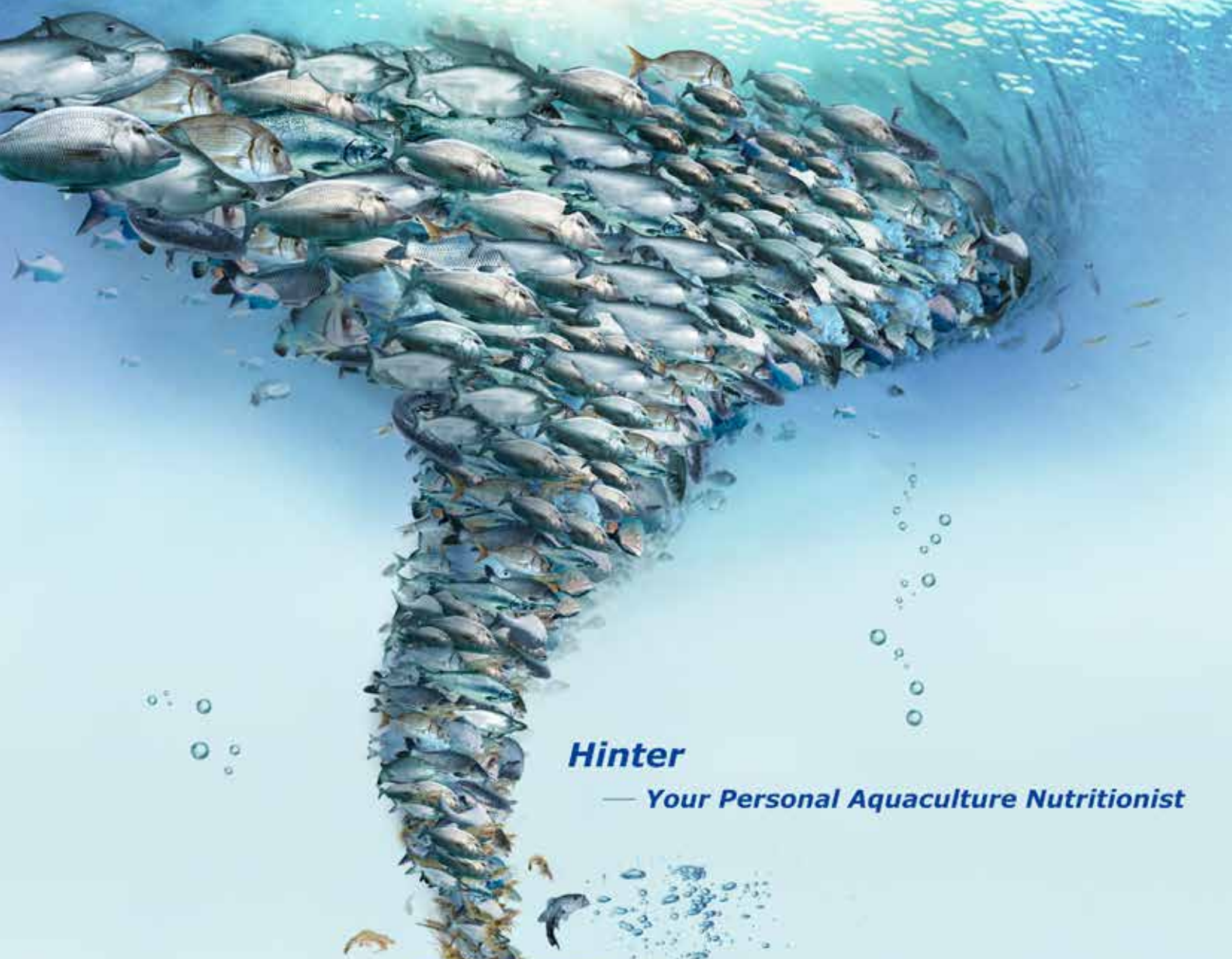
experimental tanks through a venturi. In the case of the two green water systems, water is channelled through settlers only.

“There are unique features of this RAS system. We use expandable floating media filters which do not need additional water to backwash the bio-media. These are new generation bio-filters, which conserve water. Here, the water within the filter cleans the media inside with the help of air bubbles and only the water inside the filter is drained out as sludge. The backwash will take about three minutes and this process can be automated. For the moment, we manage this manually. Unlike other systems where water flows from top to bottom, here it is the reverse.

“Another feature is the ease and low maintenance of the whole system. This system has no blowers or aeration plumbing which makes it very energy efficient. Each 20 tank system has its own pump. Maintenance and general cleaning is very easy with sludge removal, backwash. A single motor runs the system and water is delivered to each tank through a venturi which provides aeration, acts as a protein skimmer and also moves the water around in circular tanks for easy settling. Actually, what we have achieved is to simplify the system for ease of operation and move away from complicated RAS developed in Europe and US.”



Pond trials at Growel. Dr Sudhakar Reddy (right) Assistant Manager, R&D conducts feed trials in ponds such as testing high density feeds for tilapia and pangasius, effects of density on feed performance for the pangasius and mineral requirements for the vannamei shrimp.



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A solution for dietary methionine for shrimp

Evonik is creating waves with its new dipeptide/ amino acid product.



Nicholas Guthier

Global market leader for feed amino acids, Evonik Industries AG is active in aquaculture with products such as MetAMINO® and DL-Methionine for aqua, especially in the salmonid feed segment but also catering to many other species such as tilapia and pangasius to name only a few. Experienced in manufacturing essential amino acids for animal nutrition, it has been looking at matching amino

acids to specific feeding habits of numerous farmed species, particularly for shrimp and crustaceans. In a skype interview, **Nicholas Guthier**, Vice President, Nutrition and Care, Asia South, tells AAP how aquaculture is becoming increasingly important for its amino acids business. His focus is also on the new product developed specifically for shrimp, AQUAVI® Met-Met, launched on April 29 at the Asian Pacific Aquaculture 2016 in Surabaya, Indonesia.

“Aquaculture is fast expanding. It needs amino acids, particularly when fish meal is replaced in feeds. From the early days, we try to understand this industry and what the challenges are. We started gradually to look into the products and solutions which could also help in aquaculture production. The challenge is particularly for the shrimp. Feeding conventional amino acids that leach into the environment, increases eutrophication of the water body. When not all of the amino acid is available to the animal, it leads to slower growth. In contrast to shrimp, fish eats the feed quickly.”

Guthier gave his views on the challenges with dietary amino acids in aqua feeds, “Evonik has customers in aquaculture who needed a different particle size depending on the species being farmed. Some customers say that some particles are too big for the larval and early stage feeds. This led us to think of a product such as DL-Methionine for Aquaculture which was specifically developed based on the demand of the industry for smaller particle size. Then as we went further to develop AQUAVI® Met-Met, we realised that the need was not for an established product but for a totally new product.

“With regards to amino acids products for the shrimp and other crustaceans, shrimp feed formulators were using high levels of fishmeal, resulting in high feed costs. Conventional methionine sources may leach out of the feed and were avoided by some producers. Evonik started looking at other forms. We asked ourselves: ‘Could a matrix product or a coated product work?’ We did a lot of trials but soon realised that coating technologies had several drawbacks: first, they are not stable during extrusion or pelletisation. Second, adding a coating substance dilutes the purity of the product, resulting in a loss of space in the diet and higher specific costs of the feed additive. Evonik investigated different derivatives of DL-methionine. The easiest solution, the dipeptide, was the best solution because it is 100% digestible.”

This has been a learning curve for Evonik, “If customers have a specific requirement and we meet their demand, then marketing the product will be much easier. This is contrary to developing a product and telling customers that they need the product.”

Towards sustainable shrimp feed

Fish meal is becoming increasingly expensive. However, it is a source of important amino acids. The elimination of this expensive raw material in aqua feeds requires supplementation with synthetic amino acids. “With this new product, we can say that we help our customers to lower costs of production and increase profitability. Another equally important point is that the industry needs to create a sustainable shrimp feed.”

Guthier added, “With this product, we do not price according to raw material or according to demand and supply, as is usual with fish meal and other products. We try to calculate the value which our customers achieve from using a methionine product. We then discuss with our customers the actual value we create when using AQUAVI® Met-Met in their feed formulation, the money they will save and based on that, establish our pricing.

“Although AQUAVI® Met-Met, will be produced in Antwerp, Belgium, which is a traditional site for DL methionine, it will not affect our pricing for most of our customers who are based in Asia and Latin America. For us it is important to manufacture close to a DL Methionine site, which uses the same raw materials. Based on our efficient global supply chain the costs of logistics will be minimal.”

For the shrimp, slow release and low leaching

The development took into consideration several specificities of the shrimp’s feeding behaviour and digestion mechanisms. “Shrimp is a slow feeder so that the feed need to be stable for several minutes in the water. If valuable nutrients leach out of the feed, they are not available for the animal growth and will contribute to the eutrophication of the water. Developing our new methionine source which is not water soluble, is a cornerstone in addressing this challenge. Shrimp has a rather primitive digestive track so that a slow release of nutrient enhances growth of the animal. Because AQUAVI® Met-Met consists of four product forms, called isomers, it is released slowly in the crustacean’s gut. Feed efficiency is increased, the growth of the animal is optimised and its nitrogen excretion in the environment is minimal.”

After experimenting with several different molecules, Evonik’s aqua R&D group created AQUAVI® Met-Met, the dipeptide DL-methionyl DL methionine (Met Met for short). A mixture of four stereo isomers confers an extremely low water solubility when compared to traditional methionine sources. The isomers are absorbed at different rates, i.e. LL Met Met>LD Met Met>DL Met Met>DD Met Met.

Guthier added, “With AQUAVI® Met-Met we now have developed the best product for shrimp and crustaceans. The low leaching and slow release in the gut ensures a significantly higher nutritional value than any other methionine source. The effectiveness of feed miller’s feed formulation is preserved in the water and enhanced in the gut. We know this from the digestibility

trials conducted in the laboratory as well as field trials under normal conditions. We compared results with other products such as DL Methionine and MHA-FA. Dose response experiments provided levels of supplementation for optimal growth. We have done trials in all directions by working with large integrators and farmers, and have used academia to manage certain criteria of the trials under controlled conditions. We have done trials where we reduced fish meal by 50% from 16% inclusion in diets.”

In trials in China, Evonik worked with the South China Sea Fisheries Institute to demonstrate that efficacy of this new

product has a nutritional value of 298% when compared to DL Methionine. These results however, are yet to be confirmed with field trials. Through various research, Evonik believes that AQUAVI® Met-Met is at least twice more efficient than regular methionine.

Finally, Guthier said, “If the customer is acquainted with the product and sees the results, they will be satisfied with this product.”

Launch of AQUAVI® Met-Met in Asia-Pacific at APA 2016



The Evonik Nutrition & Care team at the APA2016 trade show, from left: Feliana Widjaja Marketing Manager, Animal Nutrition, Mercyawati Subianto, Grant Xie, Director, Regional Marketing, Gaëlle Husser, and Alexandros Samartzis, Technical Sales Manager-Aqua, Animal Nutrition.

At the Asian Pacific Aquaculture 2016, Evonik organised a press conference to present this latest product, as an aquaculture feed additive. Mercyawati Subianto, Business Manager, Indonesia-Singapore, said, “Evonik will enter a new era with the aqua feed industry in Indonesia with this new product. We will share our expertise in aqua nutrition and will ensure that our product will fit with the demand of the industry in Indonesia.”

Gaëlle Husser, Director Industry Marketing, Aquaculture went through the story in the development of the new product. “There are some specificities in feeding the shrimp. Feed pellets and extrudates must be stable in the water to ensure the valuable nutrients reach the gut of the animal without leaching. AQUAVI® Met-Met is the dipeptide of DL-Methionine. The peptide breaks down in the gut of the shrimp and methionine becomes available for protein synthesis at exactly the right time. AQUAVI® Met-Met has an extremely low water solubility; hence, feed formulation can be preserved in the water and enhanced in the gut. Here we provide 4 isomers, all of which is 100% digestible within one hour. The particle size of this product meets the post grinding specifications of below 300 microns.

“*In vitro* and *in vivo* trials were conducted with academic partners. We looked at its efficacy and role in reduction

of fish meal in diets. We could prove that the product was efficient at twice that of the second best alternative in the market. That was an achievement. We then moved to test in real farming conditions with industry partners. Our last trial in Latin America was targeted at reducing fish meal inclusion in diets from 10% to 5%. We also proved that organoleptic criteria were not affected when marine ingredients are low in the diet. All in all, the product has three values: reduction in feed cost, better feed performance as methionine is a limiting amino acid in many diets and is sustainable.”

“In AQUAVI® Met-Met, we offer a cost-efficient and sustainable solution also for shrimp and crustacean farming. Asia Pacific as the home of aquaculture, has the largest population in the world, with the raising demand for seafood, we can see the pressure on aquaculture to increase productivity in this region and this appears to us to be vitally important.” said Dr Emmanuel Auer, Head of the Animal Nutrition Business Line at Evonik in the press release.

AQUAVI® Met-Met is registered as a feed additive in many countries, with more to follow. The new methionine source will initially be available for shrimp and crustaceans but its efficiency is currently being tested for other species. More information: www.evonik.com/seaanz

China's aqua feed industry in 2016: Upgrade to survive

By Ju Peng, Zhang Jinxuan, Dong Qiufen and Zhang Song

Aqua feed production in China reached 18 million tonnes in 2015 with a drop of up to 8% compared to 2014. In 2016, the government's focus on food safety and environmental protection is expected to affect the competitiveness of medium sized feed millers. Competition will be even tougher with companies already reducing feed prices but industry is prepared with improving feed technology, service or redeveloping business models.

In China, the total production volume of aqua feed in 2015 was around 18 million tonnes which translated to a drop of 5-8% of the production in 2014. Competition is very stiff with dedicated aqua feed producers starting a 'price war', accompanied with technical upgrading, and the introduction of new service models. The entry of new players from the poultry and swine feed industries with ambitious plans to break into aqua feed production makes the aqua feed industry even more competitive. Many medium and small-scale aqua feed mills are struggling for survival, while some with unrivalled advantages are still doing very well.

Tough competition

The growth of aqua feed production was much higher than for swine and poultry feed in China. From 1998 to 2005, aqua feed production increased 14.26% annually, compared to only 5.49% for poultry feeds and 1.3% for swine feeds. However, aqua feed production increased by only 6.21% from 2006 to 2013, while the increase of poultry and swine feed was 8.12% and 15.65% respectively. Year 2006 was the turning point for China's aqua feed industry. The total volume reached 10 million tonnes in 2015, but this was only an increase of 7.07% from that in 2014. A year earlier it was 22.15%. Competition in the aqua feed industry is increasingly tough.



The traditional and major aqua feed millers in China are Tongwei, Haid, Yuehai and Hengxing (Evergreen). The top three shrimp feed producers account for around 55-60% of the total volume. Yuehai's high-value species feed volume is higher than the rest but it is increasingly challenged by Haid and Tongwei since 2014. In 2016, all of the major feed millers plan to increase their production volumes and have already started reducing feed prices several times since the beginning of this year.

Meanwhile, more and more livestock feed giants are gradually entering the aqua feed sector, thus increasing the competition dramatically. At the end of 2015, DBN Aqua-Tech Group opened up to 14 service centres in Fujian and Guangdong, which are major areas for aquaculture. Moreover, New Hope Liuhe has planned to increase by 20-30% its aqua feed production from 2016 onwards. The targeted volume for 2018 is 2 million tonnes. Both DBN and New Hope Liuhe are public listed companies.



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“ Now the entire aqua feed industry is looking for better solutions for fish meal replacements. Innovative use of raw materials is one of the most effective ways to reduce formulation costs.. ”

Technical improvements

With more competition, the strategy for China's aqua feed millers is not only to improve feed formulation, but also to focus on technical innovation. Dr Song Zhang, Vice President of LinkOcean Group, shared his views during 'the 10th Symposium of World's Chinese Scientists on Nutrition and Feeding of Finfish and Shellfish'.

"The first point is the importance of quality control for feed technology development. In 2006, fish meal was imported only from Peru and Chile. However, China has imported fish meal from about 18 countries including USA and Russia since 2011. There are so many kinds of fish meal and so many ways to get these raw materials. In addition, the inclusion of fish meal in aqua feed formulations is reducing. Fish meal is prone to quality risk. With the sharp changes in raw material prices and quality, it is worth investing in quality control rather than in formulation. Research and quality control technology have become important components of aqua feed technology innovation.

"My second point is the innovative use of raw materials. Now the entire aqua feed industry is looking for better solutions for fish meal replacements. Innovative use of raw materials is one

of the most effective ways to reduce formulation costs. For the unconventional raw material such as red rice bran and white fish meal from Vietnam, Nutriera (the subsidiary company of LinkOcean Group) is able to analyse all parameters and evaluate the products with a careful and strict quality control program.

"The last point is the change from experimental to commercial nutriology. Today, feed formulation technology is market-oriented. So it is of practical significance to emphasise on the commercial aspects of nutrition." He stressed, "Product positioning is the first essential factor determining product quality. Nutriology will only be applied to the end-user with the combination of production and research, based on theory and oriented by market.

"There is another feature of commercial nutriology. This is care for company competition where the weakness is indicated by benchmarking with other companies," added Zhang. Nutriera has continuously helped a number of aqua feed companies both at home and abroad to improve their technology. Many of them became better, both in technology and sales volume and are comparable to the top players."

Service marketing

Technical services for farmers in the aqua feed industry is crucial. The value created through services to farmers determines the competitive edge. Most of the large to medium-scale aqua feed mills are providing different kinds of services to farmers and dealers. Besides feed, high quality fingerlings (or post larvae) and probiotics for improving water and pond bottom quality, or animal health are effective solutions for farmers. Some technicians even help in the treatment of diseases or harvesting



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of fish or shrimp. Some companies also help farmers optimise their farming practices. Large scale feed companies may not see the apparent advantage with a superior product.

Government control

The Chinese government is managing aquaculture and aqua feed production more strictly than before in line with the strategy on food safety and environmental protection. Following the revised 'control regulations on feed and feed additives' effective May 1, 2012, all provinces have developed a series of new systems to standardise feed production and operations. A management system on feed safety consisting of hazard analyses, monitoring and accident mitigation, was also launched by the Ministry of Agriculture.

There is a more detailed and complete system of laws and regulations. There are five related regulations such as 'The Administrative Regulation for Production Permit of Feed and Feed Additives' and three technical regulations including the 'Feed Raw Material Catalogue'. This is followed by a strict control on market access and elimination of sub-standard enterprises. Since December 2014, only 7,061 companies obtained permits for feed production. In contrast, the number in 2013 alone was more by 3,000. However, only 2,000-3,000 of the existing feed companies will be able to survive in the coming five years, according to the national 13th 5-year plan. Among these companies, the top 30 players will then account for 60% of the total volume.

Under 'The Administrative Regulation on Feed Quality Safety' regulation, the companies with permits are provided guidance

on how to attain quality safety during the production period, via teaching videos or on-site supervision by experts.

Conclusion

At present, challenges such as climate change as well as extreme climatic conditions, depressed consumption, low aquaculture product prices and poor success rate of aquaculture are threatening the healthy development of the aqua feed industry in China. For many companies, 2016 will be even tougher than 2015. Large companies will continue to compete with rivals by improving technology, reducing price, providing financial assistance and service, or redeveloping business models. Medium sized aqua feed millers may still have the chance to survive and redevelop if they can find the right way. Some in the industry have predicted this year will be the worst for the aquaculture and aqua feed industries; however others still believe that opportunities still exist during a crisis.



Ju Peng



Zhang Jinxuan

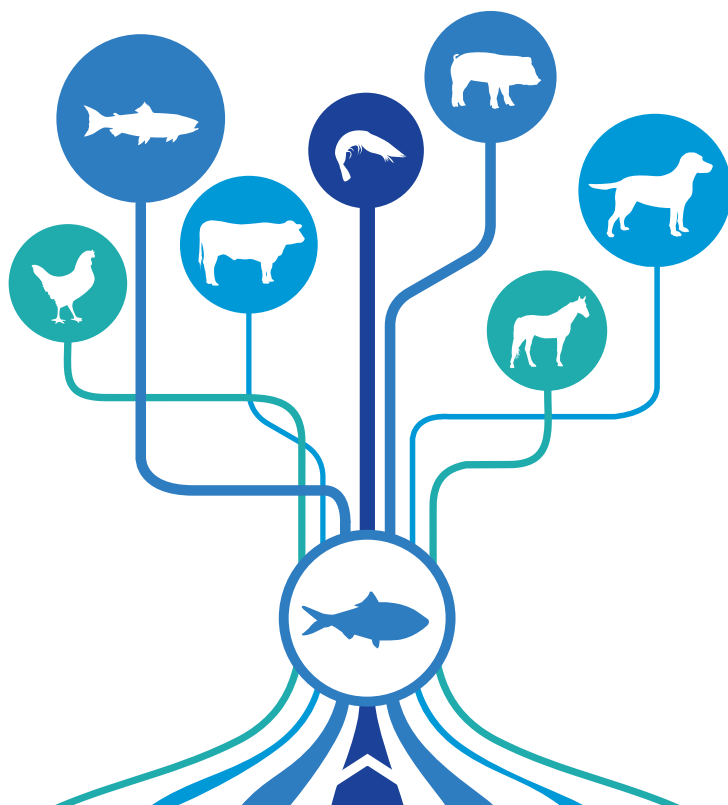


Dong Qiufen



Dr Zhang Song

Ju Peng, Zhang Jinxuan, Dong Qiufen and Dr Zhang Song are experts in aquaculture nutrition and health from Guangzhou Nutriera Biotechnology Co., Ltd. Email: qiufendong@gmail.com (Dong Qiufen).



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A new and unique tool for shrimp feed producers

By Kristin Weel Sundby

Laboratory and trials at a feed mill in Thailand show how a new processing aid and binder optimise water stability and stable operating conditions.

Binders such as PMC (Polymethylolcarbamide)/Urea formaldehyde, wheat gluten and gelatin are commonly used to achieve the required water stability of shrimp feed pellets. PMC is the most popular one. Even though this binder provides good water stability, it also adds some challenges to the feed pelleting process. For example, the addition of PMC makes it difficult to achieve the desired conditioning temperatures, giving rise to unstable operating conditions. This has the effect of increasing mechanical energy consumption, resulting in a higher demand for electricity and increased production costs.

The challenge with shrimp feed production is the seasonal demand. Hence, there is a need for a particularly effective and stable production prior to and during peak demand. Optimising production capacities in existing production units will be a cost efficient way to increase shrimp feed production.

A new combined processing aid and binder has been developed especially for the shrimp feed industry by Borregaard LignoTech (Norway), a leading suppliers of high performance additives and



ingredients to the animal feed industry. The product is optimised to ensure both optimum water stability and stable operating conditions. When added to the shrimp feed formulation this product will lower the energy consumption, which makes it possible to reach the desired conditioning temperature and increase the production rate.

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Introduction to work done

The goal of this project was to optimise production capacities and costs for the shrimp feed producer while assuring optimum water stability. The work started in a laboratory pilot plant, where a selection of binders were added to a feed formulation and pelleted using a small pelleting press. Process parameters were logged during pelleting and water stability of the produced pellets were measured. Positive results from the laboratory trial were later followed by a full scale plant trial at a shrimp feed mill in Thailand.

Results from the laboratory trials showed that this new product, Intact Aqua, gave the best water stability of the products tested. In addition, the plant trial confirmed that this product has clear process related benefits compared to pure PMC/urea formaldehyde. Intact Aqua is composed of a highly modified lignin product (HMLP) and PMC.

Trials in laboratory pilot plant

A Munch laboratory pellet press with 3.5 x 45 mm die and a data logging system were used for the laboratory trials. A simplified feed mix consisting of 40% wheat meal, 40% soybean meal and 20% fish meal was used in all trials, and pelleted at a conditioned meal temperature of 95-100°C. No post conditioning was used for these trials. A 3.5 x 45 mm die gave a compression ratio of 12.9. Typical ring die compression ratio for shrimp feed pellets is 18-24. The pellets produced in the laboratory trials were manufactured with a lower compression ratio and a larger diameter than commercial shrimp pellets. However, for the screening of different binders at otherwise equal conditions this was considered as acceptable.

The startup of the pelleting trials was difficult, due to blockages in the die at around 80°C. Hence, it was not possible to produce pellets at stable relevant conditions (90-100°C) without the addition of the specially developed HMLP. With this product it was possible to increase conditioning temperature to >100°C without problems. Figure 1 shows a data log for one of the first trials, where this positive effect of HMLP is clearly demonstrated.

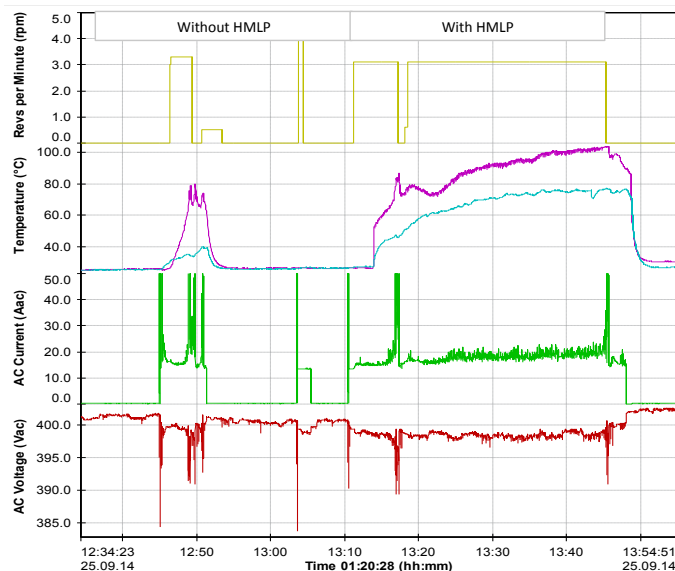


Figure 1. Data log from initial pelleting trials, without binder added. First only feed mix; not possible to run at stable conditions, then with HMLP added; stable operation conditions, even possible to increase conditioning temperature (purple trace).

Next, combinations of HMLP and a selection of binders (PMC, a gelatin based binder, cationic starch, chitosan or calcium chloride dihydrate) were tested. One example of a data log from the laboratory trials is shown in Figure 2. The peaks on the purple trace (temperature before die/conditioning temperature)

illustrate the start of each new trial/binder. The log shows that the trials were conducted at equal and stable conditions.

Water stability of the pellets produced during these laboratory trials was measured and some of the results plotted in Figure 3. Several runs were carried out and all laboratory trials showed that the composition of HMLP and PMC gave the best water stability among the combinations tested.

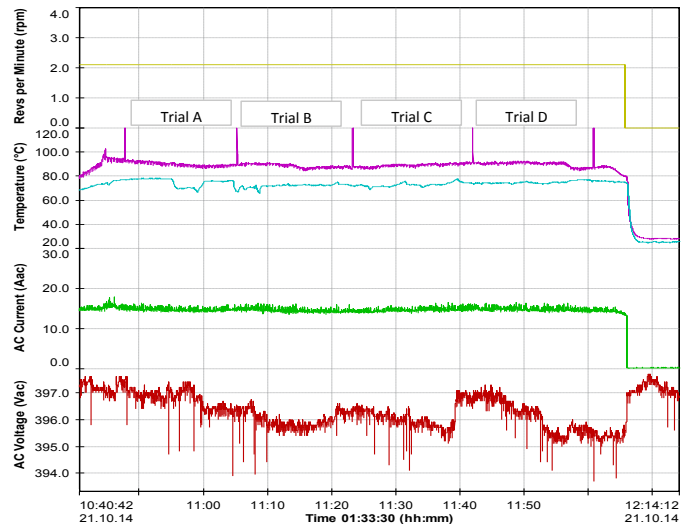


Figure 2. Data log from laboratory pelleting trials. Production rate (yellow), temperature before die (purple), temperature after die (turquoise), amperage (green) and voltage (red)

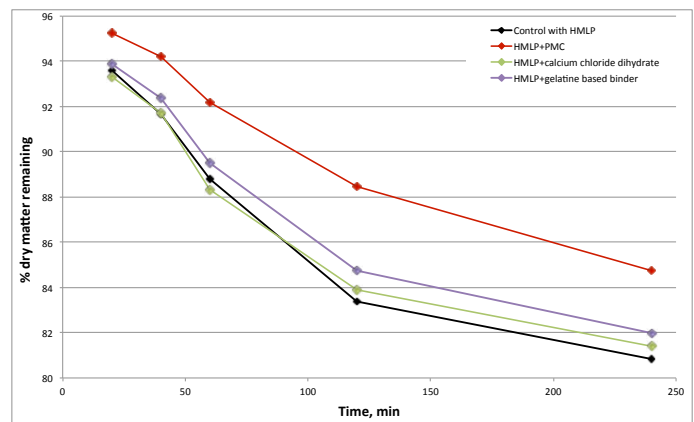


Figure 3. Water stability, as dry matter pellets remaining as function of time in water (~23°C). Control with HMLP (black), pellets with HMLP + PMC (red), pellets with HMLP + calcium chloride dihydrate (green) and pellets with HMLP + gelatine based binder (purple).

Plant trial

Following the positive laboratory trials described above, a plant trial was conducted in a shrimp feed mill in Thailand. The purpose of this trial was to verify the results seen in the laboratory, and to optimise the dose of Intact Aqua. Figure 4 is an illustration of a typical pelleting process for shrimp feed in a commercial feed mill.

The same shrimp feed formulation was used throughout the trial, and the control contained the pure PMC binder normally used by this feed producer. Pellet diameter was 2mm and the compression ratio in the die was 24. Process parameters during pelleting were carefully monitored and water stability of the final pelleted feed was tested.

Intact Aqua was added at different inclusion levels (0.4 % - 0.8%) and these were referred to as trial 1 - trial 5. The control (C) contained the pure PMC binder added at the usual inclusion

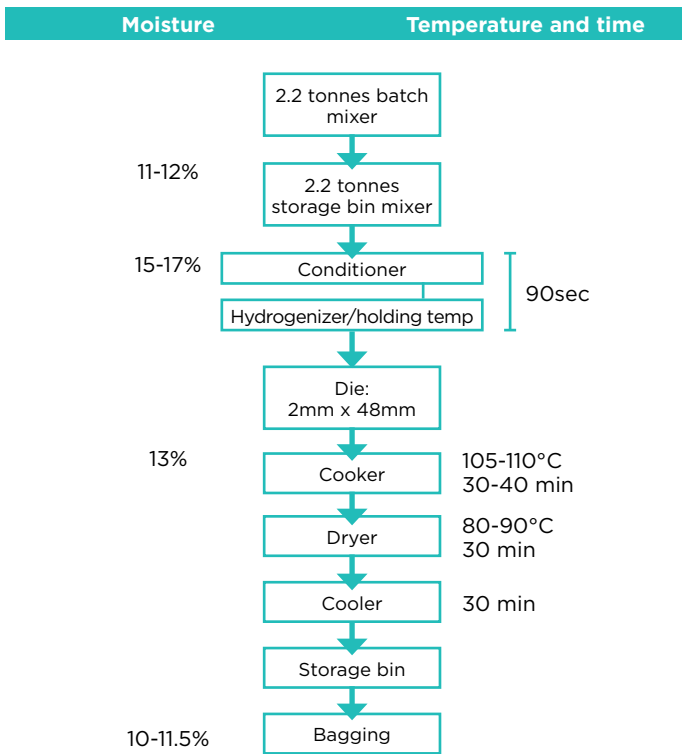


Figure 4. Illustration of a typical shrimp pelleting process

level of 0.55%. The data log from the trials in Figure 5 showed production rate, amperage, meal temperature and voltage. Green vertical lines indicate the shift between trials. By studying the process data log, it was clear that the amperage varied among the trials. Trial 4 had the highest energy input which was at the same level as the control (~26 kWh/T). Trial 3 gave the lowest energy input (~22 kWh/T), which was a 15% reduction compared to trial 4 and the control. Hence, Intact Aqua with the inclusion level used in trial 3 (0.5%) was the most energy efficient processing aid in this particular trial.

Water stability

Energy consumption in the pelleting process is of course important, but the water stability requirements of the finished feed also needs to be met.

Hence, the samples collected during the plant trial were measured for water stability by the shrimp feed producer, using his standard test method. Two samples from each trial were tested; one collected in the middle of the trial and the other at the end of each trial. The feed producer concluded that the pellets produced during trials 3 and 4 had a good water stability.

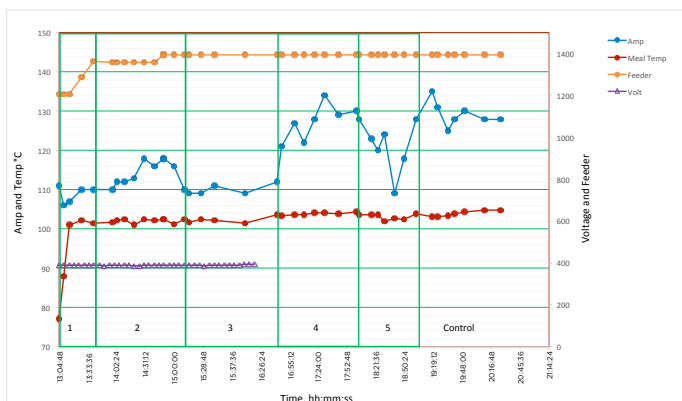


Figure 5. Data log from plant pelleting trial. Feeding rate (orange), amperage (blue), meal temperature (red) and voltage (purple). The vertical green lines illustrate the period of each trial.

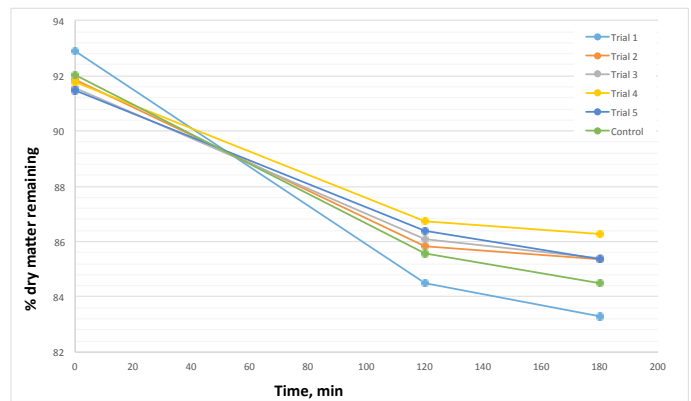


Figure 6. Water stability, dry matter pellets remaining as function of time in water (~23°C).

Pellets produced during trial 1 were rejected based on both water stability tests, which is not surprising since the process had not yet reached stable conditions (Figure 5). For trials 2, 5 and the control, the feed producer reported one sample approved and one sample rejected.

After approximately two weeks, a sample from each trial was also tested by Borregaard, using the same method as for the earlier laboratory work. According to the results plotted in Figure 6, all trials except trial 1 produced pellets with water stability similar to or better than the control.

By combining the process data and water stability results from the plant trial, it was clear that Intact Aqua, at the inclusion level of 0.5% (trial 3), provided good water stability and also reduced energy consumption during production by 15% versus the control (pure PMC at 0.55%).

The inclusion level of the HMLP +PMC product in shrimp feed mix was slightly lower than the pure PMC in the mix. This means that replacing a pure PMC binder with this product also reduces the total PMC/urea formaldehyde inclusion in the feed.

Conclusion

Based on laboratory and plant trials, the product Intact Aqua has been developed and optimised as a combined shrimp feed processing aid and binder. At a recommended inclusion level of 0.5%, shrimp feed producers can expect the following benefits:

- Reach the desired conditioning temperature without destroying key nutrients and equipment
- Lower energy consumption or higher production rate
- Stable operating conditions
- Optimum water stability assured
- Reduced use of PMC/synthetic binders
- Lower cost when compared with the use of PMC/Synthetic binders

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Pure coincidence or true treatment effect?

By Delphine Weissman

Statistics will guide us on how to judge differences and is a tool to help us in interpreting results.



Fish pond with 48 cages can be used for example to determine nutritional requirements of fish at different stages, to test new formula, to validate the interest of raw materials in substitution of fish meal and fish oil, etc.

What is statistics?

Statistics is a tool to evaluate results observed during an experiment and are very important when working with live animals. Each animal is unique, has a unique growth rate, its own feeding behaviour or resistance to diseases. As a consequence, each group of animals, each cage of fish, each pond of shrimps will present its own characteristics, even if animals are reared in the same conditions and come from the same initial population, just because of the randomness of animal sampling. The risk when comparing two groups of animals is to conclude a true difference exists between them where there is actually no true difference. This risk is called “alpha risk”. Statistics allows us to estimate the probability of this risk.

Then when comparing two treatments, two additives or two feeds, statistics will give us keys to judge if we can consider the difference observed as a true difference due to the factor tested or as a difference only due to the variability of the population. Statistics is therefore a tool to help us in interpreting results.

How to interpret results?

Two groups of animals are always different from each other. We commonly agree to conclude that a true difference exists if the probability of alpha risk is below 5% ($P < 0.05$), which means that we have less than 5% risk of being wrong saying this difference is true. When the probability of alpha risk is above 5%, it is more risky to conclude that a true difference exists. When no significant difference is observed between groups ($P > 0.05$), we should always wonder why and question the power of the experimental design or have a look at the population heterogeneity before concluding to a true absence of difference. To conclude to an absence of difference when there is one is called “beta risk”.

How to design an experiment?

In order to be able to judge if differences are due to the variability of the population or to a real effect, the population chosen must be as homogeneous as possible at the beginning of the trial and environmental parameters must be the same and controlled from one cage (or tanks, ponds) to another. In order to better differentiate differences due to natural variability or treatment effect, we must be able to judge the variability of a population, and as a consequence, multiply the replications of a specific treatment. Allocation of animals to treatments, number of replicates and rearing homogeneity are some of the most important points to care about when designing an experiment. Moreover, data based on a large number of animals are more reliable than data based on fewer animals. So the number of animals involved in the experiment also influences the quality of the results.

An original tool to perform R&D studies in Vietnam

Invivo NSA has invested considerably in R&D in aquaculture. It owns two important stations to carry out aquaculture research. Based on the know-how the company has built over the last 60 years in livestock production on how to run R&D trials (swine, ruminant, rabbit, poultry, etc), the aquaculture R&D stations have very effective tools to work on nutritional requirements, additives, raw materials and farm management. An Invivo NSA aquaculture R&D station is based in Nha Be, south of Ho Chi Minh City in Vietnam where trials can be conducted on local species such as tilapia, catfish, barramundi or shrimp. The objective of Invivo NSA is to conduct trials with the highest quality.

To achieve this goal, animals are weighed individually to select a homogeneous population at the beginning of each trial (for example, up to 8,000 fish are weighed to select 3,840 homogeneous fish for one experiment). Whereas some published studies use only 3 to 4 replicates, Invivo NSA has chosen to have 8 replicates per treatment in order to reduce the beta risk and provide much more reliable conclusions. Invivo NSA considers this as essential and worth the effort, even if it requires more resources.



These 220 L fish tanks can be used for example to work on nutritional requirements of fish juveniles, study the bioavailability of some nutrients or minerals or to compare feed additives in environmental challenging conditions.



A shrimp pond with 48 cages can be used for example to improve feed formulation, work on nutritional requirements or substitution of fish meal in feeds.

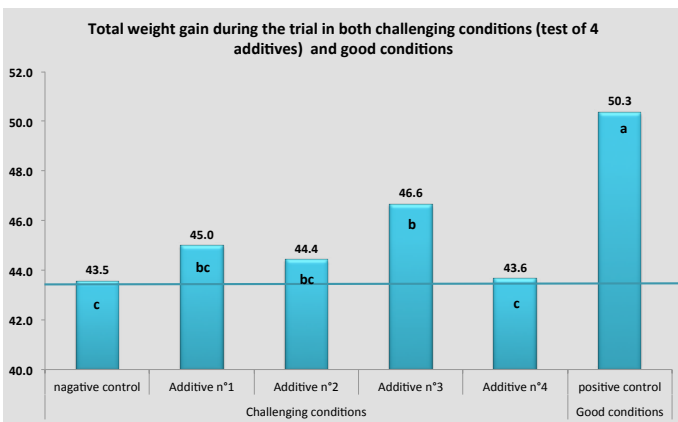


Figure 1. An example of weight gain results testing different additives in challenging conditions in tanks

Fish facilities

Several ponds are dedicated to run trials on fish of different sizes. Up to 48 cages are placed in a single pond which allows the comparison of 6 groups with 8 replicates to guarantee results of high quality and statistical significance in an environment that is close to farm conditions. Indoor facilities are also available in the centre for fish studies.

Another facility of 48 tanks of 220L is available to run trials on more specific topics using juveniles. There is also the possibility of introducing challenging conditions to evaluate feed additives of interest.

A unique facility is a set of 24 digestibility tanks where fish faeces can be collected to calculate digestibility of raw materials, to assess nutrients in raw materials or the impact of additives (enzymes) or technological treatments.

What about shrimp?

As for fish, several ponds are dedicated to run R&D trials on shrimp. Each pond contains 48 cages where up to 6 treatments with 8 replicates can be compared. In the 48 indoor tanks, trials can also be conducted in clear water to limit the effect of natural biomass intake and measure only the effect of different feed treatments on shrimp performance.

A tool open to external partners

Invivo NSA works on many different topics in R&D including raw materials, nutritional requirements, feed additives and sustainability. The R&D centre of Invivo NSA combines many strengths: highly trained staff on the farm, team of scientists to work on the protocol and data, high number of replicates, and guarantee to insure confidentiality in trials conducted. The flexibility on parameters that can be measured and the diversity in facilities available to answer a question provide a lot of possibilities to study all kind of topics. For example, digestibility tanks can be used to work on enzyme effects, improve raw materials knowledge as well as study environmental impact of feed. These are not common tools to find in R&D aquaculture systems.

All these tools in the R&D centre are also available for use by external partners looking for testing facilities to carry out trials on their products, solutions or additives.



Delphine WEISSMAN is aquaculture R&D Manager for Invivo NSA company. Based in France, she is in charge of the research and development program for aquaculture. Email: dweissman@invivo-nsa.com

Selective antibacterial action of a specific composition of short- and medium-chain 1-monoglycerides

By Manuela Parini, Yu Yu, Alessio Paoli and Rahul Gaddipati

These include preventing EMS, inhibiting *Vibrio parahaemolyticus* and other aquatic pathogenic bacteria in fish and crustaceans, in a species independent way.

Early mortality syndrome (EMS), white gut syndrome caused by *Vibrio parahaemolyticus*, infections and mortality caused by *Aeromonas spp.*, *Flavobacterium spp* and *Vibrio mimicus*, are pathological conditions which differ in etiology and target species. Nevertheless, they can have a unique solution. For several years the R&D staff of SILO SpA (Italy) has been cooperating with the Public Animal Health Institute “Bruno Ubertini” in Italy in developing specific combinations of 1-monoglycerides of short and medium chain fatty acids to inhibit, in a selective way, pathogenic gram-positive and gram-negative bacteria independently from the environmental pH value.

Since 2013, a specific combination of 1-monoglycerides of short- and medium-chain fatty acids is available in the market under the name SILOhealth 108. This has been shown to exert a selective antibacterial action against the most common aquatic pathogenic bacteria at pH values from 2 to 8 which is also the pH range in organs of aquatic species such as the gut, liver and hepatopancreas.

Trials on MIC values

An *in vitro* trial was conducted to determine the minimum inhibitory concentration (MIC) of Silohealth 108 in comparison with free acids at pH 7- 8 buffer. Bacteria strains from the strain collection of the Public Animal Health Institute “Bruno Ubertini”, commercial propionic acid, butyric acid and Silohealth 108 were used in the trial. Each product (2 g) were diluted in 8 g of buffered peptone water (BPW) in a tube (stock solution 20%). pH was buffered in order to evaluate the MIC of each product at pH 7-8.

The following controls were prepared.

- strain growth control by mixing 50 µL of BPW in three wells with 50 µL of an overnight culture of bacteria grown in Brain-Heart Infusion Broth (BHI);
- a BPW control by siphoning 100 µL of BPW into three wells;
- BHI control by siphoning 100 µL of BHI broth into three wells;
- products control by siphoning 100 µL of the stock solution into three wells.

Ten-fold dilutions (from 2% to 0.002%) were prepared in sterile tubes and siphoned into wells in triplicate. Fifty µL of an overnight culture of bacteria grown in BHI broth was added to each well and mixed at different concentrations. Wells were incubated at 37°C for 24 hours. The MIC was assessed via visual observation.

The results of the *in vitro* test show that low concentrations of SILOhealth 108 (from 0.01% to 0.1%) inhibit growth of pathogenic bacteria, without inhibiting the beneficial *Lactobacillus*. The antibacterial action is very selective and seems to be a prebiotic-like effect, since the growth of the beneficial micro-flora is enhanced while harmful bacteria are killed.

Table 1. Minimum inhibitory concentration (MIC) at pH 7- 8 buffer

	SILOhealth 108	Butyric acid	Propionic Acid
<i>Aeromonas hydrophila</i>	0.1%	>1%	>1%
<i>Aeromonas salmonicida</i>	0.01%	>1%	10%
<i>Bacillus cereus</i>	0.1%	>1%	>1%
<i>Edwardsiella ictaluri</i>	0.1%	>1%	>1%
<i>Flavobacterium columnare</i>	0.01%	>1%	>1%
<i>Photobacterium damsela</i>	0.01%	>1%	>1%
<i>Pseudomonas anguilliseptica</i>	0.01%	>1%	>1%
<i>Pseudomonas dermoalba</i>	0.01%	>1%	>1%
<i>Streptococcus uberis</i>	0.1%	>1%	>1%
<i>Tenacibaculum maritimum</i>	0.1%	>1%	>1%
<i>Vibrio alginolyticus</i>	0.01%	>1%	>1%
<i>Vibrio mimicus</i>	0.1%	>1%	>1%
<i>Vibrio parahaemolyticus</i>	0.1%	>1%	>1%
<i>Yersinia ruckeri</i>	0.1%	>1%	>1%
<i>Lactobacillus plantarum</i>	No inhibition	ND	ND
<i>Lactobacillus acidophilus</i>	No inhibition	ND	ND

Trials with white sturgeon and Indian major carps

Anabas, tilapia, sturgeon, salmonids, carps, shrimps and crabs have different digestive systems and different feed transit time and metabolism. Nevertheless, in our scientific trials and field observations we always find a common trait. SILOhealth 108 significantly reduces mortality and increase specific growth rate (SGR), due to a quick bacteriostatic action, water affinity and solubility of monoglycerides inside the digestive tract and capacity to enter the blood stream and to reach liver and hepatopancreas.

A scientific trial was conducted under the supervision of the Public Animal Health Institute “Bruno Ubertini” to evaluate the effects of this additive product on survival rate, growth rate and feed conversion ratio (FCR) in juvenile white sturgeon *Acipenser transmontanus* experimentally infected with *A. hydrophila*.

A. hydrophila strain was isolated from the brain of white sturgeon affected by this pathology. Juvenile sturgeon were supplied by a large sturgeon producer in Italy. A total of 612 juvenile fish with average live weight of 3.1 g were allotted to 6 experimental tanks. Juvenile fish in control tanks 1, 2 and 3 received a commercial feed, while those in tanks 4, 5 and 6 received the same feed supplemented with 0.8% of SILOhealth 108, incorporated into the

pellets. Each fish was individually infected with 11×10^6 CFU/g of *A. hydrophila*, through intraperitoneal injection. The trial lasted for 48 days. At the end of the trial, mortality, SGR and FCR were measured.

Results showed that, even in the presence of a high individual infection equal to 11×10^6 CFU/g of *A. hydrophila*, mortality was reduced by 76%, SGR increased by 13%, while FCR reduced by 10% in the group fed with SILOhealth 108 compared to the control group.

Significant antibacterial effect in terms of mortality decrease combined with growth promoting action and FCR decrease are the goals achieved in this trial.

In field trials we observed a reduction in mortality caused by *A. hydrophila* in other fish species such as Rohu, an indian major carp. In 2 ponds, each of 10 acres (4 ha) and each populated with 30,000 carp, the mortality caused by *A. hydrophila* was reduced from 12% to 1.8% after 3 days of feed supplementation with the additive product at a dose of 0.5%. No recurring infections were

observed in the subsequent growing period. In control ponds of 8 and 12 acres, containing 24,000 and 35,000 carp respectively, treatment with enrofloxacin (10 g/tonne of fish), oxytetracycline (10 g/tonne of fish), furazolidone (10 g/tonne of fish) or doxycycline (5 g/ tonne of fish) reduced the mortality caused by *A. hydrophila* by the same degree - but only after 6 days of use. Microl Aqua Lab Bhimavarm, India monitored the trial. This trial will be the subject of a future publication. Nevertheless, this short mention is valuable because of the similarity with results achieved with completely different species such as the sturgeon and carp. This confirms the species independent activity of the additive product.

Controlling EMS in *Penaeus vannamei*

SILOhealth 108 is used in several Asian countries (China, Vietnam and India) to prevent or cure EMS caused by *Vibrio parahaemolyticus*. Its inclusion as a feed supplement either as top dressing or added during feed processing, usually starts as early as at stocking, to ensure the maximum protection and also to effect a significant improvement in FCR. Nevertheless, in some cases the use of the additive product starts after the first EMS

Table 2. Growth rate, FCR and mortality in juvenile sturgeon after intraperitoneal challenge with 11×10^6 CFU/g of *A. hydrophila*

Treatment	Average live weight prior to infection (g)	Average live weight at infection day (g)	Average live weight 20 days after infection day (g)	SGR	FCR	Mortality %
Control	3.1	4.6	5.8	1.14	2.64	38.9
SILOhealth 108	3.1	4.8	6.2	1.29	2.38	9.4
Delta				+ 13%	-10%	-76%
Statistical significance	(n.s.)	(n.s.)	(**)	(**)	(*)	(***)

(*) p< 0.05; (**) p< 0.01; (***) p< 0.001 - Method Proc GLM SAS



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clinical signs are observed. The field observation described here below is an example of treatment in presence of EMS clinical signs.

The trial was carried out in Zhanjiang county, Guangdong Province, China, a month after post larvae stocking. The average temperature during the trial was around 23°C, water pH was 8-8.5, salinity around 12‰ and the density was equal to 210 shrimp/m² in three seawater aerated ponds, each 2.4 mu (1600m²) in size.

Mortality rate was monitored in check trays. Thirty days after stocking, a mortality ranging from 35-40% of the individuals in each check tray per day was observed, combined with anorexia, hepatopancreas reddening, low feed intake, white gut and white fecal matter.

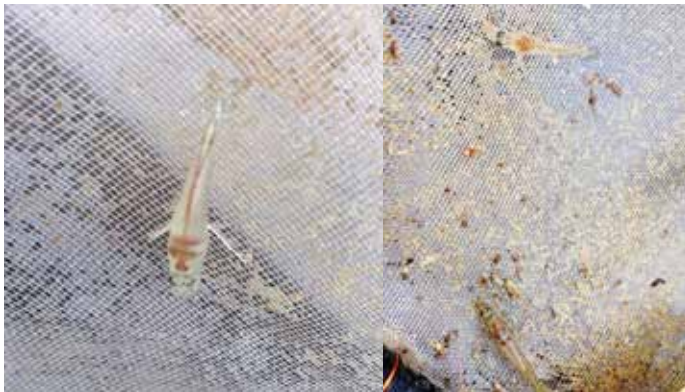


Figure 1a and b, Signs of *V. parahaemolyticus* infection and observed mortality before administration of SILOhealth 108

V. parahaemolyticus was isolated by the local animal health institute laboratory. SILOhealth 108 was then added to the feed at a dose of 1%. After only 3 days of feeding, shrimp mortality reduced by 70%. Total mortality reduced by 93% after 5 days. Normal growth, feed intake and vitality were restored. Observations lasted until harvesting and no further EMS outbreak was observed.

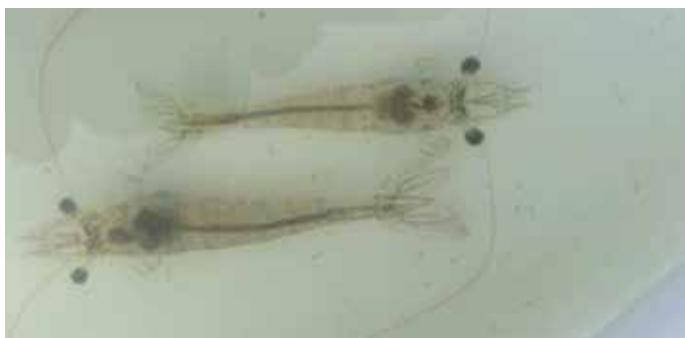


Figure 2. Restored health conditions after SILOhealth 108 administration

Better growth rate and FCR in *P. vannamei*

The following trial was conducted in Vetapalam, Praksham district, Andhra Pradesh, India to measure the effects of the additive on growth rate and FCR. In two one-ha ponds, 700,000 post larvae from Golden Hatchery in Pondicherry were stocked. Shrimp was fed feed containing 5 g of the additive/kg of feed for all the four daily meals during the entire period of 63 days in the experimental pond. Shrimp in the control pond were fed feed without any supplementation of the product. Weekly growth was recorded from day 35 after stocking. Feed consumption was recorded throughout the trial period.

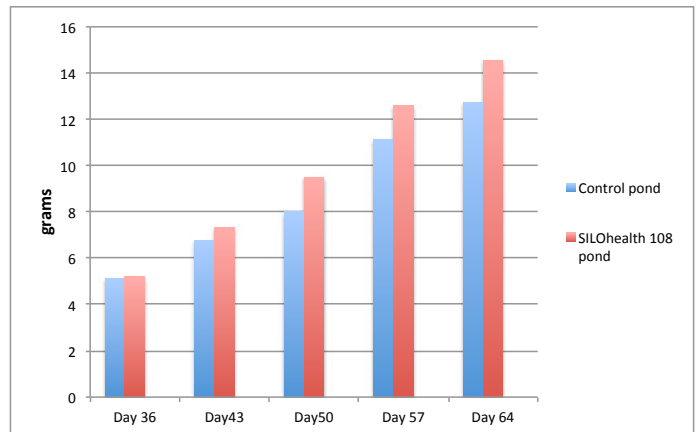


Figure 3. Weekly average weight of the shrimp measured from day 35 after stocking

On day 63, the average weight of shrimp from the control pond was 12.73 g, while in the treatment pond, shrimp weighed 14.56 g which was 15% higher. The FCR was 1.68 in the control pond as compared to 1.35 in treatment ponds. The return on investment was 1:19.

Meta-analysis and conclusions

Results achieved with these different species showed that feed supplementation with the additive reduced the average mortality caused by pathogenic bacteria by 70-90%. FCR decrease by 10% and improvement in SGR was by 13-15%. The specific composition of 1-monoglycerides of short and medium chain fatty acid contained in Silohealth 108 proved to be a valid alternative to enteric antibiotics. It exerts a specie independent growth promoting effect even in the presence of a high level bacterial challenge. Antibacterial and nutritional effects are exerted independently from the differences in the metabolism of aquatic species. We conclude that the 1-monoglycerides were able to pervade and permeate internal organs of fish and crustaceans, even in cases of a rapid transit in the digestive tract.



Manuela Parini



Yu Yu



Alessio Paoli



Rahul Gaddipati

Manuela Parini is with the R&D Department at SILO SpA (Italy). She was work-package leader of the EU-project "Feeding Fats Safety" aimed at improving the safety of lipids in commercial feeds. She has published several studies on short-medium chain monoglycerides as compounds alternative to antibiotics. Email: manuela.parini@silospa.com

Yu Yu, PhD has been working for many years as Research Director of Purina (Canada). Currently, he is Director of East Bright Consulting (USA) and scientific consultant for leading feed companies such as New Hope, Asia Pacific Chinwhiz Group, Hinter, DaChan and Gentech group.

Alessio Paoli, is with the R&D Department, SILO SpA, Italy as well as in charge for quality control. He graduated in pharmaceutical biotechnology at the University of Florence.

Rahul Gaddipati, is Sales Manager for SILO SpA, Italy for Asian markets. He holds a postgraduate diploma in international marketing and management (Lancaster University) and has a diploma in aquaculture. He is active in shrimp culture in India since 2012.

Innovating for alternatives to marine proteins at Aquaculture 2016



Allan LeBlanc (left) and Dennis Leong, VP Business Development

Aquaculture is expanding rapidly, putting pressure on the use of fish meal, a major dietary protein for several aquaculture species. Although, inclusion levels of fish meal have dropped in feeds for several species, demand still exceeds supply for high quality fish meal, leading to rising prices. Research to identify alternatives to fish meal are often presented at aquaculture conferences such as Aquaculture 2016, held in Las Vegas from February 22-26.

Single cell protein from methane fermentation

Josh Silverman, founder and Chief Product and Innovation Officer, Calysta Inc. proposed FeedKind™ protein as traceable, sustainable and cost effective alternative for fish meal. FeedKind is produced via natural fermentation with non GMO organisms.

Silverman developed a methane fermentation technology to create innovative industrial products from sustainable sources and founded Calysta Inc. In 2014, it acquired Norwegian company BioProtein A/S Norway, creating a synergy of two technologies, Calysta's novel natural gas conversion technology using methane for high value chemicals and fuels and BioProtein's technology to directly convert natural gas into biological products.

In his presentation, Silverman said that. "For aquaculture in particular, FeedKind Aqua protein has been demonstrated to perform significantly better than fishmeal in promoting growth and health in Atlantic salmon. The composition of FeedKind Aqua protein is comparable to fishmeal, and superior to many novel protein sources under development. FeedKind is approved in the European Union and the production process has been validated commercially. The product is expected to be available in the marketplace in 2018."

FeedKind Aqua has 71% crude protein with an amino acid profile superior to plant sources in terms of lysine, methionine and cysteine, tryptophan, threonine and isoleucine. The 10% crude fat comprising short chain, saturated fatty acids contributes to a firm flesh texture in fish. It has a shelf life of a year and consistency of composition batch to batch is assured.

"As a company we are focussed on FeedKind for the moment. We believe that this is good alternative for aquaculture. We just completed series C funding and Cargill is on board to partner for commercial production in North America. This commercial plant is expected to be online in 2018. Production will be in the 15,000 tonne range initially, and we can expect to scale up to 200,000 tonnes in the future," said Allan LeBlanc, Product Manager.

"Calysta's aim is to provide an alternative to fish meal for aquaculture species as well as for livestock production. We believe there will be a market for FeedKind around the world and market adoption of this ingredient is the core goal of the company.

"At the moment we have approval to sell into the EU. On the EU register of feed materials, it is a single cell protein suitable for all aquaculture species. Globally, we are targeting the salmon feed industry as this industry has previously used several thousand tonnes of FeedKind protein. Next will be the seabass and seabream in Europe, and we are evaluating additional species in Asia, with shrimp feed a high priority."

Marketing into Asia

According to LeBlanc, Calysta is actively evaluating South East Asia markets. "At the moment, approval is pending to enter these countries. Each country will have their own set of processes for registration and timeline for marketing clearance.

"The aquafeed industry in Asia is an important future market, partly because we see that there are species constrained with the use of quality feed. We are looking for partners, both academic and commercial and hiring for local and technical sales."

Algae for aqua feeds

The Algae Biomass organisation conducted a session on algae for aqua feeds. In his introduction to the session, John Benemann, MicroBio Engineering, Inc. said that a major attraction of microalgae is their potential to substitute fish oil and fish meal. Current commercial microalgae production is relatively small-scale, globally less than 20,000 tonnes of biomass is produced annually by autotrophic cultures (grown in sunlight and CO₂), and



Dr Geoff Horst (middle) with Shelley Turner (left) and Daniel F Villamar at the Algal Scientific booth.



Meagan Wairama and Chris Wilcox (left). Nutrinsic manufactures a single-cell protein product called ProFloc™. The facility in the US is now online and is capable of producing 5,000 tonnes of ProFloc™ per year. At the conference, Andy Logan, R&D vice president, presented results on a trial where the single cell protein progressively replaced up to 100% fish meal in feeds for 10 g vannamei shrimp. It was concluded that ProFloc™ can replace up to 100% of high-quality fishmeal in feeds for this shrimp.



WAS-APC student board member, Noe Noe Lwin, USSEC (left) and students at Auburn University, Lay Nguyen (Vietnam, tilapia/catfish), Sirirat Chatvijitkul (Thailand, tilapia/catfish), and Van To (Vietnam, shrimp)

approximately an equal amount by fermentation. *Spirulina*, the main microalgae currently cultivated is used for some specialty aqua feeds. Microalgae for aqua feeds are also produced by dark fermentations, a rapidly growing business. Seaweeds with several million tonnes being produced commercially is another rapidly expanding ingredient for animal and aquaculture feeds.

A promising new ingredient for the aqua feed industry is algal meal made from *Schizochytrium* sp, which is a rich source of docosahexaenoic acid, DHA. **Vikas Kumar** from the Aquaculture Research Centre, Kentucky State University presented work done using of ALL-G-Rich™ algae meal, *Schizochytrium* sp. (65% lipid, 27% of which is docosahexaenoic acid, DHA) as a fish oil replacement in a fish meal (25% fish meal) based diet and fish meal free plant protein-based shrimp diet (51% soybean meal). The trial was conducted with juvenile vannamei shrimp. He concluded that the microalgae (*Schizochytrium* sp.) can be used as a replacement for fish oil in both fish meal and plant protein based shrimp diets.

AlgaMUNE and AlgaGLUCAN are beta-1,3-glucan products of Michigan, USA based biotech developer Algal Scientific. According to **Dr Geoff Horst**, CEO, Algal Scientific started five years ago growing algae in large amounts. Algamune is produced by growing a selected strain of natural, non-GMO microalgae (*Euglena gracilis*) in a controlled and sterile fermentation system so that it contains more than 50% by weight of beta-1,3-glucan. Unlike other sources of beta glucan, such as yeast, mushrooms, and oats, this product contains only the pure, unbranched form of beta-1,3-glucan. There are no beta-1,6 side chains and it is not bound to other cellular components such as cell walls.

As a result, this beta-1,3-glucan is highly bioavailable. Controlled laboratory research at the University of Arizona has shown that Algamune incorporated into shrimp feed at a concentration as low as 500g/tonne increases survival after a challenge with highly virulent white spot syndrome virus (China strain). In a presentation, Yamamoto and colleagues at Texas A&M University showed some immunostimulatory effects in tilapia fed diets supplemented with the product at inclusion rates of 200 mg/kg of dry diet. Fish were challenged with a virulent strain of *Streptococcus iniae*.



Canada based Jefe is a global leader in non-medicated performance feed additives. From left, Herve Lucien-Brun, Ramon Jimenez, Jan Breckman and Dr Kabir Chowdhury.



The Wenger team, from left, Brian Streit, Jesse Mitchell, Marilyn Edelman and Joe Kearns.

Transforming aquaculture in China

By Cui He

China is the largest country in aquaculture production, trade and consumption. To date, we have been confronted with adverse economic situations globally and face various challenges posed by an economic slowdown in China. The transformation and updating of China's fishery and aquaculture industry has become the inevitable choice for future development. Therefore, it is of vital importance to understand the motivation behind this transformation and the core concept of sustainability.

China's aquaculture

The fisheries industry has seen zero growth for several years and aquaculture is also reaching saturation levels. The seafood processing industry has been slowing down too. Imports and exports of aquatic products underwent negative growth in 2015, for the first time after 17 years of continuous growth.

Transformation of fishery and aquaculture industry

Today, the Chinese government is emphasising ecological and environmental protection at unprecedented levels. Capture fisheries is reducing, easing the dependence and pressure on wild marine resources. Traditional farming is being transformed into more ecological models.

At present, aquaculture contributes 74% to the total production of aquatic products. Over the next 5 to 10 years, this ratio will increase to 80% while the output from capture fisheries will continue to fall. The traditional style of extensive farming is over. The model of high production but low efficiency is no longer encouraged. Aquaculture will and is turning towards a more ecological, high-quality and sustainable direction.

The seafood processing industry

In recent years, China has increasingly stressed the importance of environmental protection, which intensifies the contradiction between surplus of processing capacity and shortage of raw materials. Private businesses still have difficulties in obtaining loans while the cost of labour continues to increase every year. The processing sector's transformation includes: meeting the huge potential demands in domestic market, shifting to improve quality.

Trade transformation

The trade volume of Chinese aquatic products occupies 15% of the global trade. In 2015, China Aquatic Products Processing and Marketing Alliance (CAPPMA) issued a Consumption Guide for Aquatic Products for the first time. According to the Guide, the following products are encouraged:

- products with domestic and international certifications like MSC, ASC, BAP, organic certification and green product certification;
- low-carbon products like carp, silver carp, etc.;
- carbon sink fish like shellfish, algae, etc.

Promoting transformation

China's fishery needs transformation and updating. Our aquaculture should move towards sustainable development. We should establish an aquatic model directed towards ecology and health. The market demands higher value add aquatic products. Meanwhile, better quality and high value should be created for aquatic by-products. With the fishery industry structure in China becoming better balanced, consumers can enjoy better and safer aquatic products. We are confident that China's market access system will be gradually implemented. China can play a more active and crucial role in global sustainable development only by taking sustainability into consideration in various and comprehensive views.

Asia-Pacific Aquaculture Expo

The overall development of the industry needs everyone's participation and contribution. These are the reasons behind the organisation of Asia-Pacific Aquaculture Expo and related conferences.

In 2015, aquaculture professionals from 16 countries around the region gathered in Xiamen City, China to display the latest products and technology and attend 17 fascinating themed conferences and activities, such as the Global Aquaculture Summit and the 7th Chinese Prawn Industry forum.

Asia-Pacific is the core region of global aquaculture and China plays a leading role. Regular hosting of the Asia-Pacific Aquaculture Expo will promote information exchange and trade activities of new products, equipment, and new technology. The event will motivate industrial upgrading and transformation. The conference will start on May 25.



Dr Cui He is the Executive Vice Chairman of China Aquatic Product Processing and Marketing Alliance (CAPPMA).
Email: mickcui@hotmail.com



APA Expo 2016 will be held from May 26 to 28, 2016. It will have exhibits covering the whole industry chain ranging from breeding, feeds, technology, equipment, processing, and transportation to the final products. In 2015, the expo had a total of 105 exhibitors, including from Norway, Ecuador, Canada, America, Japan and China. The number of Chinese exhibitors accounted for 88% of the total. Support came from leading businesses in China including Evergreen Group, Yuehai Feed Group, Tongwei Group, Great Seven Bio-Tech, Grobest, Nanrong Group, Zhangzidao Group and Baiyang Group.

The Global Aquaculture Summit on May 25 will be in Chinese and English at Juntai Xiamen Hotel. The one-day conference will have a plenary session and three breakout sessions. Presentations will cover topics such as development trends in global aquaculture, potential and future of China's aquaculture, business and market expansion, sharing of experiences in marine aquaculture and innovation and trends in freshwater aquaculture. Breakout session topics include innovation and practice of modern aquaculture and industrial aquaculture. More information: www.en.apaexpo.com.cn; For more information on CAPPMA, <http://en.cappma.org/>

Launch of 'care for growth' at APA 2016

During Asian Pacific Aquaculture 2016 in Surabaya, Indonesia, INVE AQUACULTURE launched a renewed and intensified approach to the market, strongly focusing on knowledge transfer and information sharing as a catalyst for growth in the industry.

This is part of the global campaign titled 'Care for Growth' where the company will deploy a series of new concepts and initiatives, a new visual brand identity and a reinforced dedication to the sustainable development of the global aquaculture industry. At the press conference, Philippe Léger, CEO; Stelios Leontios, Commercial Director and Rudi Bijmens, Regional Sales Director for Asia (INVE Aquaculture) gave detail insights into the most current developments and activities in all major global aquaculture markets and specifically in the Asia Pacific region.

Care for growth

"Aquaculture is growing faster than any other food production industry at 5-6% compared to 3% for meat production. It is more efficient and ecological with lower emissions of nitrogen and phosphorus. However, we need to increase production by 90 million tonnes between now and 2050, double the current capacity within 1.5 generations. INVE Aquaculture is an actor in this growth," said Léger.

"For over 30 years, INVE Aquaculture has been enabling growth in aquaculture: the healthy growth of fish and shellfish, the growth of local businesses of clients and the global aquaculture as a whole. We started in 1983 in marine aquaculture, creating hatchery feeds for the marine fish and we are still active in this segment.

Léger added, "Our mission is to enable growth of aquaculture by taking care of this 'growth'. As a spin-off from Ghent University, we have the expertise and solutions from working with the pioneers of aquaculture of the eighties as well as working with the new generation of experts. Starting in Europe and expanding to the Americas and Asia, we understand the need to bring the industry together. Providing solutions is not only to resolve, but also to understand, what the market needs. At the heart of all these, we have our 500 people in close partnership bringing together customers and suppliers. 'Shaping aquaculture together' is still our tagline."

Since December 2015, INVE Aquaculture has become part of Benchmark Holdings, a leader in applied biotechnology and knowledge transfer to businesses in aquaculture and agriculture. "There is a lot of synergies. Benchmark is active in animal health and breeding solutions and we complement with our current offering of advanced nutrition and health portfolios. The synergy is across species too as we are strong in marine fish and shrimp and they focus on tilapia and salmonids. Together we now offer the most complete nutrition, health and environment solutions portfolio in the market. As a result, we contribute even more effectively to our clients' sustainable growth and long term success," said Léger.

"We care for growth of the whole aquaculture environment and for a sustainable supply for customers. We do this, is by creating the right environment and the right solutions. Aquaculture is moving towards a maturity level in establishing itself as a business," said Leontios.

"We have knowledge and passion for innovation and quality, which is translated into answers which the aquaculture world wants. Although our vision, mission and technologies remain the same, we apply them according to the needs of the industry in the Americas, Europe and Asia. Specifically in Asia, the market is far from mature and is fragmented. This market provides food on the table for many families and we contribute with cooperation with the main players in this market. We believe that not only do we bring aquaculture a step further, but support the large companies who in turn support the smaller farmers. If companies have the same philosophy, we can work in synergy to reach the same goal for the final consumer," said Leontios.

"In Asia and Latin America, we have such partnerships. In Brazil, farmers came to us when they wanted to diversify into tilapia farming and together we work to create a product for the consumer. Together we are stronger and in the past 30 years, we have been working this way. All the companies sharing their stories with us during this launch know the benefits of working together. By taking care, growth will come.

"The bottom line is that we bring together the scientific world with the business world. It is essential that these two worlds go hand in hand."

More information: www.inveaquaculture.com



Dr Patrick Sorgeloos (back row, left) and Philippe Leger (back row, second left) and Stelios Leontis (back row, right) with the team at the APA 2016 trade show. Front row, from second left, Dr Patrick Lavens, Innovations Director, Dr Olivier Decamp, Product Manager -Farm and Feedmill and Rudi Bijmens

An ethoxyquin-free site

AQUATIV Thailand recently announced the complete removal of ethoxyquin additive from its whole range of products. Today, only BHA, BHT, Propyl gallate, rosemary extract and tocopherols can be found in the list of antioxidants used in the production plant.

"We, Aquativ Thailand, have been working very closely with our partner TC Union Agrotech to supply marine ingredients to the aqua feed market with the highest standards. Thanks to this collaboration, we are proud to be able to offer a wide range of products made from synthetic and natural antioxidants, 100 % ethoxyquin-free", says Phatthranit Rungsitsathien, QHSE Manager of the plant. "Our quality management system, our know-how of antioxidation solutions and our robust traceability program allow us to make this significant and positive move and to provide the market with perfectly preserved and guaranteed ethoxyquin-free products"

Aquativ Thailand produces and supplies high quality functional marine hydrolysates to the aqua feed market. The plant is located

in Samutsakhon, 30 km far from Bangkok. The factory is set up under European standards with ISO 9001, ISO 22000, GMP, HACCP and SEDEX certifications.

Belonging to DIANA, part of Symrise AG, Aquativ creates and offers a unique and sustainable range of marine based functional hydrolysates to aqua feed manufacturers seeking enhanced feed performances. Liquids and powders are obtained from the freshest and most sustainable marine raw materials sources one can possibly find in the market.

Adding to its expert knowledge in the field of marine protein hydrolysis inherited from DIANA, Aquativ has built up a team entirely dedicated to aquaculture, including fish and shrimp nutritionists, health specialists and veterinarians. Aquativ delivers natural ingredients bringing high functionality to the aqua feed and ultimately better productivity to the farmers. Web: www.aquativ-diana.com; www.diana-group.com

Nutriad increases aqua footprint

Nutriad, multinational feed additives manufacturer, continues to invest in aquaculture as it announced the expansion of its regional aqua teams.

Tkangairulappan Gnanamani, based in Chennai, India has been appointed as Aquaculture Manager of South Asia and **Bruno Urach**, based in Pernambuco, Brazil as Sales Manager of North East Brazil.

"Regional aquaculture specialists are an integral part of our strategy to increase our footprint in key aquaculture markets around the world. Within the growth market of Asia, India has dramatically increased its aquaculture production in the past years, particularly of white shrimp. Brazil continues to be an important aqua country in South America, with interesting growth potential in freshwater fish such as tilapia and local species. At the same time, the sustainability of the industry is challenging in both India as well as Brazil by disease outbreaks and scarcity of marine ingredients for aqua feeds, two areas where Nutriad offers specialised solutions and services", said Dr Peter Coutteau, Business Unit Director Aquaculture for Nutriad.

"Besides shrimp, important volumes of freshwater fish are farmed in India and Bangladesh, which places this area among the main aquaculture regions worldwide. The local expertise of Gnanamani in fish and shrimp aquaculture in India, and extensive knowledge of the local farming conditions perfectly complements the Nutriad aqua team in Asia Pacific", said Allen Wu, Regional Manager Aquaculture APAC.



*Tkangairulappan
Gnanamani*



Bruno Urach

Gnanamani said, "Having worked over 20 years in fish and shrimp aquaculture in India, supporting feedmills and farms, I see a great potential in the specialty programs offered by Nutriad to improve feed cost-efficiency and prevent disease using natural products. My position with Nutriad will allow me to apply my knowledge and experience towards solutions that help farmers and feed millers deal with day to day performance and health challenges in aquaculture."

Urach has 13 years of experience in the aquaculture industry in Brazil where he has worked in various positions with producers of fish and shrimp. "Bruno's deep knowledge of the aquaculture market throughout the northeastern region as well as the main production centers of southeast and south of Brazil complements our livestock sales team in Brazil," said Marcelo Nunes, Nutriad's Regional Director of South America.



An international showcase for Asia

Once again FIAAP, VICTAM & GRAPAS Asia proved that quality counts! This was the early verdict of visitors, conference delegates and exhibitors alike, said the organisers, Victam International BV. The exhibitions and series of accompanying conferences were again held at BITEC in Bangkok.

There were 223 exhibitors and co-exhibitors, from 28 countries. The show was sold out again and was 11% larger than the 2014 show. Exhibitors were very satisfied with the visitors. Exhibitors were able to have serious discussions and negotiations with their clients and new potential clients that they had met at the show. The exhibitors also commented on the very high quality of the visitors and the wide range of countries from which they came. There were 6,374 visitors, an all-time high for this show. An increase of 5% from the 2014 show. A very high proportion (40%) of the visitors were from outside Thailand. These figures clearly demonstrate that the event is now Asia's international showcase for the feed and grain industries. A full post show report is expected in the next few months.

At Victam, Joe Kearns, Wenger, USA, a leading feed equipment manufacturer said, "The show has been tremendous for us, especially for the first two days. We are seeing what is being predicted, that aquaculture is expanding and need to produce more feeds. Enquiries came from new and existing feed millers. Many of them are integrators."

The conference delegates also confirmed the quality of the papers presented at the numerous conferences. The conferences had extensive programs which were well received. The different conference organisers stated that the delegate attendance was good and that the delegates have appreciated the quality of both the speakers and their papers. The organiser of Aquafeed Horizons conference said it was fully sold out and there was only standing room available!



Henk Van de Bunt (left) and Erik Heemskerk at the press conference to announce his retirement

Victam International BV also organised the 2nd ASEAN Feed and Rice Symposium. Speakers from IFIF, ADM, the Thai Department of Livestock Development and FAO addressed the audience of senior international executives from ASEAN feed and rice industries. There were over 100 in the audience. The Victam Foundation organised and funded the ASEAN Feed Summit. The Thai Feed Mill Association hosted this closed session. Its President, Pornsil Patchrintanakul chaired the session, while Alexandra de Athayde, IFIF Executive Director was the moderator. This event brought together senior feed regulators and industry representatives from Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Thailand and Vietnam. During the discussions, a number of relevant issues were identified for potential cooperation, including capacity development for feed safety, sustainability, efforts towards regulatory harmonisation and standards development to facilitate trade and production at regional and international level.



Andritz Feed and Biofuel Technologies announced in its newsletter that it has supplied 20 tph lines, the highest capacity fish feed pelleting line to three leading corporations in the Mekong Delta, Vietnam. It also finished a turnkey aqua extrusion plant with a 120,000 tonnes capacity in China.



Thailand's Agentis Innovations specialises in process optimization. At Victam Asia 2016, it won the Grapas innovation award for its moisture density measurement control. The new and innovative M007 microwave resonance technology provides real time moisture and density measuring. Data generated by the M007 system is uniquely interfaced to provide real time automated process control solutions. The range of instruments includes: in line high speed sensors, portable hand held devices and laboratory instruments.



Wenger, USA team. From left, Joe Kearns, USA, Ramesh Gangatharan, Wenger India, Curtis Strahm, Marc Wenger and Brian Streit from Wenger USA, Jason Ho, Wenger Taiwan, Cliff Zhou, Wenger China, Paul Chen, Wenger Taiwan.

Wenger presented its new addition AquaFlex XT - capable of making a wide range of aquatic feeds from 0.5 mm to the desired diameter, floating sinking or slow sinking, said Joe Kearns at the booth. "We can build this in two configurations, up to 6 tph and then 10-12 tph. We have a dual die to get double the capacity. The model on display has been resold to Vietnam for the production of floating microfeeds."

Victam also celebrated its 25th anniversary of holding events in Asia with a dinner. The international audience of over 400 executives from industry attended and were treated to a wonderful evening of both modern and traditional Thai entertainment. The winners of the coveted Innovation Awards were announced. The Animal Feed Technology & Nutrition Award, sponsored/organised by AllAboutFeed, was won by Huvepharma from Belgium and Kemin Industries (Asia), Singapore won the Aquafeed Innovation Award, sponsored/organised by Aquafeed.com. Eye-Grain Apps from Denmark won the GRAPAS Award, sponsored/organised by Milling and Grain magazine.

At the press conference, Victam's General Manager, Henk Van de Bunt announced his retirement. Van de Bunt has been with

the organisation since the very first show in Bangkok in 1991 and during his time has seen the show grow over 600%. Van de Bunt will join the Board of the Victam Foundation. On June 1, Erik Heemskerk, currently Brand Director Growth Markets Pharma at UBM, will take over.

The next FIAAP, VICTAM & GRAPAS event in Asia will be from March 27- 29, 2018. Victam will organise a new event in Cologne, Germany from June 13-14, in 2017. This is FIAAP, VICTAM & GRAPAS conferences 2017. This new event will be conference led and will be co-located with a small expo. More information: www.fiaap.com, www.victam.com and www.grapas.eu

Aquafeed Horizons Asia 2016



At Aquafeed Horizons, Juadee Pongmaneerat, Department of Fisheries (second left) with from left, Jareerat Suratrongrojkul and Suphol Phantumaophas, Charoen Pokphand Foods Public Co, Dominique Bureau, University of Guelph, Canada and Martin Guerin, consultant, Malaysia.

This 9th Aquafeed Horizons began with a welcome address by Dr Juadee Pongmaneerat, Deputy Director General Department of Fisheries and Suzi Dominy, Publisher of Aquafeed.com, organiser of the meeting. The conference program was designed for commercial aquaculture, feed manufacturers and those interested in the latest formulation and processing solutions available for aquafeed production.

Joe Kearns, Vice President, Aqua Feed Division of Wenger Manufacturing presented on interactions of extrusion and ingredients for aquafeeds. Kearns gave some criteria for starch inclusions for sinking and floating fish feeds. He said that extrusion is the method for controllable inputs to the system. He also discussed aspects of hygiene in feed processing. The focus of the presentation by Urs Wust, Product Management, Aquafeed and Petfood, Buhler, was formulating durable

sinking feeds with low starch formulations. According to Wust, twin screw extruders allow for lowered starch inclusions in comparison to single shaft extruders. The cost saving is 0.5 to 1% less starch. The conference continued with presentations on process control in aquafeed production as well as pre-processing of feed stuffs to improve their feeding value.

The afternoon session dealt with nutritional issues ranging from amino acid nutrition to functional feeds for fish and shrimp. Dr Kabir Chowdhury, Jefe, Canada discussed feed for the future for a sustainable aquaculture while Dr Margriet Drouillon from Ghent University discussed using GART as a platform to investigate control strategies against AHPND/EMS.



Yeo Keng Joon, Chairman Bharat Luxindo Agrifeeds Pvt Ltd presented a souvenir to Dr Warren Dominy, chair of the Aquafeed Horizons conference on the occasion of his retirement from Oceanic Institute, Hawaii.

Marine algae to reduce the use of antibiotics in farming

As part of a partnership with Olmix Group, Inra researchers have shown that a compound extracted from green algae inhibited the growth of pathogenic bacteria *in vitro* and stimulated the production of immunity mediators by intestinal epithelial cells. This type of preparation could be used in livestock feed to improve animal's resistance to infections and therefore reduce the use of antibiotics. It could also be used as an aid in vaccine strategies. These results were published on 8 March 2016 in the *Journal of Applied Phycology*.

Marine algae are chlorophyll-containing aquatic plants that grow on the seabed. They are classified in three groups depending on their pigments: brown algae (phaeophyceae), red algae (rhodophyceae) and green algae (chlorophyceae or ulvales). The cell walls of these marine algae, are rich in sulphated polysaccharides, which possess physicochemical and biological properties that could have potential applications in the pharmaceutical industry, biomedicine, cosmetology and farming or as additives in human and animal food.

Created in 1995, Olmix Group specialises in promoting the use of green algae harvested in Brittany by processing them into innovative natural products for plant, animal and human nutrition and health sectors. With the aim of identifying beneficial bioactive molecules, Olmix Group prepared an extract of sulphated polysaccharide known as marine sulphated polysaccharides (MSP), using *Ulva armoricana* green marine algae harvested in Brittany. Within a research partnership between Olmix Group and the Inra Val de Loire Infectology and Public Health

Research Centre, an MSP was studied *in vitro* to test its capacity to inhibit bacterial growth and stimulate the production of immunity mediators. The MSP's ability to inhibit bacterial growth was observed on a panel of 42 strains of pathogenic bacteria isolated from livestock or their environment. MSP also induced an increased production of cytokines, in an *in vitro* system of differentiated porcine intestinal epithelial cells. The stimulation of these immune mediators indicate a potential stimulation of intestinal immunity by MSP.

Marine algae represent a source of natural bioactive molecules (including MSPs), which could be used in livestock feed to inhibit the growth of pathogens and boost the immune response. This could improve animal's resistance to infections and reduce the use of antibiotics on farms. Inra and Olmix are pursuing their partnership to determine the MSP's mechanism of action, identify the cell receptors involved in recognizing MSP and confirm the *in vitro* results with *in vivo* testing.

More information: Inra media relations: presse@inra.fr; Laurence Guillevic, Olmix: contact@olmix.com

Reference:

Marine sulfated polysaccharides extract of *Ulva armoricana* green algae exhibits an antimicrobial activity and stimulates cytokine expression by intestinal epithelial cells. Mustapha Berri, Cindy Slugocki, Michel Olivier, Emmanuelle Helloin, Isabelle Jacques, Henri Salmon, Hervé Demais, Matthieu Le Goff, Pi Nyvall Collen. *Journal of Applied Phycology*, 8 March 2016.

Borregaard launches pelleting aid Intact Aqua in Asia

Borregaard LignoTech has launched a new pelleting aid for the aqua feed sector in Asia. Intact Aqua, a combined processing aid and pellet binder, has been developed and optimised to assure both optimum water stability and stable operating conditions. When added to the shrimp feed formulation Intact Aqua will lower the energy consumption, which enables the shrimp feed producer to reach the desired conditioning temperature and increase the production rate.

When added at the recommended inclusion level of 0.5% Intact Aqua can offer the following benefits to the shrimp feed producer:

- Reach the desired conditioning temperature without destroying key nutrients and equipment
- Lower energy consumption or higher production rate
- Stable operating conditions
- Optimum water stability
- Reduced use of PMC/synthetic binders
- Lower cost in use than PMC/synthetic binders

Intact Aqua will be officially launched in India in May. Borregaard has appointed ABT Corporation as their licence producer and distributor for the Indian market. Intact Aqua will be launched in phases in other South Asian and South East Asian countries during the coming months.

Borregaard LignoTech is the world's leading supplier of pellet binders and die lubricants to the animal feed industry. Products can improve pellet quality, reduce energy consumption, increase production rate and improve overall feedmill profitability. The Borregaard Group has 1080 employees in 16 countries.

Information about the product is available at www.intact-aqua.com

AquaGen acquires majority shareholding of Aquabel

AquaGen AS, the world's leading salmon genetics company, has concluded an agreement to take majority ownership of the shares in Aquabel, the Brazilian-based tilapia breeding and distribution company.

Aquabel has become the leading supplier of genetic material to the Brazilian tilapia farming industry, the fastest growing aquaculture sector in the Americas. The company develops, produces and sells genetic material distributed as fingerlings and juveniles, tailored to the aquaculture sector's requirements for farmed tilapia. With its head office in Londrina, Aquabel has production facilities in 6 different states in Brazil close to their customers in a rapidly growing industry.



One of Aquabel's production sites in the state of Ceara, north east Brazil.



From left, Ricardo Neukirchner, Owner and CEO of Aquabel and Odd Magne Rødseth, Chairman of AquaGen.

"Our partnership with Aquabel represents an important milestone, which extends our priority areas into the expanding aquaculture industry," says Odd Magne Rødseth, Chairman of AquaGen. "The position Aquabel has built up and the results which have been created document that this company has unique expertise and a

strong position in the market. A big potential exists for Aquabel and AquaGen to work together in securing synergies through the exchange of experience and technologies. This will provide the tilapia industry access to more than 40 years of research and experience-based knowledge related to applied industrial breeding that has made AquaGen into the world's leading company in salmon genetics."

"I am pleased at the interest shown by AquaGen, and very satisfied that we'll be affiliated to an ambitious long-term strategic partner like AquaGen", says Ricardo Neukirchner, CEO of Aquabel. "To be a part of a team with the world's leading salmon breeding company will make important genetic knowledge and research resources available to Aquabel. Our new relationship with AquaGen will contribute to further genetic progress in our breeding program, and strengthen Aquabel's position as a trusted and independent supplier to the aquaculture industry."

With its head office in Norway, AquaGen is a part of the EW Group, a holding company of a number of independently operating companies in the areas of genetics, nutrition and animal health. These companies have worldwide leading positions in their specific fields and sell through a network of international operations.

More information: ricardo@aquabel.com.br (Ricardo Neukirchner) and odd.magne.rodseth@aquagen.no (Odd Magne Rødseth)

New appointments

Directors for sustainability and communications



Cilia Holmes Indahl



Katrin Berntsen

Aker BioMarine, a leading supplier of krill-derived products to the consumer health and wellness and animal nutrition markets, has announced two appointments at its company headquarters in Norway.

Cilia Holmes Indahl, the company's new Director of Sustainability, will further develop and implement the company's sustainability strategy while working with key stakeholders and non-government organizations (NGO's) interested in krill and Antarctica. During the past few years, Cilia has held several positions dedicated to sustainable development and climate change in Norway and abroad. She holds Masters Degrees in sustainable development and international business.

Katrin Berntsen, Aker BioMarine's new Director of Communications, will be responsible for managing and directing the company's internal and external communications. Passionate,

creative and organized, Katrin brings more than 15 years of experience specializing in messaging strategy, product launches, crisis communications, and more. Prior to joining Aker BioMarine, she managed communications for Wilhelmsen Ships Service and Opera Software. She holds a Masters Degree in European Politics and a BA in Media.

"We are happy to welcome Cilia and Katrin to the Aker BioMarine team," said Matts Johansen, CEO, Aker BioMarine. "At a time when sustainability should be considered a major component of a company's DNA, it is essential to have a director, like Cilia, who can successfully implement the best strategy possible for our business. Equally important is a communications director, like Katrin, who has the ability to properly communicate key messages about our company inside and outside of our business. We look forward to having them both continue to push Aker BioMarine in a positive direction.

More information: becky.wright@akerbiomarine.com; katrin.berntsen@akerbiomarine.com



THE AQUACULTURE ROUNDTABLESERIES® 2016

A shared vision for aquaculture in Asia



SHRIMP AQUACULTURE & THE NEW NORMAL
August 17-18 2016, JW Marriott Phuket Resort & Spa, Thailand

Shrimp & Aquaculture The New Normal

PRESENTATION HIGHLIGHTS (as at press time)

Refer to www.tarsaquaculture.com for the full program

The State of the Shrimp Aquaculture Industry in Asia



“There are several trends we must not forget as we forge the future of shrimp culture... Some say we should go back to lower density shrimp culture, using specific pathogen resistant (SPR) shrimp, while others say we must go forward with higher production, with higher efficiencies using improved disease free shrimp. These increased production efficiencies will be accomplished through the application of new culture systems technologies that provide for more control on the environment, use less water, and produce shrimp with less energy input/shrimp output. We have come a long way and we will continue to transform in ways that could not have been envisioned by the original founders of this industry...”

Robins McIntosh, Charoen Pokphand Foods, Thailand

Living with Current Shrimp Disease Threats in Asia



“There is a new type of shrimp pathology of unknown cause. Massive production of transformed microvilli (ATM) leads to gross signs of disease called white faeces syndrome (WFS) that results in decreased shrimp growth and survival... Spread of diseases including AHPND, HPM, CMD and ATM has been promoted by the use of live or fresh broodstock feeds such as polychaetes and clams... Such practices have made the whole shrimp industry vulnerable to the rapid spread of new and newly emerging diseases and causing the current crisis in Asia’s shrimp culture industry. The situation has been exacerbated since 2009 by an almost exclusive focus on AHPND, ...”

Kallaya Sritunyalucksana, National Center for Genetic Engineering & Biotechnology (BIOTEC), National Science and Technology Development Agency (NSTDA), Thailand

Genetics and Sanitary Status: SPF vs SPR/SPT



“Specific Pathogen Resistant (SPR) and Specific Pathogen Tolerant (SPT) refer to the stock’s 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. These are genetic characteristics regardless of their sanitary status, whether the stocks are infected or not. SPR/SPT may, in some cases, have the drawback of lower performance when compared to other stocks.”

Victoria Alday-Sanz, National Aquaculture Group, Saudi Arabia

The Lost Billions in Asia’s Shrimp Aquaculture Industry



“Since its emergence in China in 2009, acute hepatopancreatic necrosis disease (AHPND) caused by the bacterium *Vibrio parahaemolyticus* with a toxin gene bearing plasmid, has had devastating economic impacts for Asian shrimp. In Thailand, shrimp productivity fell from a peak of 10.6 tonnes/ha in 2010 to only 4.13 tonnes/ha in 2013 following the AHPND outbreak. National losses to date are estimated to be more than USD 5.01 billion with value added reduced by between USD 1.7 to USD 2 billion annually, and with an estimated 100,000 jobs lost as a result of infections...”

Andy Shinn, Fish Vet Group Asia Ltd, Thailand

Indonesian Shrimp Farming: Lessons from IMNV



“The infectious myonecrosis virus (IMNV) started to attack shrimp farms in Brazil in 2002, before spreading to Indonesia in 2006. During the IMNV outbreaks, shrimp production and shrimp feed production declined drastically. Fast-forward to 2016, a decade later, what is the current shrimp farming condition in Indonesia? How are farmers culturing their shrimp, and what are the lessons learnt?”

Anwar Hasan, Aquaculture, BIOMIN, Singapore

Despite some progress in rebuilding Asia's shrimp aquaculture business, its vulnerability to disease outbreaks continues to disrupt production. Faced with the presence of ongoing and emerging shrimp diseases, industry stakeholders have to contend with adverse multiplier effects, including losses in revenue, production efficiency, rising production costs, and emotional stress for farmers. Shrimp farming is viewed as a risky business today.

Shrimp Aquaculture & The New Normal

"This is a critical time for intervention and to redirect the industry into pathways that are more sustainable, economically and ecologically, if it is to remain competitive. Effective stakeholder engagement and a holistic approach are key to resolving disease issues and improving profitability," says Zuridah Merican, editor of Aqua Culture Asia Pacific magazine.

"While no one size fits all, each sector needs to find the right business model. It is important for the industry to self-regulate and take a more pro-active approach to marketing its shrimp,"

TARS 2016 is a follow-up to the TARS 2014 meeting that focused on the recovery, revival and renaissance of Asia's shrimp aquaculture. TARS 2016 will provide a neutral platform for key stakeholders to convene and exchange insights and experiences as to how Asia, as a unified group, can reconcile to increase its sphere of control in disease mitigation.

The two-day meeting aims to take the industry to a New Normal with better management and control of all the variables in shrimp farming. It will bring to focus, new management tools and production techniques, updates on research and development, and innovative business models that can be adopted.

As with the past five successful roundtable series, TARS has become the industry's foremost opinion-leading aquaculture event in Asia. TARS 2016 will feature 4 state-of-the-science plenary sessions with 16 presentations by regional and international speakers, and 3 interactive breakout sessions that have become hallmarks of this series.

TARS 2016 will also introduce **Hard Talk with Shrimp Farmers** - a dialogue session with hard-hitting questions on farming models, challenges and success with disease mitigation.

<p>Supported by:</p> 	<p>Organised by:</p>  	<p>Sponsors:</p>       
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REGISTRATION IS LIMITED TO 200 PARTICIPANTS. Early bird registration ends on **17 June**. Walk-ins are not encouraged. For more information and updates, please go to www.tarsaquaculture.com • Email: conference@tarsaquaculture.com

The Tsunami of Vannamei Shrimp in India: Challenges to Future Growth



"This tsunami of vannamei shrimp has changed the entire landscape for the farmed shrimp industry in India. After its introduction in late 2009, production rose four fold reaching 400,000 tonnes within a space of five years. But in 2015, we witnessed a drop of 10%. As a result of the setback, the industry now faces quite a few challenges to future growth... Apart from WSSV, we also have EHP, white faeces and running mortality syndromes contributing to the losses...The industry needs to consider the option of tolerant stocks to WSSV to mitigate outbreaks etc.."

Ravikumar Yellanki, *Vaisakhi Bio-Resources (P) Ltd, India*

Supply Chain and Ingredient Excellence: Foundations of a Stable Shrimp Industry



"The aquaculture value chain starts with feed raw materials and ingredients. They represent the most determining factor to yield standardized and sustainable performances in farming. However, with current challenges in the farmed shrimp industry, farmers' expectations of feed performances have become very high. Formulators must find ingredients that will match this demand of excellence. Price, quality, performance, convenience, local availability, reliability and sustainability are all equally important to consider in the formulator's equations."

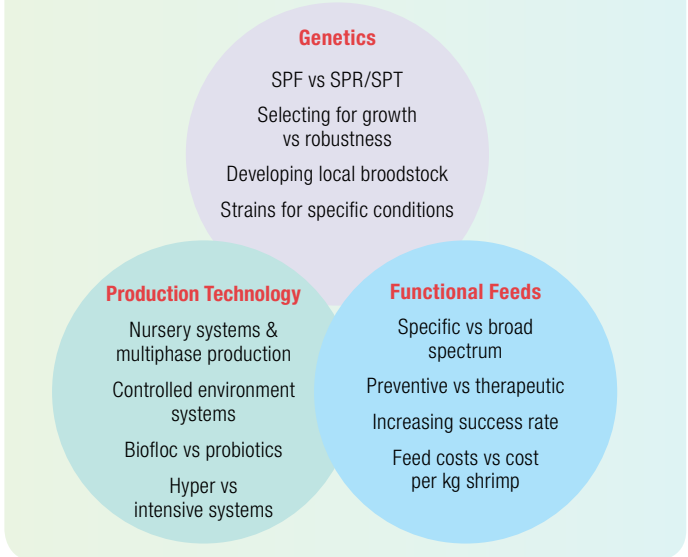
Vincent Percier & Philippe Sourd, *SPF-Diana Aquativ, France*

INTERACTIVE BREAKOUT GROUP SESSIONS

"Pathways to Disease Mitigation"

The plenary presentations will set the tone for the interactive breakout group sessions. Participants will break into groups of 10 pax per table (each with a Group Leader) to discuss challenges and opportunities; debate on the pros and cons of critical strategies and identify recommendations for disease mitigation to ensure a sustainable shrimp aquaculture industry in Asia. Leaders from each group will present a summary of the output at the Report Session.

The three breakout groups will discuss Disease Mitigation via:



International recognition for brackishwater tilapia development in Aceh

The BPBAP Ujung Batee team were awarded the JDF Father Heyne Award by the Tilapia International Foundation (<http://www.tilapiastichting.nl/index.html>) at the International Symposium on Tilapia in Aquaculture (ISTA 11), which was held concurrently with the Asian-Pacific Aquaculture 2016 conference in Surabaya, Indonesia, 26-29 April 2016. The award is made at each ISTA conference 'to a deserving proponent of using tilapia for poverty alleviation and improved nutrition'. The BPBAP Ujung Batee team was recognised for their work in developing brackishwater tilapia aquaculture in Aceh, to contribute to both income generation and improved nutrition, through the development of new 'scale-out' approaches using farmer-managed tilapia nurseries. Given that tilapia is now farmed in about 140 countries, this award is of great significance in demonstrating the impact of this work.

The award was presented by Mathieu Pinkers, President of the Tilapia International Foundation. During the award ceremony BPBAP Ujung Batee gratefully acknowledged the contribution of ACIAR through project FIS/2007/124 as well as AquaFish CRSP contributions.



BPBAP Ujung Batee team and Dr Mike Rimmer (third from left) with Mathieu Pinkers (left).

What to look forward to in Aqua Culture Asia Pacific in 2016

Our editorial calendar for 2016 reflects the new trends and technologies in aquaculture in Asia Pacific. These are most relevant to the industry and will help you reach your target audience.

Volume 12 2016			
Number	4 - July/August	5 - September/October	6 - November/December
Issue focus <i>Recent developments and challenges for the next step</i>	Industrialisation & Automation	Biosecurity & Disease Management	Probiotics
Industry Review <i>Trends and outlook, demand & supply</i>	Catfish	Marine fish	Freshwater Fish/Prawn
Feeds & Processing Technology <i>Technical contributions from feed industry</i>	Extrusion & Processing Technology	Feed Safety/Feed Enzymes	Nutrition & Formulation
Production Technology <i>Technical information and ideas</i>	Sustainable & Responsible Aquaculture	Biofloc & Biotechnology	Aeration Technology
Aqua business Feature articles	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		
Deadlines for Technical articles	May 15	July 15	September 15
Deadlines Advert bookings	May 22	July 22	September 22
Show Issue & Distribution at these events as well as local and regional meetings	11th Asian Fisheries & Aquaculture Forum August 3-7, Bangkok, Thailand	Aquaculture Europe 2016 20-23 September, Edinburgh, Scotland	
*Show preview	Vietfish 2016 August 3-5, Ho Chi Minh City, Vietnam		
	The Aquaculture RoundTable Series, (TARS 2016) August 17-18, Phuket, Thailand		



IFS2016 is the annual symposium organised to promote collaborative education, research and exchange in aquaculture and fisheries science and technology in the region. ASEAN-FEN includes 18 university members. It organises this international fisheries symposium to share the new and advanced research and technology development as well as to address to the newly emerged issues in aquaculture and fisheries for sustainable development.

This sixth international fisheries symposium (IFS2016) will be from October 31 to November 2, 2016 at Hoa Binh Phu Quoc Hotel, Phu Quoc Island, Vietnam. It will be co-hosted by Can Tho University, Nong Lam University, Nha Trang University and Hue University of Agriculture and Forestry with the theme of "Promoting Healthier Aquaculture and Fisheries for Food Safety and Security".

The scientific programs will include a plenary session by invited speakers. Other sessions will be:

• Shrimp industry and best practices	• Aquaculture biotechnology and engineering
• Aquatic animal nutrition and physiology	• Aquatic animal health management
• Genetics for aquaculture and fisheries management	• Aquatic resources, biodiversity and environment
• Seafood processing technology, food safety and security	• Fisheries economics and management
• Climate change on aquaculture and fisheries	• Other aquaculture

An excursion on activities around Phu Quoc island will be arranged within the work-frame of the symposium without any additional fee on November 2, 2016.

Abstracts for oral or poster presentation at the symposium should be submitted for review by the scientific committee before the deadline.

Submissions: Deadline: **31st August 2016**. Email to: ifs2016@ctu.edu.vn (IFS2016 Secretariat)

More information: <http://ifs2016.ctu.edu.vn/>



AQUATECH PHILIPPINES 2016 continues to be bigger and better on its **7th year!**

The **"Aquatech Forum"** was successfully held having Atty. Benjamin Tabios of the Bureau of Fisheries and Aquatic Resources as Guest Speaker. This became a venue and opportunity for the industry, government and non-government sectors to discuss on specific issues. Also in attendance was Sen. Cynthia Villar, Chairman of the Senate Committee on Agriculture and Food. This year, we are gathering various Aquaculture Groups (Farm, Hatchery Owners) for yet another forum. Its aim is to tackle important issues for a more sustainable industry.

This year's theme: **"Exploring... Latest Innovations for Higher Production, Best Alternatives and Strategies for Global Marketability."**



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Practical short course on extruded pet foods and treats

July 26-28, 2016
Texas A&M, USA

A two days Practical Short Course on Extruded Pet Foods and Treats will be presented in July 26-28, 2016 at Texas A&M University by staff, industry representatives, and consultants. The program will cover information on material handling, preconditioning, extrusion of pet foods, extruded and non-extruded treats, raw material, extrusion hardware, automation, product analysis, meat handling in pet food, drying, cooling and enrobing, food safety,

pet food and treat shelf life, and trouble shooting. Practical demonstration of pet food and treats on single and twin screw extruders. Reservations are accepted on a first-come basis. For more information, programs and application forms, contact: Mian N. Riaz, E-mail: mnriaz@tamu.edu. Web: <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@aquasiapac.com

May 26-28

Asia-Pacific Aquaculture Expo
Xiamen, China
Web: www.apaexpo.com.cn

June 2-4

Middle East Aquaculture Forum (MEAF-16)
Izmir, Turkey
Email: meaf16@meaf.ae
Web: www.meaf.ae/meaf16/

July 20-21

AQUATECH Philippines 2016
Tagaytay City, Philippines
Email: aquatech.ph@gmail.com
Web: <https://www.facebook.com/AquatechPhils>

August 3-5

Vietfish 2016
Ho Chi Minh City, Vietnam
Web: www.en.vietfish.com.vn

August 3-7

11th Asian Fisheries and Aquaculture Forum 2016
Bangkok, Thailand
Web: www.afsconferences.net

August 4-6

Asean Fisheries and Aquaculture Conference and Exposition 2016
Bangkok, Thailand
Web: www.aseanfishexpo2016.com

August 8-9

Aqua Fisheries Cambodia
Email: sabrina.hoang@veas.com.vn
Web: www.veas.com.vn

August 17-18

The Aquaculture RoundTable Series (TARS 2016) - Shrimp Aquaculture & The New Normal
Phuket, Thailand
Email: conference@tarsaquaculture.com
Web: www.tarsaquaculture.com



September 6-8

Seafood Expo Asia
Wanchai, Hong Kong
Web: www.seafoodexpo.com/asia

September 20-23

Aquaculture Europe 2016
Edinburgh, Scotland
Web: www.easonline.org

September 28-30

Aqua Fisheries Myanmar
Yangon, Burma
Email: sabrina.hoang@veas.com.vn
Web: www.veas.com.vn

October 19-21

AquaSG 16
Singapore
Email: info@aquasg.com
Web: www.aquasg.com

October 31-November 2

International Fisheries Symposium (IFS2016)
Phu Quoc Island, Vietnam
Email: ifs2016@ctu.edu.vn
Web: <http://ifs2016.ctu.edu.vn/>

November 2-4

China Fisheries and Seafood Expo (CFSE)
Qingdao
Email: seafoodchina@seafare.com
Web: <http://chinaseafoodexpo.com>

November 9-11

Taiwan International Fisheries and Seafood Show
Kaohsiung
Email: taiwanfishery@taitra.org.tw / stenly_yonardi@myexhibition.com.tw
Web: www.taiwanfishery.com

December 1

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

2017

20-24 March

Giant Prawn 2017
Bangkok, Thailand
Email: salinkr@ait.asia/new.macrobrachium@yahoo.co.uk

Food for thought

The annual meeting of the
European Aquaculture Society
aquaculture
europa
Edinburgh



16

September 20-23
Scotland



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aquaculture
society **years**

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All info on:
www.easonline.org

Organised by the European Aquaculture Society with the cooperation and support of Marine Scotland,
part of the Scottish Government and The Marine Alliance for Science and Technology for Scotland



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.



• No.16-18-20, DT743 Road, Song Than II Industrial Zone, Di An Ward, Di An Town, Binh Duong Province, Vietnam
• Tel: +84-650-3737626 - Fax: +84-650-3790819
• Email: aquafeed@upvn.com.vn



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