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AQUA CULTURE

Asia Pacific

Innovative Intensive Shrimp Farming System in Vietnam

From Bali to Global Markets

Improved Nile Tilapia Strain in Bangladesh

Performance Feeds at TARS 2017

Krill Meal and High Salinity Shrimp Farming

Seafood E-Commerce: New Route to Market

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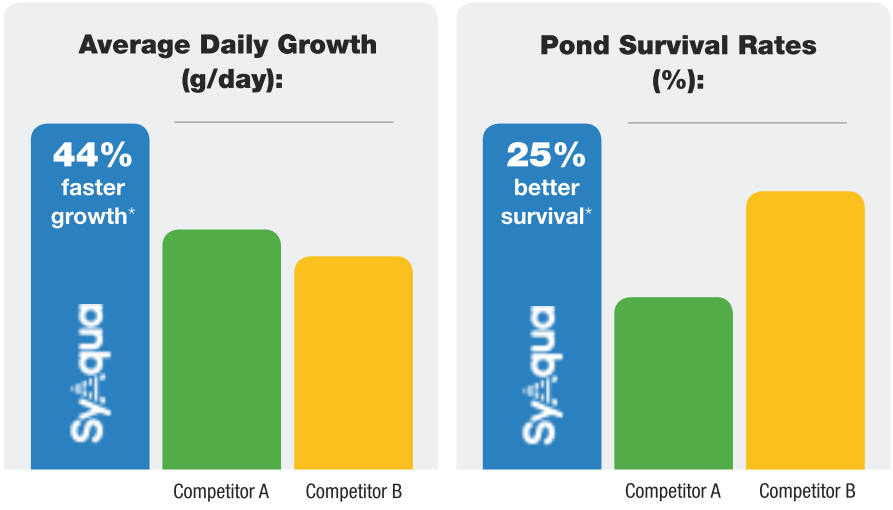

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The Year that was – lacklustre

Zuridah Merican

How does one describe a mediocre student - lacklustre and could have pushed harder? That is how one would describe the aquaculture industry in the Asia Pacific region in 2017. In terms of the market for shrimp, supply approximated demand and this supported prices at a good level. Supply has been affected by disease but compensated by increases in India and Indonesia. India continues to convert from monodon to vannamei shrimp, allowing for increase in production volumes per hectare. Indonesia is moving its farming eastwards, to more pristine waters and with cheaper coastal land.

The tilapia market is heavily skewed towards the US and demand has stagnated but production has increased in the central American countries. This stepped increase in supply has put pressure on prices, making it difficult for Chinese producers who have to battle with the poor image associated with quality and safety. With Vietnam, Thailand and India wanting to jump on the 'band wagon,' this does not help tilapia prices at all. During the past 18 months, production of pangasius in Vietnam has fallen. It was a good time for consolidation after years of expansion. However, this did not help prices when EU hypermarket chains tried to oppose price increases by claiming the age-old complaint of sustainability. The marine fish market has remained stagnant with producers still focusing on live fish which has a limited market in terms of both the premium price and distance the product can travel. However, there were some outstanding examples from the recent TARS meeting, with barramundi of Bali origin exported fresh to Australian markets.

China has evolved into a substantial market for seafood from Asia. This has been driven by the burgeoning middle class with purchasing power. With the push factor of time constraint and pull of e-commerce with cashless payment methods, seafood has become an item on the shopping list.

Has the industry regressed? Towards the end of 2017, rejections of shrimp exports, due to contamination with nitrofuran or other veterinary drug residues, to the US and the EU became rather high. The EU Rapid Alert system showed 15 notifications on rejected shrimp consignments in 2017, the peak being mid-year. Judging by these rejections, we can deduce that disease is still a major issue. In shrimp, EHP seems to have overtaken EMS as the main concern. There may not be outright panic nor many reviews or reports on the disease but the major evidence is the skew toward smaller sized shrimp being harvested. With EHP, there is no significant mortality so farmers carry-on as normal as shrimp continue to feed but ADGs (average daily gain) drop resulting in 10g shrimp harvested at higher production costs. This was never seen prior to 2015. With tilapia, chronic mortality sets in due to *Streptococcus* when water temperatures climb above 28°C, prompting the use of antibiotics.

The feed industry in 2017 saw increased competition. China-based feed companies are also expanding overseas into Asia as they see the China market stagnating and shrinking. The increased competition has put pressure on feed prices but the blame has to be placed on the industry as well where the measure is still price and feed conversion ratios (FCR). This means very little if shrimp survival rates are low or the nutrient density does not meet the needs of the genetic potential today. Again, price and FCR is only part of the equation for filleted fish when we should be measuring feed cost per kg of fillet. Freshwater fish feeds may be limited by the selling price of the final product but marine fish feeds have not stepped out of this old school thinking either.

The scorecard for 2017 looks better with genetics and the hatchery. Shrimp genetics companies are starting to look at robustness traits hence balancing the need for survival as well as growth. Marine fish hatcheries are also improving their survival rates via vaccination and heat shock treatment.

Two areas where aquaculture in Asia fails miserably are in environmental sustainability and image building. During TARS, we learnt that it took the industry in Vietnam more than 5 months to respond to a renewed social media attack on pangasius. While environmental protection ranks highly on consumers buying priorities, Asian producers continue to place environment on the bottom of its operational priorities – what a mismatch!

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Stirring Vietnam's seafood industry

New pressures require producers, processors and exporters to review industry trends and rethink market approaches.

Discussing global shrimp markets, from left, Dr Pham Anh Tuan, Carson Roper and Johan Suryadarma

The annual Vietnam Fisheries International Exhibition 2017 or Vietfish International gathered major producers and exporters within the country and region. Vietnam is a major seafood hub and the country's target is to increase seafood exports to USD 7.1 billion in 2017 from the USD 7 billion in 2016. For the first half of 2017, it reached USD 3.7 billion. The trade show, held from August 29-31 at the Saigon Exhibition and Convention Center (SECC), in Ho Chi Minh City, was an opportunity for regional and global seafood buyers to meet clients and seek new suppliers. Vietnam has been developing itself as a seafood reprocessing centre and for producing value added products, hence regional seafood producers are looking to sell raw materials. Vietfish 2017 with the theme, 'Asia's Home of Seafood' brought together over 200 leading seafood processing and exporting companies occupying 350 booths. They came from within Vietnam and 15 other countries, including Malaysia, Thailand, China, Japan, the US, Singapore, Indonesia and the Philippines.

The Vietnam Association of Seafood Exporters and Producers (VASEP) organized several seminars, the focus of which reflected recent limitations in exporting shrimp and pangasius products. Morale among pangasius producers and processors have been low recently, when the date for all pangasius shipments to the US, to undergo food hygiene and safety tests was brought forward to August 2 instead of September 1. The US Department of Commerce (DOC) is planning to impose an almost country wide anti-dumping duty on pangasius imports into the US. The US DOC imposed antidumping duties on pangasius in 2003 and yearly, industry in Vietnam prepares for the annual reviews. The US catfish market accounts for more than 20% of the Vietnamese catfish exports (vietnamnews.vn). China is an interesting market, both for the pangasius and shrimp; but how do producers and exporters tap or even enter this market? A bottleneck in exporting the pangasius is the generally low acceptability level. What are the measures to make pangasius more popular?

On another front, since the end of 2012, the European Union (EU) has been working on illegal, unreported and unregulated (IUU) fishing in Southeast Asia, Vietnam included, with a threat of a yellow card. A yellow card creates nervousness among EU retailers on seafood imported from the country, and retailers may seek alternative sources. Thus, VASEP's seminar on 'How to improve IUU management in the seafood supply chain' focused on experiences by Thailand's Department of Fisheries on how it managed the IUU issue. Thailand was issued a yellow card in 2015 and since then, its Department of Fisheries has been frantically implementing various measures to improve the situation. In October, the European Commission has issued a yellow card warning to Vietnam for not doing enough to tackle IUU fishing (europa.eu).

Global shrimp demand and Vietnam supply capacity

"The global production for shrimp (wild caught and farmed) showed a 104% increase over the 15 years (2000-2015)," said **Carson Roper**, Consultant, France, in his historical perspective on global shrimp consumption. Quoting FAO data, production was 8.31 million tonnes in 2015. Farmed shrimp accounted for 3.88 million tonnes valued at USD 24.9 billion. Price/kg has dipped to USD 5.12/kg from USD 11.84/kg in 1985. In terms of per capita consumption patterns in the traditional markets, Japan, US and EU, Carson said that in Japan, it peaked to 40.2 kg in 2001 and dropped to 27.3 kg in 2014. In the US, shrimp was the leading seafood at 4 lbs/capita/year in 2015 but Roper added that in the US, with dual incomes, consumers are not spending in restaurants, preferring to purchase at discount stores.

Dr Pham Anh Tuan, Vice Chairman, Vietnam Fisheries Association, said that Vietnam's farmed shrimp production was 595,000 tonnes of both black tiger and white shrimp in 2015. In 2020, the projection is 933,000 tonnes. This will comprise of 420,000 tonnes of black tiger shrimp by increasing productivity to 0.7 tonnes/ha from 0.47 tonnes/ha and 513,000 tonnes of white shrimp by increasing productivity to 5.7 from 3.64 tonnes/ha. The challenge to meeting these targets are: climate change, soil erosion, brood stock and post larvae quality as well as rising costs of production.

According to **Johan Suryadarma**, Chairman of the Indonesia Frozen Seafood Association, as a group, producers in ASEAN should work together to identify the global shrimp market and meet the demand and supply gap. "Along the supply chain, we should be working on issues related to compliance, traceability, certification and building trust in Asian shrimp. It should not be 'prevention after detention'. We should also work together to be market oriented and not just focus on production. The former requires us to look further on value added products." He added, "We should be building trust with quality, in products, services and communications." Roper reminded that, "The large ASEAN market with a combined population of 600 million is where the future growth is going to occur."

Pangasius: a choice white fish

The approach for the seminar on 'The world needs pangasius - a responsible choice,' co-organised with Directorate of Fisheries (D-FISH) was to solicit buyers' views on the pangasius and reach out to producers on environmental responsibility and supply chain management. While VASEP needs new solutions to help industry during a downturn, D-Fish sees a further need for a more responsible industry. Globally, annual production of the pangasius has reached 2.1 million tonnes with Vietnam leading at 1.1 million tonnes. Other producers are Bangladesh, India, Indonesia and Thailand. "Laos and Cambodia also farm the fish," said **Vo Van Son**, Scientific & Technological & International Cooperation at D-Fish. "It is a nutritious fish but needs a more sustainable development with environmental integrity. In 2016, our exports shifted to China with difficulties in the EU and US markets."

"If we are doing a good job, there should not be issues in meeting market requirements.."
- Vo Van Son

Vietnam's pangasius is farmed in eight key provinces, with an average production of 312 tonnes/ha/crop. Almost all the production meets national and international standards and regulations. Son asked, "In developing a responsible industry, how else should the pangasius industry integrate with certifications? We have already put in considerable efforts to be in line with requirements." Today, 80% of the culture area is managed by integrated companies, with hatchery, farms, feed mills and processing plants. Only extruded feed is used. Production is monitored by competent authorities with strict requirements all along the supply chain. Farms are certified with VietGAP, GlobalGAP, Aquaculture Stewardship Council (ASC), Best Aquaculture Practices (BAP), etc. "However, we have reports of consignments rejected and returned because of antibiotics residues. If we are doing a good job, there should not be issues in meeting market requirements."

"Our challenges are that we do not have the correct communication to counter the misinformation on the bad image of the fish in the EU. We need to affirm that Vietnam's pangasius cannot be too cheap. But as consumers are more exigent and demanding full hygiene, all players in the industry need to have the same standards," Son emphasized.

In the last two years, the industry is moving at a slower pace and **Nyugen Ngo Vi Tam**, General Director of Vinh Hoan Corp presented on buyers' views on the pangasius. Tam counted 11 names that the pangasius is known as: from striped catfish, basa to swai. "This means that the consumer is not aware of the fish on their plate. It confuses them. Price is also a main problem. With over supply, pangasius was marketed as a cheap fish raising suspicions and allowing it to be mislabeled. This reputation of a cheap fish allowed for prices to be lowered further. Yet, we have gone a long way with certification which comes with market demands."

Vietnam's pangasius is also known as 'swai' in the US.

Tam gave results from a mini survey conducted by Vinh Hoan, on 'what buyers demand'. "It is not a surprise to learn that buyers value equally, price and quality. It will be difficult to raise prices when buyers perceived the pangasius as a low value fish. Buyers are primarily concerned with quality and consistency (in quality control and on time shipment)." Arising from this, Tam suggested some changes for the industry. "On the part of the producers and exporters, we must have sales personnel with integrity and sufficient knowledge as well as language fluency to communicate with buyers. Producers and exporters should show sustainable farming standards with product innovation, and written information presented clearly.

"Lastly, more than 95% of respondents revealed that the industry needs to have a better marketing strategy to improve on the reputation of the fish."

Thong Tien Nguyen, Assistant Professor, University of Southern Denmark discussed strategies to upgrade the global supply chain for the pangasius. "There is a branding problem as there is no brand for the pangasius; packaging and labeling is by the retailer or wholesaler. Too many certifications can amount to 20% of production costs. With branding, producers could have collective brands or geographic brands. They, however, need support from the government and associations. There is a need for more investments in R&D, from science in farming and processing to market research."

"..industry needs to have a better marketing strategy to improve on the reputation of the fish."
- Nyugen Ngo Vi Tam

Value added shrimp products at the booth of leading shrimp producer, processor and exporter, Minh Phu

Potential of China's seafood market

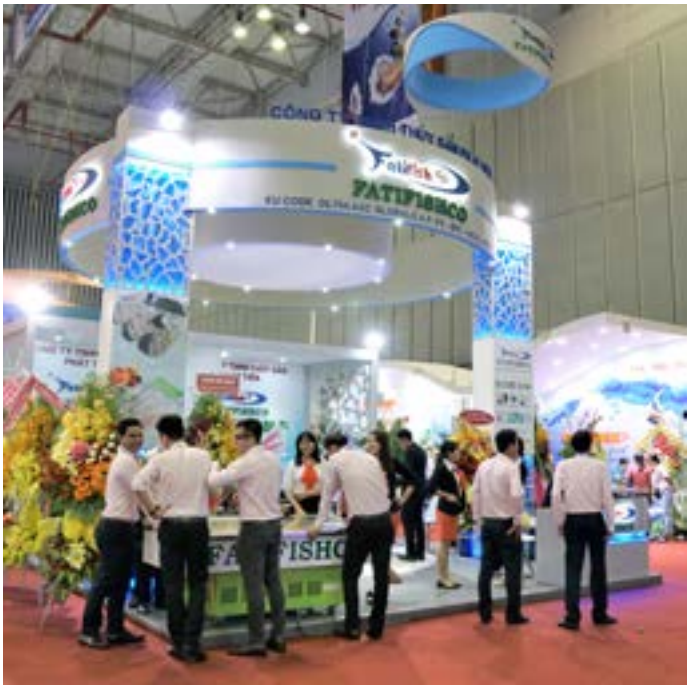
Vietnam's seafood products have been making their way to China. **Ba Le Hang**, Deputy Director, VASEP PRO Centre, showed data where exports of shrimp to China totaled USD 435.6 million in 2016, 39 times more than in 2015. It was already USD 282.8 million for the first half of 2017 (January-June). Shrimp and pangasius exports are progressing, more than 10 and 8 times, respectively since 2007. In total, China imported 1.05 million tonnes of aquatic products in Q1 2017 valued at USD 2.39 billion, according to **Dr Yang Yong**, Chairman of Guangdong Nutriera Biotechnology Group. Therefore, China is a large market to be tapped. Yang added that seafood consumption is rising annually at 4%, much more than meat products. Not only is China a country with 1.4 billion population but yearly wages are increasing and disposable incomes are increasing at more than 8%. "In the case of aquatic products, different income groups have different levels of expenditure; the high income group spends most of its household budget on seafood compared to meat, poultry and other processed products. Hang said that the rising demand is an opportunity for Vietnamese exporters but they face challenges with custom procedures and lack of market information. However, she added that China may tighten regulations on food safety and quarantine in the near future which may limit the growth of Vietnam's exports.

"If the flesh quality (in terms of flavour) and nutrition can be improved, be differentiated from the tilapia and other white fish, then the pangasius can be better accepted, perhaps at a higher price." - Yang Yong

With regards to marketing channels with seafood, Yang said, "Although traditional fish markets and retail are still the leading retail outlets, e-commerce is the new economic model in China. It may not be very big but has the potential for strong growth. The young generation, i.e. those born after 1990, buy from the internet and not from supermarkets or wholesale markets." Big data from JD Mall showed that online sale of seafood has been no 1. "A Nielsen survey reported that e-commerce sales are growing at 53% annually in China," said Carson Roper. (see related article on pages 52-55 on e-commerce in Asia)

However, supply should match demand. In China, there are more concerns on quality, safety and health. Brand reputation is important. According to Yang, Chinese consumers are ever willing to pay more, even as high at 400% more, for processed fish as long as they are convinced on quality and food safety aspects and do not need to spend time on preparation. Fish farmed under stringent conditions can fetch high prices, such as the ecological grass carp, processed and packed in oxygen retailed at USD 5.82/kg.

Yang suggested the following for pangasius to have better access to the Chinese market, "If the flesh quality (in terms of flavour) and nutrition can be improved, be differentiated from the tilapia and other white fish, then the pangasius can be better accepted, perhaps at a higher price. It will be a bonus if plant extracts can be used in the feeds to increase its omega-3 content. Special additives can improve flesh taste."



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What can functional feeds bring to tropical aqua farming?

By Eric Leclercq, Sylvie Roquefeuil and Stéphane Ralite

Often the benefits of functional feeds become most visible when local farm conditions deteriorate and when they help to buffer against performance degradation and reduction of severe losses.

With more than half of all seafood of farmed origin, the blue revolution is already a success. Yet, global aquaculture must continue to expand and intensify if it is to continue bridging the gap between an ever increasing seafood demand and a stagnating capture fishery. The growth of modern aquaculture has also relied, sometimes excessively, on chemical interventions against pathogen propagation inherent to high-density culture. In recent years, maturing legal frameworks and market expectations, both locally and cross-borders, are increasingly demanding for healthy, safe and quality seafood farmed with a minimal impact on the environment. Adding to this challenge, aquaculture is faced with the necessity to increasingly incorporate terrestrial raw ingredients in place of traditional fish-based material. Delivering more, healthier, better performing and sustainably farmed fish and shrimp is with no doubt a difficult mission; however, this is the 21st century blue revolution vision.

Success is evidently dependent on best practices and integrated health management which, in essence, are preventive strategies aimed at expressing the livestock's full potential to achieve consistency of outputs over successive cycles. Attention is therefore shifting from intervention to prevention, taking a proactive approach to risk mitigation and acknowledging health and performance as sensitive, multi-factorial traits. With dedicated commitment, this positive approach clearly pays; it contributes to a lower risk of disease outbreak and treatment side-effects and the healthier, stronger stock leads to an upward positive spiral with broad benefits at the farm-gate and beyond.

Amongst a range of considerations such as genetics, water quality and stocking strategy, feeding strategy is paramount. The use of natural functional feeds is rapidly emerging as a central tool to good health maintenance and preventive risk mitigation.

Functional feeds are defined as "*feeds with dietary ingredients that provide health and economic benefits beyond basic nutrition.*" These benefits can range from improved digestibility and growth performance, as well as better maintenance of fish health under adverse conditions via improvement of immunity, physiology or gut health. The knock-on benefits are multiple. Along with more robust animals, comes an easier and more accurate feed, stock, health and water quality management, which in turn enhance the production capacity, predictability, product quality and business reputation.

Figure 1. Juvenile *Penaeus vannamei* from Vietnam. Left with EMS; right appears normal Picture courtesy of Dr Loc H. Tran, ShrimpVet Laboratory, Vietnam.

Targeted health risk management

In recent years, new pathologies have appeared in shrimp farming that cause significant economic losses. For example, early mortality syndrome (EMS) or acute hepatopancreatic necrosis disease (AHPND), are commonly attributed to the production of toxins by *Vibrio parahaemolyticus* bacteria in the shrimp's digestive tract (Figure 1). In the same way, white faeces disease (WFD) affects the gut of shrimp and thus, its performance and survival. The cause is still unknown but there is a strong suspicion that it is due to the toxins produced by some pathogenic bacteria. *Enterocytozoon hepatopenaei* (EHP), also a fairly recent disease, infects young shrimp in particular. It is due to a microsporidian parasite invading and severely damaging the digestive tissues. EHP has not been directly associated with mortality outbreaks but it weakens animals which become more prone to other pathogens such as *V. parahaemolyticus*.

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Functional feeds applied preventively ahead of an identified risk period can help to mitigate the risks of certain pathogens by directly up-lifting the fish and shrimp innate immune competence. For example, aquafeeds incorporating the formulated yeast derivatives show positive results in several shrimp trials under pathogen challenges. The contrasted yeast cell structures of interact with an enlarged set of immune receptors and are therefore more effective than single-strain yeast products. The result is a deeper, synergic modulation of immunity at low inclusion level without the risks associated with targeting single immune receptors.

In a trial conducted in 2017 in Vietnam, juvenile white shrimp *Penaeus vannamei* were challenged with EHP. The shrimp were fed preventive supplementation with YANG at doses below 1 kg/tonne of feed for 2 to 4 weeks prior to the challenge, and this contributed to a reduction in the EHP load in the hepatopancreas and related loss of body growth. EHP load was reduced by a significant 64% at the peak of infection (5 days post-challenge) when compared to the non-supplemented infected group. As a result, the shrimp body weight was better maintained, being significantly higher by 8% in the group fed the formulated yeast derivatives. Importantly, the proportion of shrimp with a severely compromised body weight was much reduced (Figure 2). The benefits are multi-fold and include lower health risk in weakened animals, easier feed and water quality management and a higher potential yield.

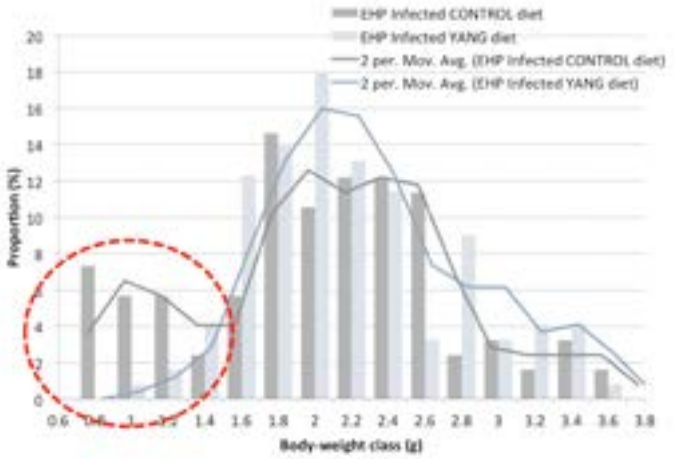


Figure 2. Effect of specific yeast derivatives YANG on the size distribution in juvenile shrimp following an EHP challenge.

In a distinct test challenge, supplementation with the formulated yeast derivatives for 3 weeks prior to a controlled *V. parahaemolyticus* challenge was associated with a 4.6 fold improvement in survival (12.0 % survival in the control, *vs* 56.3 % survival – $p<0.05$).

These specific examples show how functional feeds targeting enhanced immune competence can be applied preventively to mitigate direct losses from severe outbreaks and, importantly, the negative carry over effects on the surviving stock.

Supporting mucosal defences

The mucosal barriers of the skin, gills and gastrointestinal tract are the first line of defence against pathogens as well as non-infectious harmful agents such as toxins, physical insults, chemical baths or irritating dietary components. Their integrity is also critical in maintaining essential physiological functions such as respiration, osmoregulation and nutrient absorption.

Holding to their immune potential, yeast derivatives may have benefits on skin and intestinal mucosal surfaces. For example, in rainbow trout (*Oncorhynchus mykiss*), skin mucus level was 65 % higher in the treatment group with formulated yeast derivatives YANG compared to the control group after 4 weeks of feeding, indicating a quicker skin mucous recovery following the transfer into the rearing system. After 8 weeks of supplementation, skin mucus level stabilized to a 27% higher level in the treated group compared to the control group. These results were further validated with the up-regulation of a molecular skin biomarker, which indicates that yeast derivatives increases the immune function and regenerative capacity of the skin mucosal layer (wound healing). Similar beneficial effects were observed on the skin and intestinal mucosa of seabass supplemented at low incorporation level. In particular, the formulated yeast derivatives were shown to reduce the inflammatory reaction elicited from a high-plant dietary regime and to safeguard a high level of intestinal surface absorption area (Figure 3).

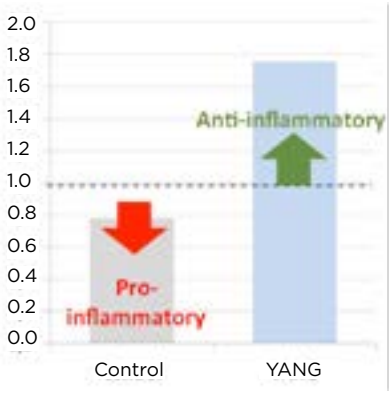


Figure 3. Effect of YANG on IL-10/IL-1β gene expression in seabass following high salinity challenge, indicating mitigation of the inflammatory response (Plymouth University, UK, 2014).

The mucosal surfaces of aquatic species could be positively modulated by continuous dietary supplementation with a novel-generation, multi-strain yeast derivatives. This can prove particularly beneficial against a range of physical, pathogenic, dietary or chemical treatments at the farm level, with accumulating benefits over the rearing cycle.

Protecting performance via microflora stabilizer

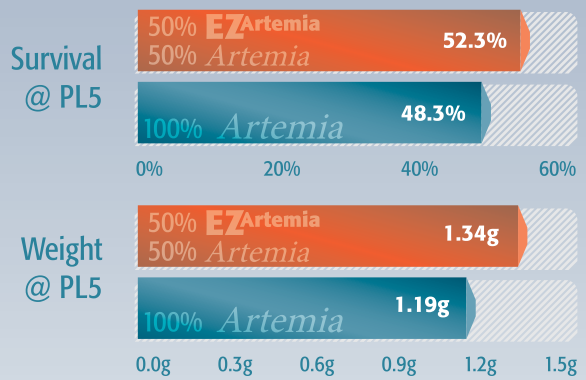
When considering robustness and performance as multi-factorial traits, the central importance of gut health and of the gut microflora should immediately come to mind. The intestinal flora is essential to digestive functions as well as to the proper functioning of the animal immune system with which it constantly interacts. The gut flora can be easily destabilized by factors such as physical (handling), environmental or dietary stress, drug and antibiotic administration or pathogen invasion. A destabilized microflora impairs normal digestive and gut immune functions. It makes the gastro-intestinal tract (GIT) prone to invasion by opportunistic pathogens and increases the direct exposure of the epithelium to the outside world, thus risking its integrity.

The lactic acid bacteria strain *Pediococcus acidilactici* MA18/5M (BACTOCELL, Lallemand Animal Nutrition) is a unique gut microflora stabilizer registered as a feed additive for use in fish and shrimp feed within the European Union. It is effective under a variety of temperatures and salinity conditions, survives in the digestive tract and, importantly, is non-sporulated for a rapid activation and association with the gut mucosa.

As the gut microflora is easily disrupted under stressful conditions, its stabilization ahead of challenging events such as the transfer to grow-out facilities or rapid environmental changes, is particularly beneficial to safeguard the stock's performance, from energy intake to survival, under fluctuating local conditions (Figure 4).

A trial conducted in a research station (Laboratory of Aquatic Animal Nutrition, LABOMAR, Eusébio, Ceará, Brazil) evaluated

from PL's fed 50% EZ Artemia - 50% Artemia vs. 100% Artemia



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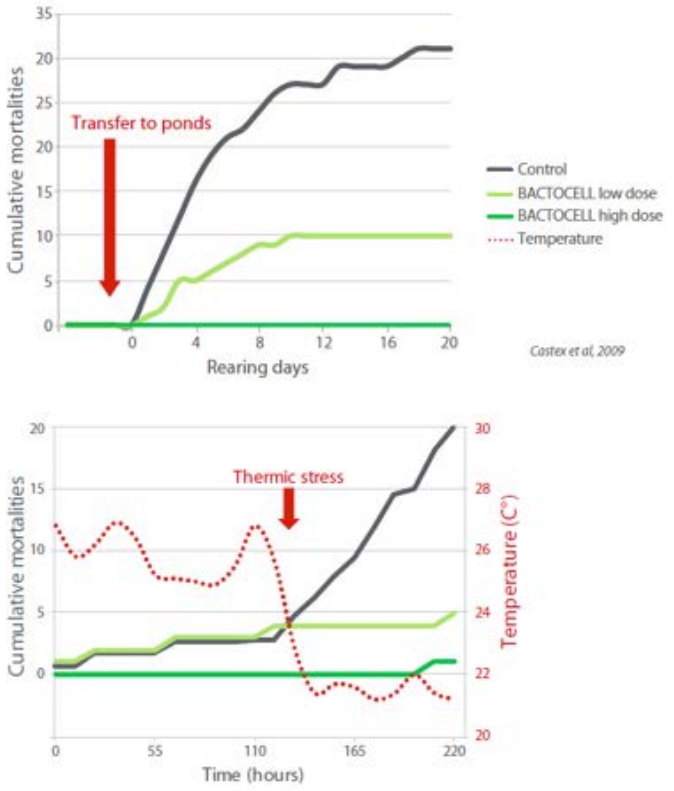


Figure 4. Effect of probiotic *P. acidilactici* MA18/5M supplementation on shrimp survival following environmental stress: transfer to ponds and thermic stress.

P. acidilactici MA18/5M supplementation in shrimp juveniles (*P. vannamei*) within a standard diet, under high stocking density, and high salinity conditions, mimicking demanding commercial practices. The trial showed a significant improvement of shrimp body weight at the end of the 80-day grow-out period, resulting in higher yield (Figure 5). This benefit is linked to the improved feed conversion ratio by 5.4 %; it indicates a better biomass gain per unit of feed offered under the demanding conditions tested, with resulting potential higher revenue for the farmer.

Quality probiotics directly reinforce the gut microbial barrier and in turn its mucosal shield against external challenges. Probiotics naturally sustain health, growth and feed performance particularly under stressful conditions, dietary challenges and potential enteric pathogens which can be prevalent under high density culture conditions.

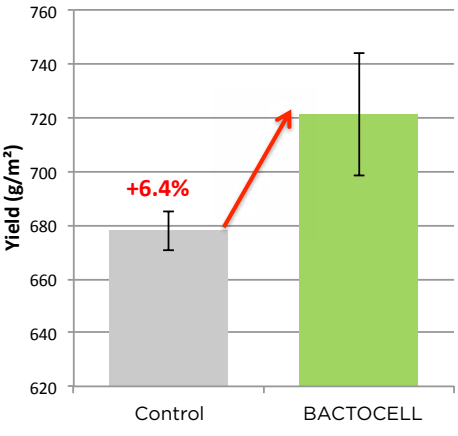


Figure 5. Effect of probiotic *P. acidilactici* MA18/5M supplementation on shrimp yield under challenging conditions: high stocking density, high-salinity (LABOMAR, Brazil)

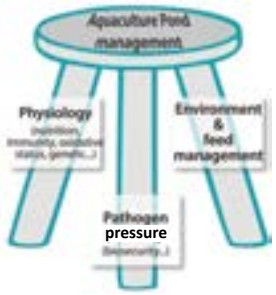
Conclusion

Functional feeds are preventive tools to help maintain performance under both infectious and non-infectious challenges. They can be applied over targeted risk periods or more continuously for general risk mitigation to support optimal, more consistent performance under varying local conditions and a lower risk of serious losses.

The targetted approach requires dedicated solutions against high risk conditions that are often species, life-cycle specific (e.g. shrimp hatchery or nursery feed) or season specific (e.g. summer or monsoon season). The ingredients selection and application dose require strong documentation through trials to ensure on-farm efficacy, as well as the capacity to effectively target the window of intervention. A second possible approach is to formulate functional feed with basal level of proven multi-functional ingredients (the article shows for example that specific yeast derivatives can support against infectious and non-infectious threats) to support overall immune-competence and performance. This can often prove a winning strategy as the fish and shrimp stocks are commonly exposed to a recurring diversity of challenges.

It is paramount to keep in mind that different functional ingredients hold different modes of action. Their combination can provide additive and synergic effects by acting at different levels towards a common goal. For example, consolidating the resident gut microflora using a probiotic while directly supporting immune-competence via yeast-based products can often prove a worthy strategy to safeguard health and performance where challenges are diverse and expectations high.

Finally, one should keep in mind that functionality is directly dependent on the characteristic of the product used and on the process applied during its production and inclusion into the feed (e.g. probiotics are live microorganisms and their inclusion in aquafeed must ensure their livability during farm use, while inactive yeast ingredients such as YANG do not require specific attention when incorporated in feeds).



Functional feeds are becoming an essential component of modern aquafeed to support a responsible and performing aquaculture industry. Their benefits often become most visible when local farm conditions deteriorate, when they help to buffer against performance degradation and reduction of severe losses. However, they are not a silver bullet. Best practices and integrated management strategies are necessarily multi-factorial and must integrate a variety of considerations at the animal, environment and pathogen levels, which are all part of the 'three-legged stool' of aquaculture pond management.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Pioneer shrimp farmers in Iran

By Benedict Standen

It is a very strange experience arriving at a shrimp farm in the middle of the desert. Yet shrimp production in Iran, has been growing year-on-year.

After the 1970s, the global aquaculture industry was transformed by more intensive commercial production which brought a number of opportunities to communities all over the world, in terms of employment, wealth creation, trade as well as providing a supply of local and sustainable animal protein. Currently, the majority of aquaculture activities are located in Asia, and to a lesser extent Latin America and Europe. Whilst still in its infancy, aquaculture in the Middle East is growing. Countries such as the Islamic Republic of Iran are recognizing the potential of aquaculture and currently culture rainbow trout and a diverse range of carp species (mainly common carp and silver carp). Whilst the production volumes are lower than fish, a lot of progress has been made in shrimp production, with the country focusing on Pacific white shrimp, *Litopenaeus vannamei*. Iranian shrimp farming is much younger than its Asian counterparts; the first farm was opened in 1994 in the south-west, in Bushehr. Today, shrimp farming is a common activity along the southern coastline, stretching from the Oman Sea and up into the Persian Gulf. According to FAO data, the production of *L. vannamei*, in Iran was 22,500 tonnes in 2014 (Figure 1).

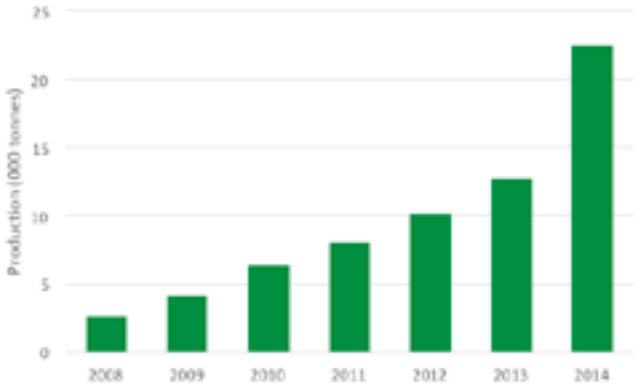

Figure 1. Production of *L. vannamei* between 2008 and 2014. Source: FAO Fishstat

Unique challenges

Securing financial investment for aquaculture facilities is always a challenge, and Iran is no exception. On numerous occasions, industry in Iran said that obtaining capital through bank loans is extremely difficult, since shrimp production is considered 'high risk'. Even with loans in place, there are more hurdles to overcome. Shrimp production in Iran is typically semi-intensive, with stocking densities of between 20-35 post larvae (PL)/m^2 although it can be higher depending on whether aeration is provided for. Farms can harvest twice per year using a 120-160 day production cycle and the yield can fluctuate between 3-8 tonnes/ha. The physico-chemical parameters of water (temperature, salinity, dissolved oxygen) can also present challenges; furthermore, the availability of water can be scarce, so changing water is not always possible, meaning that salinity can reach 50-60 ppt during the hot season.

Poor post larvae quality results in non-uniform growth creating problems at harvest

Many problems during production can be traced back to poor quality post larvae; this can result in reduced survival and poor uniformity in size. Iran has 12 hatcheries for post larvae production, but the adoption of specific pathogen free (SPF) technology has not been realized, and only a few farms use SPF post larvae, imported from Hawaii.

Optimum growth is strongly dependent on appropriate nutrition. Producers identified the need for high quality, locally produced diets; most feeds are currently imported from Southeast Asia. Whilst some producers rely on local feeds, or produce their own, it is important that the diets meet the nutritional needs of the animals and that local raw materials should not be contaminated (e.g. with mycotoxins), otherwise growth performance will be compromised. This must be a priority if the shrimp industry is to grow.

Thus, it can certainly be argued that Iranian shrimp farmers face some unique challenges. However, during the recent visits, two issues were repeatedly raised: first, maintaining good water quality and second, disease control.

Actually, these issues are interlinked. For example, *Vibrio* spp. are part of the 'normal' microbiota associated with seawater. Despite this, under normal culture conditions healthy shrimp will grow well. However, if shrimp are stressed due to poor water quality, they may become immunocompromised which presents an opportunity for these opportunistic pathogens. Therefore, by maintaining optimum water quality, one can reduce the likelihood or severity of disease.

The main disease threat in Iran comes from white spot syndrome virus (WSSV), which is a major concern for Iranian producers. There are no reports of acute hepatopancreatic necrosis disease (AHPND) or *Enterocytozoan hepatopenaei* (EHP). Biosecurity remains a priority for the authorities and it is imperative that producers follow the regulations imposed by the governing authority, Iranian Veterinary Organization (IVO). The one thing that both these disease threats have in common (whether bacterial or viral), is that they can be mitigated, or controlled, through enhanced biosecurity and management; prevention is really better than cure.

Producers discuss with the BIOMIN team on the challenges of shrimp farming in the desert

Pond management

In Iran, the objective is in the sharing of expertise in the use of probiotics, and how they can be used as a valuable management tool. In collaboration with the distribution network of Etouk Farda, BIOMIN works with shrimp farmers across Iran to improve aquaculture pond management with innovative probiotic solutions such as the AquaStar® range. The formulation contains multiple beneficial bacterial species which have complimentary and synergistic benefits. For shrimp producers, it offers greater nutrient release, improved water quality and better survival rates.

Greater nutrient release

The majority of commercial probiotic products are based on *Bacillus* spp., primarily because of its ability to produce large quantities of enzymes. BIOMIN's AquaStar® products contain *Bacillus* sp. and enzymatic digestion of organic matter is further intensified by an enzyme cocktail. This facilitates the release of highly digestible nutrients, which can be utilized by the shrimp. In addition, the enzymes break down organic matter, preventing the accumulation, and directly reducing 'black sludge' in the pond sediment.

This benefit was demonstrated through numerous field trials. Shrimp were stocked at 50 PL/m^2. After 57 days of culture, ponds supplemented with the probiotic showed higher productivity, improved growth performance and higher profitability (Table 1). Furthermore, visual differences could be seen in the quality of the pond sediment (Figure 2).

Water quality

To improve water quality, the probiotic products contain unique bioremediation strains which promote the conversion of toxic

The accumulation of organic matter has a negative effect on pond soils in Iran

Table 1. Improved revenues after using the probiotic in a commercial field trial

Treatment	Production (kg)	Commercial shrimp price (USD*/kg)	Sales revenue (USD*)
Control	2,306	2.92	6,736
AquaStar®	2,687	3.54	9,503
* Based on exchange rate at time of print			

Δ+41%

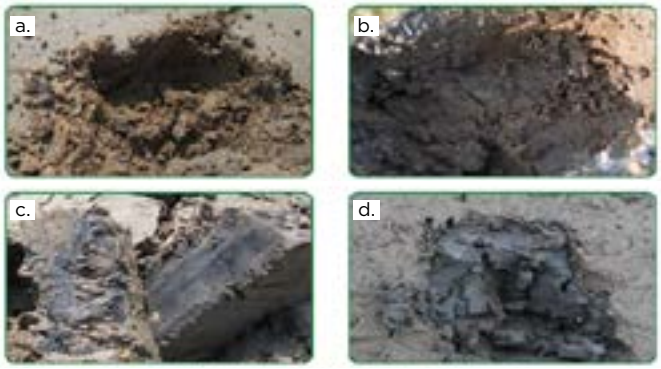

Figure 2. Samples of pond sediment with (a and b) and without probiotics (c and d). Layers of black anoxic sediments can be seen in the pond bottom when the probiotic was not used.

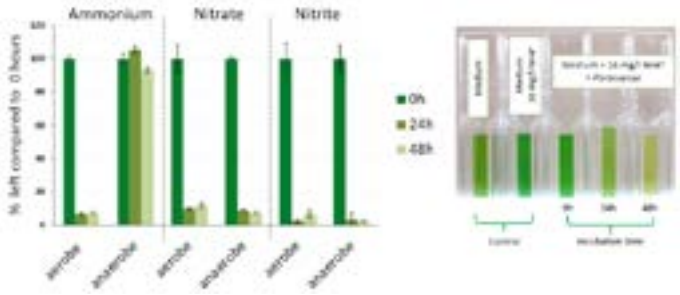

Figure 3. The effect of *Paracoccus* sp. on the removal of nitrogen waste under aerobic (with oxygen) and anaerobic (without oxygen) conditions after 24 and 48 hours. Inlay: Dark green indicates high ammonia at 0 hours. After 48 hours the lighter green indicates this ammonia has been removed by the probiotic.

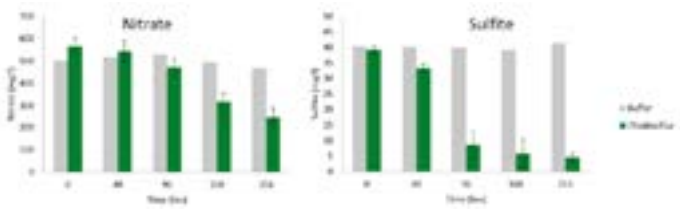

Figure 4. *Thiobacillus* sp. can remove nitrate and hydrogen sulphide

ammonia to nitrate, via nitrite (nitrification; Figure 3). While nitrate is not as toxic as ammonia or nitrite, its accumulation can be harmful to shrimp. Nitrate also acts as a fertilizer leading to dangerous phytoplankton blooms, and therefore its removal is also important. AquaStar® is the only commercial probiotic to use *Thiobacillus sp.*, to convert nitrate to harmless nitrogen gas (denitrification). While most bacteria need a carbon source to grow, *Thiobacillus* can take its energy from an inorganic source.

Thus, this species has a dual function: the removal of nitrate and hydrogen sulfide (Figure 4).

Improved survival

While other probiotic species are capable of reducing pathogens, lactic acid bacteria (LAB) are by far the best candidates for this role. LAB directly reduce a wide range of pathogens by producing numerous potent antibacterial substances, termed bacteriocins. Furthermore, when LAB are ingested, they can colonize the intestinal epithelia where they drive immunity and enable the shrimp to fight pathogens using their own immune response. This was demonstrated in a recent field trial. When shrimp were challenged by *Vibrio parahaemolyticus*, survival was significantly higher in those ponds that had received the probiotics (Figure 5).

In Iran, BIOMIN continues to show how probiotics can benefit shrimp production. The multi-species formula of AquaStar® is designed to bring multiple benefits to the producer: better water quality, reduced organic matter, reduced sludge, enhanced pathogen control and increased pond productivity.

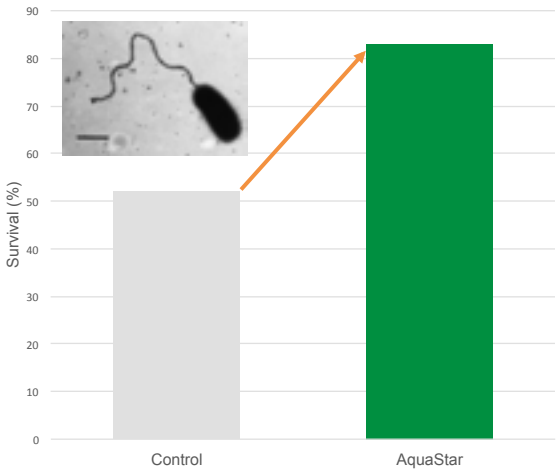

Figure 5. Survival of shrimp in control treatments and probiotic treatments when challenged with *Vibrio parahaemolyticus* under field trial conditions. Inlay shows a single *V. parahaemolyticus* cell.

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Innovative and intensive shrimp farming system in Vietnam

By Zuridah Merican

A solution to help shrimp farmers reduce farming risks and environmental impact with maximum potential output.

Vietnam's shrimp farming is doing well relative to its neighbours, Thailand and Malaysia. Shrimp production crept up in 2016 to 595,000 tonnes (VASEP, 2017) as compared to 541,740 tonnes in 2015 (FAO). For the first nine months of 2017, the estimate is 468,000 tonnes (Fisheries Information Centre). Nevertheless, the industry is beset with occasional disease outbreaks. One of the weak links is the quality of water, such as those in bays where many farms draw in water for shrimp farming and also discharge their effluents. Another problem is climate change which is a current and future hazard for the industry. Thus, how should the industry overcome all these challenges? For sustainability, it needs a more controlled shrimp farming system. Aqua feed producer Neovia Vietnam, has developed a controlled super intensive system called BIOSIPEC (or Bio-Security Intensive Production Environmental Control). A 2-ha pilot scale located within its R&D centre, outside Ho Chi Minh was officially launched at an elaborate ceremony in September (see page 61).

A year ago, Thomas Raynaud, Marketing and Technical Director at Neovia Vietnam started the construction of this pilot project which comprised two indoor nurseries and an outdoor pond. This innovation consists of a 2-phase nursery system; phase 1 to grow post larvae (PL10) to 250 mg juveniles over 28 days and phase 2, further on-growing to 5 g juveniles within 42 days. Shrimp leave the controlled environment when they are stocked into open ponds to continue the crop over 42 days for marketable 14 g shrimp.

"The success during these initial trials over 6 months and the production output have exceeded expectations. What we have is a workable system that helps to reduce disease and environmental impact while maximizing farmer's profits."

"..my main attention was to solve the water quality issue and to bring some innovations for the industry for consistent and sustainable production." – Thomas Raynaud

View of the greenhouses and reservoir.

Phase 1 of nursery rearing is in this raceway holding 6,000 to 12,000 PL/m².

Over the past 2 years, Thomas has been studying the industry in Vietnam, the characteristics of the industry, factors influencing production (water quality and weather etc) and diseases faced by farms. He has been researching the practices in Mexico and other parts of Latin America with the intention of developing workable practices to bring over to Asia. "In Vietnam, farmers are hardworking and capable of farming shrimp with good yields but the reality facing them is poor water quality. In developing Biosipec, my main attention is to solve the water quality issue and to bring some innovations for the industry for consistent and sustainable production. Farming will be done through a controlled environment for as long as possible," said Thomas.

The prerequisite for such a system is suitably treated water. "What we need is a change: a low cost water treatment system which any Vietnamese farm will find easy to adopt and operate. We should also look into an efficient and yet low cost aeration system which any farmer can adopt," added Thomas. "We have taken a pragmatic approach whereby the greenhouse construction is not too costly. The location of the pilot project is ideal for us to test out our water treatment protocols. We draw water from Nha Be, just like many other shrimp farms and where the water quality is very challenging."

Applying innovative technologies

These are in three areas: development of a mobile water treatment system, energy efficient aeration system to move water around and aerate water, and sound feeding system to reduce feed conversion rate.

Water treatment and aeration

Water drawn from the river is channeled into a 2,000 m² reservoir pond. Prior to use, water is filtered and passes through an ozone tower. The main advantage of this innovation, developed by Acui-T (a Neovia company), is a mobile unit which generates ozone. It can be moved around to attach to pumps and treat the water. According to Thomas, the generation of ozone is a cost saving factor for the farmer. "We control the ozone with oxidation reduction potential (ORP) monitoring. Some 100% of water is in contact with ozone. Ozone is a very powerful oxidant (as chlorine) without the residues risk. Indeed, 5-6 hours after disinfection, it breaks downs into oxygen molecules."

At Biosipec, the team has opted not to use paddlewheels for aeration. Common in many systems in Vietnam, paddlewheels will only provide surface aeration. Acui-T specially designed energy efficient large tubular airlifts placed at specific locations in the raceways. "The energy cost is very low as it is much cheaper to pump air than water," said Thomas. "However, for the moment, paddlewheels are still used in the pond culture phase. This will be gradually phased out and replaced with airlifts."

Feed and management

There is the automated sound feeding system developed by the Australian company AQ1. It uses a hydrophone to detect the level of feeding and regulate the autofeeders. It also submits real time information on feeding and other water parameters to a control centre. "We control feeding and feed conversion ratio. The main problem we face is to adapt the automatic sound feeding system in nursery phases. This is because the level of background noise from the airlifts may confuse the system," explained Thomas

"We are bringing these innovations for the industry in Vietnam. Ideally, all are suitable for larger farms. They are designed such that a large or small farm may wish to implement all in total or take up only one or two components. Each component can work equally well independently."

Nursery phases in greenhouses

Phase 1 of nursery rearing is in a raceway which can hold 6,000 to to 12,000 post larvae (PL)/m². The total number ranges from 180,000 to 360,000 post larvae. Biofloc technology is used to avoid exchange of water and control water quality. Biofloc is produced in an adjacent tank stocked with tilapia. The raceway is inoculated with biofloc every 2 to 3 days. Feeds used are nursery feeds from Bernaqua. Average survival during this 28-day stage is around 90%. Thomas said, "There is no exchange of water so you need to control the biofloc production, probiotics usage and water movements to keep the floc in suspension all the time."

Thomas in front of the ozone tower. On the left is the mobile unit which generates ozone

BIOSIPEC

Innovative & Intensive Shrimp Farming

INNOVATIVE TECHNOLOGIES

Biosecurity: mobile water treatment

Energy cost and intensification: special aeration system

Feeding management: sound feeding system

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a brand of neovia

Phase 2 of the nursery is grow-out of 250 mg to 5-6 g shrimp in this raceway. Note the specially designed energy efficient large tubular airlifts

The 1,200 m² lined outdoor grow-out pond

Shrimp of 250 mg are transferred via gravity through pipes to raceways in the next greenhouse. Here semi-biofloc technology is used. The stocking density range from 350-600 PL/m² and the average survival throughout the culture duration of 42 days is more than 80%. During this stage, shrimp are fed Ocialis shrimp feed, specially formulated for intensive culture systems. This feed has a high digestibility which reduces ammonia production. Shrimp of 5-6 g each are then transferred to the 1,200 m² lined outdoor grow-out pond. Shrimp is harvested all at once on reaching 14 g but in the future, partial harvesting is a possibility. There is no water exchange at the moment over the 42 days. Now the pond is using a traditional system with paddlewheels for aeration. The next step is to replace paddlewheels with airlifts and implement semi-biofloc conditions in this final grow-out phase.

A competitive system

Figure 1 shows some production details.

	Curent results for Biosipec system	Traditional system
Days of culture	112	90-120
Harvest size	14 g	10-15 g
No of cycles/year	5	Max 2.5
Stocking density PL/m²		
Nursery phase 1	6,000 to 12,000	
Nursery phase 2	350 - 600	
Grow-out pond	200	60 - 100
Survival rate	80%	30-50%
Yield/cycle (tonnes/ha)	30	5-10
Yield/year (tonnes/ha)	150	12-25
FCR	1.2-1.3	1.2-1.3
Risks	Reduce disease outbreaks	Low control of disease outbreaks

In comparing this system with traditional practices, Thomas said, "The advantage is the higher production due to the faster turnover of facilities and cumulative production cycles. Allowing for clean-up of raceway, a second crop for phase 1 nursery stage can be scheduled at week 10 while the first crop nursery phase 2 is still ongoing. With five cycles per year, production yield is 30 tonnes/ha/cycle giving a total annual yield of 150 tonnes/ha. To date, our production has been free of disease."

In terms of cost of production, it is today USD 3.4/kg for this pilot system compared to USD 3.1/kg in traditional farms. But with ongoing improvement of the innovations such as aeration system in pond and sound feeding system adaption to nursery, the plan is drop cost of production to the same level as traditional farms in the next cycle. The major costs are still feeds at 53% and energy at 17%.

"We have just recently sold the shrimp at VND 103,000/kg (USD 5.15/kg), much higher than expected mainly because shrimp were free of antibiotics. However, the work is still far from complete as our aim is to further reduce feed and energy costs," said Thomas.

Key management points for Biosipec

- Biofloc technique in nursery Phase 1
- Semi-biofloc technique in nursery Phase 2
- Water treatment by ozone
- Aeration system

Key performance indicators for Biosipec system

- Nursery 1: 28 days
- Nursery 2: 42 days
- Grow-out: 42 days
- Survival rate 80% from nursery 1 phase to marketable shrimp of 14 g
- Number of cycles/year: 5
- FCR: 1.2

Sample of 14 g shrimp ready for harvest

From Bali to global markets

By Zuridah Merican

PT Phillips aims not only for a steady supply of barramundi but sustainable farming with community participation.

An aerial shot of the cages (Photo courtesy of PT Phillips)

The 103 year-old US-based Phillips Foods is proud of its commitment to quality and consistency in its seafood business. Farming sustainably in Bali to produce a traceable and steady supply of barramundi or Asian seabass *Lates calcarifer* is an undertaking for the company which provides a supply of fish of the same size and in the required volumes, something small scale farmers are unable to do. Through PT Phillips Seafoods Indonesia, which has been operating for over 25 years, it started a pilot project to farm barramundi in 2008 and by 2010 a commercial operation was set up. The initial capacity was 100 tonnes/year. Today the infrastructure and 18 cages have a capacity to produce 1,000 tonnes/year. Locating the farm in Bali also fulfils one of its CSR objectives, that is to have the local community involved in the farming business.

The barramundi farm is a wholly integrated operation located in Banjar Dinas Sumber Pao, Desa Sumberkima, Kecamatan Gerokgak, Kabupaten Buleleng. It has brood stock fish in cages in the pristine waters off North West Bali, a land-based hatchery and an ocean-based nursery and grow-out facilities to produce fish of a minimum marketable size of 3 kg in 18-20 months.

"Bali is ideal for us. Our weekly harvest is transported on ice over 4-5 hours to the processing plant near Ngurah Rai airport. From there it is cut to order and air flown to Australia and the US. Within 48 hours our fish are already in our customers' hands, faster than what most of the producers within Australia can achieve. This is a major advantage of Bali. Our speed to the plate and a post-harvest point of difference has us on top in terms of quality," said Troy Keast, Director of Aquaculture and Sustainability.

Understanding biosecurity

Troy is very familiar with Indonesia and her people, where he has lived for the last 20 years, 10 of which in Bali. He swims daily the 1 km distance from the shore to oversee the floating cages. Troy's attention is on biosecurity which has equipped Phillips better to meet environmental challenges. "Biosecurity is so much more than redundant vehicle baths at facility entrances. Clean seed and feed are the areas you need to cover first. It has taken a while to reach this stage. When our workers, mostly semi-skilled, demanded separate tanks to clean utensils, I knew that they had managed to grasp the biosecurity concept," said Troy.

"Our systems are rather basic," explained Troy. "Water for the hatchery/nursery is gravity fed into our inlet canal before it is pumped into our reservoirs. Water is chlorinated before being passed through sand and charcoal filters on the way to our culture tanks. Water salinity is 30 ppt and there is an abundant supply of fresh water. With this system in place together with the focus on biosecurity, we have high survival rates in the hatchery. On average, survivals from larva to 75 g, when we transfer into the nursery, is 90 %."

Disease mitigation and prevention

In the land-based hatchery Troy has a stringent health management program which all fish pass through to mitigate diseases. The first step is vaccination of healthy fish with a *Streptococcus* vaccine Strep-Si. Two weeks later, fish are again vaccinated again with Irido-V; both the vaccines are supplied by MSD. "We have our own team of women and men to carry out vaccination. A team can vaccinate 10,000 fish/day," said Troy. If there is no demand to stock, fish are held in the hatchery until they reach ~ 75 g.

"Our health management at the nursery level is weekly baths which are carried out as part of our parasite prevention program. When conditions are deemed to be challenging such as to overcome stress prior to transfer to the cages, fish are fed functional feeds (Protec, Skretting). We are constantly trialling feeds in an effort to help our fish overcome stress. Mid-year temperatures usually will go down to 27°C. Any opportunistic diseases can take hold of fish stressed by lower temperatures. Only stocking healthy fish gives us a head start, "said Troy.

PT Phillips uses Indonesian made round cages (Aquatec) which were installed on site. It also has some polar cages bought second hand from Chile. Netting materials are the semi-rigid Aquagrid containment system which are being phased out and replaced with Kikko monofilament nets. Both of these nets have been effective in preventing escapes and predation. The company has two sites with a total of 18 cages. Both sites are approximately

Troy Keast at the cages. The attention on biosecurity has equipped PT Phillips to be better at meeting environmental challenges.

PT Phillips funded a mobile eye clinic to perform on site cataract operations, eye checks and free glasses for the local villagers (Photo courtesy of PT Phillips)

Yellow painted tanks hold 30-day larvae

1 km from shore. Troy said, "Today, we are self-sufficient with fry. Our target production is 500,000 fingerlings annually, which we stock into grow-out cages at 15 kg/m^3. During the early days, we bought fry from Singapore and Australia."

A lean Indonesian operation

In general, Troy is happy with the low-tech operations at the farm which are meeting its targets. "We are low-tech at all levels, even for harvesting. We are heavy on CSR and are one of the biggest employers here in North West Bali. We utilize the local community as much as possible and now have a dedicated team of 50 people. Our CSR projects focus on the local community. We supply seaweed seed for them to grow out and also have projects to fund schooling for some of the local orphans. We also funded a mobile eye clinic to perform on-site cataract operations, eye checks and free glasses for the local villagers.

"Our most high-tech activity is net cleaning where operations are semi-automatic, if you were to compare with net cleaning in salmon farms. Nets are cleaned on average every 5 weeks. Of course, there is a potential to introduce automation and high technology practices at the farm, but my question is, how does the Indonesian community benefit from this? It is essential that we involve the local community in our operations. Admittedly, labour costs are rising in Indonesia but we will continue to focus on our low- tech cooperative approach with the local community," added Troy.

Grow-out cages produce fish of a minimum marketable size of 3 kg

Sustainability agenda

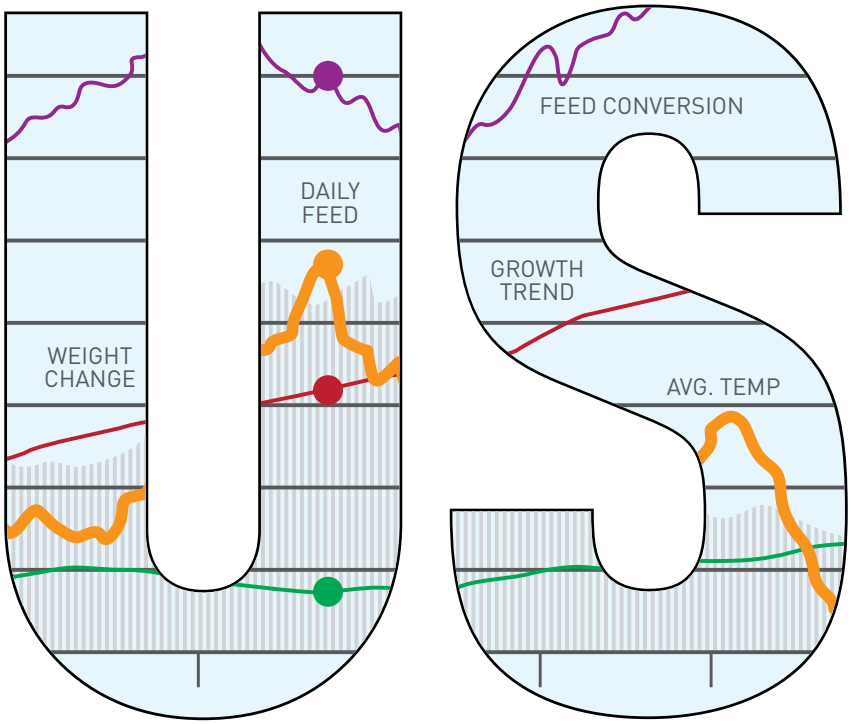
As a large multinational with global operations, sourcing sustainable seafood is important for the company. It not only sources seafood from suppliers, with the same mindset as the company, but also trains suppliers in meeting these norms. The company has a team to work on this sustainability agenda.

"Having our feed meet the constantly evolving sustainability requirements requires a combined commitment between us and our vendors. We are working very closely with Skretting who supplies us with nursery and grow-out feeds. Unfortunately, a lack of transparency and traceability with some hatchery feeds may see us walking away from some extremely high quality feeds," said Troy.

Troy has this comment on the feed market. "We are working with our vendors so that they can supply the same profile feeds that our competitors in other countries enjoy. We are currently focussing on feed with a higher lipid value which is not available in Indonesia at the moment."

On the water issue, there is little solidarity among the cage operators with regards to the environment. Awareness about plastic, disposal of dead fish and the introduction of pathogens via trash fish (ikan rucah in Indonesian) are the major points requiring focus. "Most of our neighbours, unfortunately, have no grasp on even the simplest aspects of biosecurity. Some of them bring in fish from outlying islands which accentuate disease problems and create a biosecurity nightmare which hopefully the government can intervene and address," said Troy. "The location and closeness of farms is a major concern for us. We are the biggest farm in North West Bali and are very much affected by the practices of our neighbours and other stakeholders.

"Our cages are located 17 km from the Gondol Research Institute for Mariculture (GRIM) and together with their research team and that from Kiel University in Germany, we are cooperating on a R&D project to monitor water quality parameters around our cages and to do modelling on water quality. Such data are required for the calculation of the carrying capacity and the better management of cage mariculture. We look forward to continuing our co-operation with GRIM on this matter and will use this technology for the development and rehabilitation of sites," added Troy.



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TARS 2017: Finfish Aquaculture – Strategies for Growth

Part 2: Production, health and environment

Part 1 of this report in issue September/October 2017 covered presentations on the state of the industry and its challenges, particularly in the two largest finfish producing countries; Indonesia and China. It also covered presentations on what the industry in Asia can do to counter competition based on experiences in the Mediterranean and on moving into value adding products for better gains. In this part, we continue reporting on the plenary session with presentations covering production, health, environment and performance feeds.

Tilapia: increasing value through technology

Tilapia aquaculture is in a great position, considering the recent development in genetics, biosecurity, nutrition and management tools. But like any aquaculture species, producers face challenges along the supply chain such as environmental impact, diseases and the perception as a healthy food. So how can R&D and technology make a difference in this very practical world of tilapia farming? In his insight at TARS 2017, **Dr Olivier Decamp**, Farm & Feedmill Product Manager at INVE Aquaculture, discussed the subject.

Along the value chain

Decamp started his presentation with a plea for a holistic approach in the tilapia culture value chain: "Let's start by looking at the value chain to identify the areas that can be improved. Under optimal conditions the culture cycle can be shortened. This will increase yearly production and, as a secondary benefit, better disease control. Two other areas we can still develop are the reliability of supply (especially through broodstock management) and the image of tilapia as healthy white fish. In this respect, we need to make sure tilapia does not come to face the same problems as pangasius."

As with any other fish, Decamp stated, disease is a major challenge. Research done by the Fish Vet Group (INVE Aquaculture's sister company within the Benchmark Holdings group) showed mortality levels due to *Streptococcus* of more than 26% in Bangladesh, 83.4% in Malaysia and 20% in Thailand during the hot season. The loss was calculated at USD 525 million in 2015. Research into the feared impact of tilapia lake virus (TiLV) is still ongoing.

"Whether it is nutrition, health or environment related: every problem is a challenge to find the right solution. Technology is available, but it should not be used as a band aid or to come up with stand-alone quick fixes. We really need to embrace a holistic approach if we want to improve the industry."

More predictability in the broodstock stage

Looking at the production cycle, a specific objective for the broodstock stage is to get a more predictable output of good quality fry per female. Genetic selection is critical, but not sufficient. "Even the best genetics program will not deliver optimal results if the hatchery phase is not properly managed," added Decamp. Output per female (season, rearing conditions, nutrition), egg quality (hatching, survival) and larval quality (pathogen-free, survival with/without challenge) are determined by combination of genetics and hatchery protocols. Research showed clear benefits of optimised nutrition on the percentage of females spawning, with a +20% production increase of viable eggs. Furthermore, adequate nutrition reduces the seasonal decline in weekly egg production.

"The target should be to increase egg output while improving predictability. To prevent vertical transmission of pathogens such as *Streptococcus agalactiae* and *S. iniae*, we will need to implement biosecurity measures and work with screened broodstock and disinfected eggs. Compared to a year ago, we now have access to fast diagnostic tools to screen for TiLV. Another important step is to work with safe and qualitative products to avoid the introduction of pathogens or contaminants."

Higher survival in hatchery and nursery

In the hatchery, sex reversal is a stressful phase for the larvae. Optimized condition in this stage will result in better higher survival going onto the nursery.

"Based on the work done by Fish Vet Group, the survival metrics chart clearly showed the potential improvement of larval survival till post sex reversal. With improved rearing conditions over the first 21 days, the increase in survival after sex reversal is an additional 5%. If fry is sold at USD 0.014 per 0.25g, the extra benefit equals USD 7,120 per 20 million eggs produced, each month."

In the nursery, survival varies with location, climate, quality and genetics of the fry, number of phases, etc. Examples include 70% from swimming fry to 1g, 95% from 0.2g to 20g and 60% from 1g to 5g.

"Nursery operators understand that improving conditions can make a difference. Therefore, they will accept the extra cost of good booster feeds and water treatment, as it is critical in the nursery stage to prepare the animals for the stress of the transfer onto the farm."

Better performance in the on-growing stages

Nutrition and feeding management is linked to rearing conditions, tilapia strain and cost constraint. Protocols including vaccination, control of rearing conditions, and performance enhancer diets or additives will help.

"For each product and protocol, we run trials and then analyse the performance using the complete farm data. We review the benefits of microbial products for feed and/or water on growth rate, health status, survival and yield."

Harvesting an attractive seafood product

This is the link between what happens at the farm and marketing. "In the case of the tilapia, getting rid of off-flavour is important. Protocols do exist to control off-flavour in pond-based and RAS-based systems."

With regards to the perceptions of the fish, Decamp said, "I would like to introduce production efficiencies of edible protein as shown by Costa-Pierce et al. 2012. These figures showed

that with FCR of 1.5 and 60% fillet yield, tilapia is an excellent converter. There is a lot of news on the fatty acid profile, which can be modified using additives or revised farming methods such as biofloc.

"In conclusion, we need to learn to increase value through a holistic approach. We need to exploit the interaction between key components: genetics, nutrition, health and environmental management. Usually we tend to work in silos and do not link parts of the value chain. We need to work on the whole supply chain and transfer benefits from one phase to the next for optimal cumulative gains."

"We need to work on the whole supply chain and transfer benefits from one phase to the next for optimal cumulative gains." – Olivier Decamp

Parasite prevention in fish farming

Professor Francisco E Montero, University of Valencia, Spain has spent almost 20 years of his academic career working on fish parasitology and related pathology problems in fish farming. Montero was sponsored at TARS by Nutriad International, a Belgian-based feed additive supplier, to improve the understanding of the industry with regard to fish parasites and how they interact with the fish. "We need to understand these fish-parasite interactions for the implementation of better control measures. This includes studies on parasite biology and epidemiology. We need to have a holistic view on the effects of parasites on the fish farming industry: not only the effects of parasites on production targets but on the environment as well," according to Dr Peter Coutteau, Business Unit Director Aquaculture for Nutriad International.

"Each aqua species is prone to different parasites. When parasites leave the fish farm, they can infect wild fish and generate all sorts of problems. The abuse of chemicals used for treatments affect the environment and raises questions on food safety. To reduce the impact of parasites on productivity as well as to address the adverse public perception on farmed fish, preventive measures are key in fish farming. Also, there are more options to control parasites in farmed fish than in fish found in the natural environment. In Spain, a two-year study established that farmed fish do not carry the nematode *Anisakis* because of the control on production and good management. This resulted in recommendations to eat fresh farmed fish," said Montero.

"In fish farming, usually in open environments, parasitic disease pressure is always present. Primary or secondary parasites facilitate infections while the opportunistic parasites 'make matters worse'. There is documented evidence that the direct and indirect losses from sea lice in the salmon industry in Norway and Chile, cost around USD 100 million annually. Elsewhere, losses due to parasites are poorly documented, unknown or undervalued."

How parasites live

The 'life-style' i.e. attachment and feeding behaviour of fish pathogens explain their pathological effects on fish. "We need to have the knowledge on how they attach to the host. How and what do they feed on?" These range from traumatic attachment where the fish elicits an immune response, or an invasion where the parasite may disturb tissue functionality and steal the food of fish. With a series of graphics Montero demonstrated the damage mechanism of parasites at the skin, muscle, gut and gills. Several scanning electron microscopy pictures demonstrated the attachment mechanisms of several ectoparasites, from the monogeneans to parasitic arthropods comprising copepods and isopods.

Long term host-parasite relations

Parasites look for long term host-parasite relations. They attach and invade and they feed on the host tissues thus affecting the host's functionality and then they sometimes release toxins. Isopods extend a part of their bodies into the fish and tear off the skin of fish. Monogeneans affect the skin, gills and natural cavities. They attach and feed, and will continue to actively attach if the fish remains alive. Their preference is the 'better don't kill your host' approach. Outbreaks are related to the dramatic amplication of parasites during some abnormal situations, where the host-parasite balance is destroyed. Disturbance of the host-parasite relation triggers mortalities.

Montero discussed the white spot parasite *Cryptocaryon irritans* in marine fish which attacks the fish both internally and externally and has the infective trophonts and reproductive and resistant tomonts. Monogeneans feed on blood and on mucous and epithelial cells. They are difficult to remove and fish die of asphyxia. Another example is the blood fluke *Paradeontacylix balearicus* found in greater amberjack *Seriola dumerili* and *Cardicola* spp in the bluefin tuna *Thunnus thynnus*. Once amplified, these parasites infect the gill lamellae and cause severe damage or mortality.

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> **"They attach and feed, and will continue to actively attach, if the fish remains alive. To them, their preference is the 'better don't kill your host' approach."**
> **- Francisco E Montero**

"An open environment is never 100% clean and farms in the vicinity will be sharing pathogens. Farms will need to learn to live with parasites, understand their behaviour and keep pathogens under control," explained Montero.

Strategies for tomorrow

Surveillance and monitoring, and knowing the endemic parasite populations and epidemiology will help to predict and control an outbreak. The traditional approach to combat fish parasites, based on the use of a wide range of chemicals and other therapeutics once the parasite outbreak is detected, is hampered by the increasing restrictions on the use of chemicals.

Montero emphasized that today, the direction is on preventive actions without the use of medication. There is some negativity on the latter which has collateral effects including environmental impacts and development of resistance. Good farm management and practices are pivotal to the reduction of stress in fish. The management for sea lice in Norway is an example; from farm, zone, area, region to country levels. "The future is also with vaccinations but unfortunately, today there are no effective vaccines against fish parasites," said Montero.

There are several examples of biological measures, many of them with respect to combating sea lice in salmonid farming. As sea lice occur at a depth of less than 10 m, to reduce fish-parasite contact in areas with high density of parasites, cage devices to keep fish away from the surface are used. Predator fishes, lump and wrasse, feed on sea lice infested salmon. To avoid cross infections with salmon, these fish have gone through brood stock selection and vaccination against some specific diseases. A new development is using lasers (activated by parasite image recognition in 3D images of salmon skin) to kill parasites by heat shock.

Functional feeds

This is the future, according to Montero, to complement optimized nutrition using health promoting additives with natural anti-parasitic action. "Feed additives are 'easy to deliver' solutions that fit perfectly in a preventive approach, with a good potential for positive return on investment. One way is via enhanced immune response through reactions such as an increase in mucous quality and thickness. There is also the direct action on parasites in the digestive tract. Natural anti-parasitic compounds can be absorbed in the digestive system and circulated in the blood stream to work against internal and external parasites. Overall there is a reduction in the pathogen count and/or pathogenicity as well as a reduced amplification of parasite population by the host."

Montero said that an *in vivo* challenge with gut myxosporidia, *Enteromyxum leei* in the gilthead seabream *Sparus aurata* showed a dose dependent effect of a functional feed additive. There was a reduction in the infection (observed via PCR and histology), and thus on growth and survival. The challenge was done at temperatures of 21- 27 °C and in 20-130 g fish. In a pond challenge with 100 g European seabass, *Dicentrarchus labrax* infected with gill fluke *Diplectanum aequans*, carried out during the cold season, Spanish researchers showed that a functional feed additive could reduce fish mortality by 64%. In all treatments including the control, there was no reduction in the intensity of the infestation among treatments but control fish were less able to cope with the parasite during an outbreak.

Benjamin Dong, Guangzhou Nutriera Biotechnology Co. Ltd, China (right) with from left; A K M Ruhul Amin Sarker, DSM Nutritional Products, Sayed Fazle Rabbi, Agata Feedmill and Aung Tun Aye, Agro Solutions, Bangladesh

His message was, "Parasitic disease problems in fish farms will continue to evolve with the industry. We need to better learn to cope with them!"

Benchmarking: The Salmon Model

There is no doubt that in terms of fish farming, the salmon in Norway has reached a pinnacle with high-tech production combining intensive farming, sustainability, profitability and consumer perception. This was not always the case, according to **Dr Bent Pedersen**, Global Category Manager – Aquaculture, DSM Nutritional Products, Denmark. Sharing his 25 years in the aquaculture industry Pedersen discussed some developments in salmon farming, highlighting the various subjects and technologies from the salmon industry of direct relevance and inspiration for warm water aquaculture in Asia.

"There will be areas of common interest like sustainability which is getting increasingly important also in Asia. As more people enter the middle class, consumers become more demanding on quality and food safety. A lot of the things we have been through on the salmon side will also be important here in Asia. We may not be able to cut and paste, but some experiences from one place can be applied in another. We can modulate it into a different picture in a different area because standards, cultures, and consumer preferences may be different."

The Asian challenge in a global perspective

Asia already accounts for 89% of global farmed seafood supply and of this 63% is produced in China. Aquaculture supplies 51% of fish consumed globally currently, and by 2030, this is expected to increase to 62% to an estimated per capita consumption of 21.8 kg from the current 20.4 kg, which will require an additional 28 million tonnes to be produced per annum. While Asia is expected to realize the highest growth in consumption of seafood, profitable growth within the aquaculture sector is essential.

"It is not about just producing. Years back in the salmon industry, we all talked about producing salmon. However, throughout the years, markets and the industry matured and topics like sustainable and ethical production, food safety and consumer preference grew in importance and are now essential factors defining the future growth of the salmon industry. Furthermore, one of the key bricks for the aquaculture industry is industrialisation, and that's certainly important in Asia," said Pedersen.

Future considerations for the industry according to Pedersen are to expand production of aquaculture especially by intensification, i.e. to increase yields through advances in farming technology.

Lily Li, BASF South East Asia Pte Ltd, Singapore

Nguyen Duy Hoa, Cargill, Inc, Vietnam

Rudi Bijnens, INVE Aquaculture, Thailand

Ma Patricia I Rico, Santeh Feeds Corporation, Philippines

"This implies to further develop feeds in terms of quality, use of ingredients, cost/efficacy, and health management but also to grow the industry in Asia with a view to ethical production and the environment. The future of fish farming in Asia will not be just about production."

The Atlantic salmon industry

Pedersen described the developments and characteristics of the Atlantic salmon industry in Europe. It comprises only 4% of global aquaculture supply at 1.9 million tonnes in 2016, while it is expected to grow 40-60% by 2030. "More importantly, it is research driven development, with regard to nutrition, feed ingredients, genetics, health, etc."

Extruded feed soon became the standard for the industry. Based on years of intensive research, feed composition gradually changed from fish meal/fish oil based to low level fish meal/fish oil plus a diversified blend of plant ingredients. FCR is 1:1.2. Farming here uses intensive production systems, with fish density regulated by law. Automated feeding and monitoring systems control each cage in various locations. One important trend is to produce in a sustainable way. New licenses in Norway are dependent on proof of sustainable production.

Alongside these advances in production and increased output, more and more attention is being paid to sustainable and ethical production, environmental factors, fish product processing and consumer perception of farmed fish. In Norway salmon farming happens virtually without the use of antibiotics but the health status of salmon is supported by vaccination and immune stimulation through functional feeds. "The overall success is a result of cooperation and joint efforts throughout the industry, between authorities, research, the industry and marketing," said Pedersen.

Dhanunjaya Goud, Lallemand Animal Nutrition (left) and U Dushyant Kumar Devee Biologicals Pvt Ltd, India

The new normal

"For cost and sustainability reasons, fish meal is progressively being replaced by plant meals. While in 1990 fish meal counted for 65%, this has been reduced to less than 18% in 2013. Further research by feed manufacturers, research institutes, universities, and others are ongoing and so we will see continuous development to optimise production."

Plant ingredients are being increasingly used in farmed fish diets; but what does this mean for the nutritional value of the diet? This is continuously being investigated in order to supply possible nutrients to the feed if inadequately found in these new fish feed ingredients; e.g. Norwegian researchers have recently looked at whether the levels of B-vitamins added to the feed need to be adjusted when plant ingredients are used in the diet of Atlantic salmon.

"The improved FCR in Norway has reduced the relative feed requirements by about 170,000 tonnes over five years (2009 to 2014). The strategy is not only lowering FCR but also levelling out big fluctuations in feed production/feed ingredients requirement throughout the year. "

The future is also health and biology. "Sea lice is the biggest health challenge for the European salmon industry. Sea lice is being researched intensively to find suitable ways to avoid chemical treatment of the fish and new functional feeds are constantly being developed in order to support e.g. immune functionality. 'Big smolt' production is another trend in farming being developed to control health parameters and increase output from cage culture," added Pedersen.

Power of the consumer

Of all stakeholders, consumers have the strongest impact on how fish is produced in future. "This has been an eye opener for us. Most consumers do not understand fish farming. Our role is to work on how to communicate to the consumer. We need to understand the mind of the consumer. We know we need to explain but not to overload them with information. It is important that we explain to the consumer in a correct way how we produce the fish, etc. It is amazing to see how easy it is to provide a misunderstood image of fish farming by using just a few wrong words," said Pedersen. "Remember, the middle-class consumers will continue to rise and be decisive for our permission to grow."

Living with pathogens in finfish farming: the new cutting edge

In the final presentation at the plenary of TARS 2017, **Alain Michel**, Consultant, France recounted his 16- year foray into setting up an Asian seabass *Lates calcarifer* or barramundi cage culture farm in Indonesia and open a new road for success in the farming of tropical marine fish. His presentation 'Kill the killers or live with them- How to be successful in tropical fish farming' included the farm's battle against several viral, bacterial and parasitic diseases over that period. The final outcome was the discovery of the non-lethal heat shock treatment for controlling diseases.

This presentation was published as two articles in Aqua Culture Asia Pacific. In issue May/June 2017, Michel discussed disease control in aquaculture, and the path developed to live with pathogens. In issue September/October 2017, Michel discussed farming the barramundi alongside pathogens, and learning the hard way at an integrated farm in Indonesia.

At TARS, Michel had the following messages:
Why develop more finfish farming in Asia? "There is a large demand in local and world markets for various finfish such as barramundi, snappers, groupers, pomfret, cobia or even saline tilapia cultured in offshore sea cages. We have the technology and husbandry knowledge to develop a tropical model to compete with the salmon and fulfil the high demands of the frozen fillet on the world market.

"Producers need to be conscious of the huge gap between the first experimental success on one species and the set-up of an integrated large scale production and the necessity of a strong scientific back up."

On the new direction, Michel said, "Disease is a constant threat. Current production based on the biosecurity concept which relies on pathogen exclusion, is a 'mission impossible'. The new paradigm is living with pathogens as partners. This is boosting the fish immune system through non-lethal thermal shocks. The underlying mechanism is the upregulation of the heat shock protein. It is an innovative approach of vaccination in 'live strengthening' of the juveniles at the nursery step through contact with the pathogen of the surrounding environment to prepare fish for transfer to sea cages.

"We can control various viruses, bacteria and parasites in this way without fearing viral mutation or different bacteria serotypes. Well trained and dedicated technicians can easily use this new tool at the commercial level and forget antibiotics. For barramundi and tilapia, survival can reach 80% dealing with viral nervous necrosis, different iridovirus, scale drop and big belly bacteria as well as *Flexibacter*."

"Overall success is a result of cooperation and joint efforts throughout the industry; between authorities, research, industry and marketing,"
- Bent Pedersen

"..production based on the biosecurity concept which relies on pathogen exclusion, is a 'mission impossible'. The new paradigm is living with pathogens as your partners."
- Alain Michel

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TARS 2017: Performance feeds for the finfish aquaculture industry

Palatability drivers in fish diets

Dr Philippe Sourd, Global Technical and Sales Director, Diana Aqua – Aquativ, France gave some glamour to this subject with his 'prezi' presentation discussing the modes of actions for quantifiable enhanced feed and fish performances.

Feed intake is the very first driver of a diet performance in a fish farm. "Aqua feed formulations are entirely focussed on meeting the nutritional and physiological requirements of fish for performance and economic targets. The best feed formulations will not deliver any results if feed is not consumed in the first place!" said Sourd. Feed intake is a combination of attractability and palatability.

Attractability, which is the result from a chemical attraction, will elicit faster feeding but not necessarily increase consumption. Feed intake is when feed has been swallowed and has reached the digestive system. For the feed miller, diet palatability thus remains crucial because feeding behaviour is the first criterion customers will notice. Sourd described palatability as the capacity to stimulate fish appetite and make the fish eat the feed. The more palatable the feed, the more the fish will eat. "But one must remember that feed intake (and feeding behaviour) results from complex interactions between the diet, the fish and its (temperature, oxygen, density, stress etc.)"

Raw material matters

"Thus raw materials amino acid profiles will impact palatability. The formulator, must consider this when choosing raw materials. In a trial, enhancing palatability with a crustacean hydrolysate, feed intake increased by 3% with the tilapia, whereas it increased by 20% with the European seabass. Omnivorous and carnivorous fish do not require the same level of feed palatability. We also showed a preference for raw material when the European seabass responded better to crustacean hydrolysate instead of a mixture of tuna/crustacean hydrolysates," said Sourd. "In the case of oils, this is only important for the user. The origin of the oils does not matter to fish. There is no difference in performance with fish or plant oils or even a blend of oils."

Other compounds such as nucleotides and organic acids are attractants too and are in synergy with amino acids on taste receptors. Studies showed that high levels of free amino acids stimulate feeding behaviour in fish but hydrolysates which combine both peptides and free amino acids have better palatability due to the peptides effects within the digestive system. "There is no benefit in boosting hydrolysates with extra free amino acids. Peptides trigger functional responses regulating from food intake, digestion, gut motility, metabolism and absorption," added Sourd.

Formulation and species matter

Sourd showed the pathways regulating fish appetite. Several fish species can regulate their appetite according to energy or protein levels in the diet to meet their metabolic requirement. Besides formulation, it is obvious that very hard pellet or excessively strong pellet texture can slow down food transition within segments of the digestive tract and therefore reduce feed intake.

Species are all different. Palatability should be built around them. Sourd showed a model of a palatability 'wheel' where there is much more to investigate. Snakehead, tilapia, seabass, catfish may be more or less responsive to factors such as pellet humidity, pellet texture, pellet shape or size, energy or protein content, colour etc. .

Deploying palatability enhancers

"How can we deploy them successfully to achieve higher intake, reduce feed waste in the environment as well as save staff time in feeding? Careful consideration must be paid to the formulation and raw materials. The same goes for the mode of application in the feed mill itself. The impacts of all these factors have measurable consequences on the performances of the fish in the farm," explained Sourd.

In an overwintering trial for the tilapia, Sourd said that the inclusion of crustacean hydrolysates raised feed intake to 20% at 20°C, showing again how environment conditions can affect results. Palatability enhancers allow for a decrease in performance deviation between feeds from different origin as shown with four diets from different sources.

The type and quality of fish meal content influence feed intake in the Asian and European seabass. In the former, a reduction in the fish meal in isoprotein and isolipid diets from 80% to 0% decreased feed intake considerably. In the latter species, palatability performances of four marine ingredients processed differently scored from 100% for hydrolysates to 30% for a co-product. In turn, the processing of the hydrolysate influences palatability.

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> **We must consider a holistic approach of the diet, from formulation to process, of the fish and it's environment to truly speak about palatability solutions.**
> **- Philippe Sourd**

In feed processing, coating the palatability enhancer onto pellets maximizes the feed intake and is recommended for the best cost benefit. Dosage is critical and should not be exceeded to be cost effective. Too low a dosage will put performances at risk. As the fish grows, the requirement will decrease, making the solutions still economically viable for large sized fish.

"Buying and adding a palatability enhancer to the diet will not automatically improve the outcome. We need to make the right decisions on the feed design and raw materials selection as well as choice of the palatability enhancer and its dosage and application mode. The feed has to minimize deterrent factors, variability of raw materials and inconsistencies in the feed production process to start with. Farmers expect a standardized response. Therefore, feed producers must use standardized ingredients to obtain secure solutions."

Sustainable aquaculture starts with the feed industry

This is how **Dr Thomas Wilson**, Aquaculture Nutrition Consultant based in Thailand sees the finfish industry progressing with demands on sustainability. His presentation is an extension of the article published in the May/June 2017 issue, titled 'Benefits of feed enzymes for sustainability and responsible aquaculture'.

In his introduction to sustainable aquaculture in the Asian context, Wilson said, "Sustainable aquaculture is a global issue but with local consequences. The emphasis has been on the environment rather than on social and economic sustainability. Buyers coming to Asia looking for seafood are telling us that they want us to reduce fish meal, i.e. fish in: fish out ratios. "Fish and shrimp do not actually need fish meal," said Wilson. Fish meal may be the most balanced source of nutrients for aquafeeds, but it is not the only source. Animal and plant proteins and lipids can supply everything fish meal does. "We can focus on low trophic species and expand their production without fish meal. FAO data shows we can already produce 940 tonnes of carp with 1 tonne of fish meal and 700 tonnes of carp with 1 tonne of fish oil. But we still have much higher levels of fish meal included in diets for the milkfish, a herbivorous fish! So, some good R&D needs to be done to bring fish meal levels down for milkfish."

Norman Lim, Cargill Aqua Nutrition, Singapore

Emmanuel de Braux, Barramundi Asia, Singapore

Responsible aquaculture

"Sustainability is really a big issue and it is not limited to just reducing the use of fish meal or fish oil" Wilson said, "In Asia, we tend to push economic rather than environmental interests to the forefront i.e. investments, local jobs and profits. An area of concern for all is the limited availability of land and water resources. On a per capita basis, Asia's access to freshwater is the lowest at 3.92m^3 as compared to other continents such as Europe at 4.23 m^3. As we are sharing water resources with others, we must return clean water back to the waterways."

The issues with various open aquaculture systems and the effects of external pollution were demonstrated by various news reports on failures and fish die-offs happening around Asia. "We have been focusing on using low cost feeds, possibly with low cost ingredients leading to polluting our own waters. Fortunately, both the Philippines and Indonesia are now trying to maintain aquaculture production and trying to reduce impact on the environment; moving away from sinking to floating feeds, and improving feed quality and feed management," added Wilson.

Wilson said that a number of Asian countries have experienced serious disease outbreaks with aquaculture intensification efforts, but unlike some, he did not believe that intensification should stop. The European salmon feed industry has shown that fish disease can be managed without antibiotics; using properly formulated high quality feeds, with vaccination and use of functional feeds, and by proper environmental management. Asia can benefit a lot by studying and applying the concepts that are transferable to the Asian industry.

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Minh Anh Pham, Neovia Vietnam (left) and Chuyen Ngo Tan Huynh, Diana Aqua - Aquativ, Vietnam

Piet Verstraete, Foresee Management BVBA, Belgium (left), Dr Peter Coutteau, Nutriad, Belgium (centre) and Bahadir Basaran Agromey, Turkey.

Feed and effects on water quality and animal health

Wilson showed a graph from the WorldFish Center which clearly demonstrated that based on nitrogen and phosphorus emissions per tonne of protein produced, warmwater species (pangasius, catfish, shrimp) fare worst that salmonids, although the latter is a carnivorous species with 2-3 years cycle. "The cycle for carps and pangasius is 6-8 months but emissions are higher. Thus, we need to invest in R&D of nutrient requirements, farming and feeding methods to make large improvements."

Feed is the largest contributor to nitrogen into the pond. "Poor palatability and reduced nutrient digestibility increase production cost and reduce profits. Increased organic waste brings about low dissolved oxygen (DO), excessive phosphorus excretion increases risk of 'off-flavour' in fish, and increases the likelihood of disease outbreaks," Wilson added.

In two slides, Wilson showed the following;

- In the tilapia, *Oreochromis niloticus*, protein digestibility declined to 80% at DO of 6.9 ppm and to 40% at DO 3.5 ppm. After 4 weeks, changes in intestinal morphology affected by both diet composition and DO concentration were visible. High soybean meal inclusion caused enteritis-like symptoms that were enhanced at low oxygen conditions and were made permanent under continued hypoxic conditions.

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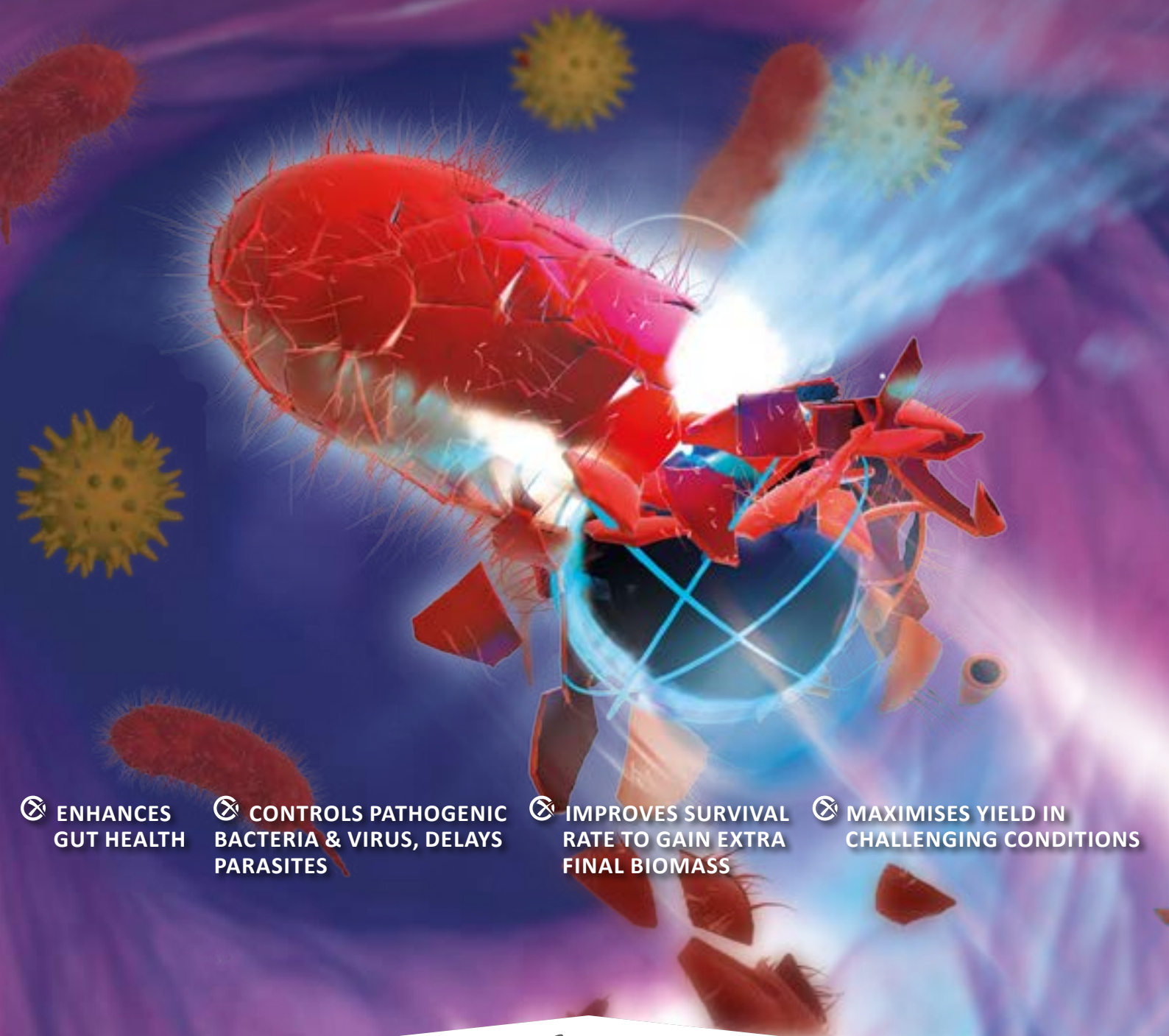

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Dr Ketut Sugama, Ministry of Marine Affairs and Fisheries, Indonesia

- Growth of Silver perch *Bidyanus bidyanus* slowed when nitrite levels reached 1.43 ppm, which is actually a low level. In freshwater, nitrite toxicity changes blood haemoglobin to methemoglobin, thus reducing the oxygen-carrying capacity of blood. Low DO and anaerobic conditions stops denitrification, which just worsens the problem.

"Levels of oxygen and nitrogen like these are commonly found in farms, yet the research is showing they cause significant declines in growth rates." Wilson said one way to solve this was to try improve digestibility to reduce nutrient wastage, but the Asian industry might not have access to the most digestible ingredients. He discussed improving feed utilization with enzymes: phytase, xylanase, β-glucanase and protease either singly or in combination. Details are available in his article. He concluded that, "Investing in higher quality, more digestible ingredients and feeds pays back by improving water quality and reducing the negative impacts of low dissolved oxygen and high dissolved nitrogen on fish growth, health and survival. Effective feeds and functional feeds are needed for the long-term sustainability of Asian aquaculture, not low-cost feeds."

His message to industry was, "My hope is that one day, we will stop talking about or we will stop using the words 'intensive aquaculture' and 'low cost feeds' in the same sentence because they do not work together."

"Investing in higher quality, more digestible ingredients and feeds pays back by improving water quality..."
- Thomas Wilson

Nutrition, feed formulation and the commercial field realities

"How can aqua feed manufacturers cope better with these commercial realities?" asked **Professor Dominique P Bureau** at the Fish Nutrition Research Laboratory, University of Guelph, Canada. "Where are the gaps in information and know-how? How can they systematically and effectively identify what works better and works less well? How can effective R&D efforts and interventions be undertaken to address these challenges?

"In Asia, we have a large number of species produced, diversity of production systems and strategies used, and differences in market preferences. These factors impel aqua feed manufacturers to produce a diversity of feed types for different fish species. They have to formulate feeds with costly and imperfect ingredients, accept low profit margins and rely on limited public 'knowledge base' for many of these species and feed ingredients," said Bureau.

Approaches to challenges, step by step

Bureau proposed three recommendations and urged industry to adopt a more systematic and rational approach:

- Properly identify context and challenges;
- Adopt systematic and rational approaches;
- Invest in monitoring and continuous improvement.

Aqua feed manufacturers do not just impart nutrition and feed technology knowledge, but also knowledge on animal health management, and farming and breeding technology to their clients. Bureau explained to feed manufacturers that "There are a number of activities where you could positively influence how well your clients are doing with their farm without large investments. These include providing diagnostics support to your clients, access to preventive measures, such as the use of vaccines or production strategies to mitigate disease, or the use of feed additives which can have an impact on the health management on the farm."

Systematic and rational research

"This step up approach starts with a review on the scientific and technical information already available. In my research group, we use this type of approach: the systematic compilation of data analysis to address multiple questions on feeding formulation, such as effectiveness of fish meal replacement by some ingredients. It can be done, with existing data and, in some cases, we did not have to carry out a single trial," added Bureau.

Next is to try a few concepts at the laboratory level and then move on to a small scale aquatic facility to test the diets and treatments on a small scale. We control conditions to be really sure of the standard response. Field research is more likely to yield variable

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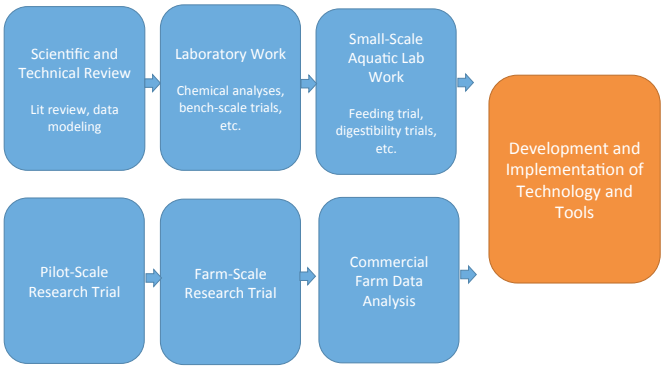

Figure 1. The step by step approach to scale up research

June R Sayo, Novus International Pte. Ltd, Philippines (left) and Kamphon Mike Wongwilawan, Cargill Siam Limited, Thailand

results and be risky. Proper field research should involve proper replications and that may mean involving and collecting data from multiple clients." (Figure 1)

The message here is to do the homework first: understand the problem, understand how things are working, and then invest in large scale research at the farm level. There should be a meaningful translation of research results into guidelines, tools and into integrated feed formulation programs.

Nutrition and feed technology

At the feed mill, the first focus is nutritional requirement to ensure the best feed specification. The fine characterisation of nutritional requirements can be done through research trials in aquatic facilities but it can also be done through the review of scientific literature, and even through the use of a nutritional model. At TARS 2015, Bureau presented details on the nutritional modelling his team used to develop the International Aquaculture Feed Formulation Database (www.iaffd.com).

"With the number of species that we have and the different life stages and types of feed to formulate, the best way is to do nutritional modelling. This is the most effective and rational way of defining optimal nutritional specification. Next is to characterise feed ingredients. We still refer or rely on proximate analyses to define the quality. Clearly this is no longer sufficient; we have to go down to analysis of the nutrients of the same ingredients which requires digestibility or bioavailability trials or more advanced chemical indicators," said Bureau. "Most companies invest in very significant human and financial resources in QA/QC but the efforts need to be a lot more systematic and focused on understanding the true nutrition value variation in good feed ingredients and finished feeds."

Today in Southeast Asia, more feed manufacturers are aware of the importance of digestibility of nutrients in their feed ingredients. Bureau commented that, "However, the challenge is predicting digestible nutrient (e.g. lipids, phosphorus) contents of balanced feeds formulated to widely different digestible nutrient levels and made with a great variety of ingredients."

An experimental assessment of digestible nutrient level of a certain feed comprising a wide variety of feed ingredients would be too daunting experimentally because all the combinations require testing of all the ingredients at all levels. "Here again, nutritional modeling may also be of great value. We have shown under commercial conditions that the phosphorus and lipid digestibility models that my group developed were really valuable," added Bureau.

"However, the value of these tools is only as good as the calibration. Thus, you have to do your own research yourself, given your species and your condition in order to get good results."

Investing in monitoring and continuous improvement

Aqua feed manufacturers usually use field research to establish feed efficacy. However, data from farms are estimated values and are often sporadic values but aqua feed manufacturers try to make some conclusions. For easy improvements (low-hanging fruit), such as improving feed conversion ratio (FCR) from 2.0 to 1.6, it may not really matter how systematic you are. However, when the search is for small but commercially meaningful improvements, such as improving survival from 65 to 70% or decreasing FCR from 1.6 to 1.4), it is a lot more challenging.

The goal is to collect information more effectively. "In the American dairy industry, data had been collected systematically since 1893 and then shared and compared among industry. The sharing and advanced analysis of the data has supported the development of improved tools, technologies and practices. This has in turn allowed very significant improvement of the production of dairy cows. In aquaculture, we do things the other way around," said Bureau.

"We develop the fish, the genetic or genomic technology without having proper data, proper benchmark, proper growth model, proper mathematical equation, and proper sharing of data. Everybody's working on his/her own. We need a more unified and standardised system where data are put together, and then we can develop more reliable predictions and reach more meaningful conclusions.

My dream is to develop this commercial aquaculture data analysis platform and production management platform where we compile the data from different farms, crunch data, report to producers and feed manufacturers and others in the value chain," concluded Bureau.

"We need a more unified and standardised system where data are put together, and then we can develop more reliable predictions."
- Dominique Bureau

New tendencies and challenges in aqua feed formulation

As aqua feed manufacturers work at replacing fish meal with plant meals, **Michele Muccio**, BIOMIN Holding GmbH, Austria, said that alongside this trend, issues with mycotoxins will rise. According to FAO, the average inclusion rate of fish meal in aqua feeds is 25% but it accounts for 43% of raw material costs and 32% of the total production costs. Alternative proteins (e.g. soybean, wheat and corn gluten), which represent 45% of volume, account for 19% of raw material costs.

"Therefore, there is a string of arguments to include plant protein sources to overcome the high costs of aqua feeds. Besides costs, fish meal can be subjected to greater spoilage issues (i.e. nutrient depletion and bacterial contamination), and contamination of dangerous substances such as melamine," said Muccio.

"Although plant meals are cheaper and contain valuable nutrients that can benefit production, some nutrients are less accessible requiring higher inclusion rates. Nutrient optimization is needed perhaps with enzymes, acidifiers, yeast, fungi, bacteria, genetic manipulation, and supplementation with feed additives, probiotics, prebiotics, synbiotics and nucleotides. There are also possibilities of bacterial and fungal contamination and the presence of antinutritional factors such as mycotoxins."

Plant meals lack some essential amino acids (e.g. lysine, tryptophan and valine in wheat and methionine; tryptophan and lysine in corn and corn gluten meals) and therefore do not provide the nutritional balance in aqua feeds. High content of non-starch polysaccharides (NSPs) reduce feed efficiency and nutrient utilization with significant effect on feed performance. Proteins derived from seeds and oils often contain lecithin which alters the intestinal structure with changes in immunological parameters. Two thirds of total phosphorous is in the phytate form in oilseed meals; this lowers the bioavailability of phosphorous and reduces the availability of micronutrients such as zinc and apparent digestibility of proteins.

Anwar Hassan, BIOMIN, Indonesia (left) and Natalia Jorge Trevilla, Industrial Tecnica Pecuaria S.A. (ITPSA), Thailand

Focusing on mycotoxins

In his presentation, Muccio introduced the different types of mycotoxins which produce toxic fungal metabolites with a broad range of severe negative effects on performances. These infect all kinds of commodities worldwide. According to FAO, at least

“Mycotoxins present an emerging issue in aquaculture with the increasing tendency to include higher ratios of plant-based ingredients in aqua feeds.”
- Michele Muccio

25% of the world’s crops are contaminated by mycotoxins. Some mycotoxin-producing fungi, such as *Fusarium* mainly grow in the field, while others, such as *Aspergillus*, are mainly found under adverse storage conditions.

“Mycotoxins present an emerging issue in aquaculture with the increasing tendency to include higher ratios of plant-based ingredients in aqua feeds. As far as agriculture is concerned, we have 400 different mycotoxins in various commodities,” said Muccio.

The effects of mycotoxins in aquatic species are documented in the literature. These depend on the type of toxins, species, and among environmental factors. Effects also depend on the mycotoxin concentration, as well as duration of exposure, the nutritional status of the animal as well as the inclusion rates of plant meals in fish feeds. Some of the effects with aflatoxin (AF) contamination include vacuolar degeneration, histopathological changes, decreased feed conversion ratios and growth rate in the tilapia. In catfish, histopathological changes and stomach necrosis after 10 weeks was reported with 10,000 ppb AF. In carp, a strong immunosuppression was reported with 350-1000 ppb of deoxynivalenol (DON) contamination. Growth and average weight gain of tilapia fingerlings were affected by 10,000 ppb of fumonisins (FB).”

Indications of contamination levels

Muccio gave some maximum values for the main mycotoxins contaminating Asian samples of plant meals from a survey conducted in 2016. “Soybean meal, widely used at more than 40% in fish feeds, had a low contamination level but wheat meal, used at 20-25% levels in low trophic species and 10-20% in feeds for higher trophic species showed contamination levels of more than 6,900 ppb of DON.”

He added that although corn and corn meal is used at low levels, from 10-40%, FB contamination reached maximum levels of more than 16,000 ppb. Corn gluten meal, used at less than 10% in feeds for high trophic level fish registered DON at 11,518 ppb. Rapeseed and canola meal, usually included at 40% in carp feeds and only 5% in salmonid feeds, had low contamination levels with DON at 2,431 ppb while cottonseed meal, added at 25% in feeds for tilapia, was contaminated with AF at more than 9,000 ppb. Rice bran is popular in Asia as a supplemental feed for the pangasius and often included at 10-25% in tilapia feed, has relatively low contamination levels of 545 ppb of zearalenone.

The message is that, “Mycotoxins act as threats to aquaculture and even at a low dose they can depress the immune system and decrease performances.”

Dr Jarin Sawanboonchun, Gold Coin, Thailand (left), Vorapong Pattrakulchai, Cargill Inc, Vietnam (centre) and I Gusti Arya Ameri Eman, PT Bali Barramundi, Indonesia

Early weaning with high performance larval feeds for marine fish

“Development of microdiets for early life stages has been a priority in academic and industrial marine fish larval research since the 1990s. However, there continues to be challenges and difficulties,” said **Dr Luís Conceição**, CEO and R&D Director, SPAROS Lda, a Portuguese R&D-driven start-up dedicated to find innovative solutions for feeding fish.

“Progress has been considerable, with good weaning results shown with commercial microdiets, for the European seabass and gilthead seabream in the Mediterranean and red seabream and olive flounder in Asia. The work still remains challenging for nutritionists and formulators but solutions are critical as early nutrition may affect utilization of on-growing diets,” said Conceição. “For example, there is work in France where a short-term early exposure of trout fry to a plant-meal diet improves its acceptance and utilization at later life stage.

“The fish larvae paradox is due to the immature digestive system but high growth rates (10-20%/day and up to 50%/day) which means high requirements in terms of amino acids, highly unsaturated fatty acids (HUFAs), phospholipids, vitamins and other nutrients; moreover these nutrients must be given to larvae in highly available forms, meaning high quality ingredients,” added Conceição.

Inert microdiets

The main challenges with inert microdiets are that they tend to be poorly digestible when compared to live feeds. These have resulted in low predictability in survival, sub-optimal growth (larvae and juveniles) and quality problems (deformities). “In the last 20 years, there has been progress with inclusion of protein hydrolysates, information on requirements on HUFAs and phospholipids, and on feed processing technology. However, we still see that *Artemia* replacement is making slow progress at many seabass and seabream hatcheries such as those in the Mediterranean, where for example, a 20-million fry hatchery may use 40 to 120 kg *Artemia* cysts/million fry during the 3-6 weeks early stage. The dependence on *Artemia* cysts costing up to USD 7,000 per million fry, is largely because of the risk perception by hatchery managers and the fear of an increase in skeletal deformities.”

There are biological and technological constraints toward the development of effective microdiets. “Even if we have a reasonable understanding of what fish larvae roughly require in their diets and sources of micronutrients, the exact nutritional requirements are still poorly understood. Then we must look at nutrients leaching in inert microdiets, due to the small particle sizes. We need improved technology and formulations for high performance diets,” explained Conceição.

"A major constraint is that we cannot measure easily the efficacy of diets because of the small size of the animals. Most species do not perform well on inert diets; assessing food intake and digestibility of diets is a major challenge and dose-response studies are very difficult to perform," added Conceição.

A good microdiet for fish larvae needs to meet some specifications, such as:

- nutritional adequacy to the requirements of the target species;
- a technological production process that promotes ingestion, allows easy digestion, prevents nutrient loss to the surrounding water by leaching and disaggregation; and
- optimal physical properties such as floatability, sinking speed, dispersion both in the tank surface and water column to ensure a higher ingestion by fish larvae.

Some nutrient requirements of larvae

"When we look at the amino acid profiles of larvae and try to match with live feeds, we see some imbalances. Dietary amino acids have functions besides growth; these include energy production or their conversion to lipid, hormones, enzymes, purines and pyrimidines and cofactors. A diet with a balanced amino acid profile reduced incidence of skeletal deformities in white seabream.

"Fatty acids are required for growth and energy but also critical for larval quality and pigmentation. HUFAs such as docosahexanenoic acid (DHA 22:6n-3), eicosapentaenoic acid (EPA 20:5n-3) and arachidonic acid (ARA 20:4n-6) are most important. Phospholipids also play a role in stress resistance and skeletal development. However what are the dietary requirements, and optimal ratios? and can we find sources (raw materials) at reasonable prices?" asked Conceição.

He showed results of studies where the meagre and seabream required high protein and high energy diets (64% protein; 22% lipid) and in contrast, the Senegalese sole, performs better on moderate dietary lipid levels (14%) and a high DHA/EPA ratio. In the case of phospholipid sources, seabream survival was higher with krill meal than with soybean lecithin.

The way forward with microdiets

Diets must be highly digestible with bioavailable ingredients as well as low leaching levels. Too much leaching will affect water quality. Microencapsulation can reduce nutrient leaching but this may affect digestibility, so a balance between these two factors is required. "Cost-effective technological solutions are needed," said Conceição.

Ho Gim Chong, Nutriad Asia Ltd (right) and Laura Khor Li Imm, KS Aquaculture, Malaysia.

From left: Michael Leger, Nutreco International, Vietnam; Marc Le Poul, Skretting Asia; Anang Hermanta and Candra Yanuartin, PT Sinta Prima Feedmill, Indonesia and Fauzan Bahri, Skretting Indonesia

Does one larval feed fit all?

The optimal diet changes with fish species, size and environment. Conceição said, "It has been shown that sole larvae perform very well with a diet based on a mix of vegetable and marine ingredients." Interestingly, when this same microdiet was used on gilthead seabream larvae results were not as positive: a lower growth was observed compared to other microdiets. Seabream larvae perform better on a diet based on squid meal.

"While most commercial microdiets available were developed in Europe and Japan targeting slower growing species, we know that fast growing fish larvae such as the amberjack/yellowtail, have exceptional requirements for protein and other nutrients. A prototype feed for *Seriola dumerili* is 62% crude protein: 18% crude fat. Compared to a commercial diet, the feed conversion ratio (FCR) was 13% better with the fast performance prototype diet. Weaning was achieved at 34 days compared to 42 days when fed a high quality commercial diet."

Early co-feeding promotes growth in the long-term; in sole it was shown to be advantageous to use a co-feeding regime from the time of mouth opening, as even if growth is initially somewhat reduced, it results in the production of larger and better-quality post larvae at the later development stages.

Live feed replacement will increasingly be a reality, leading to many species feeding exclusively (or almost) on high quality inert microdiets "While in 2010, for the Senegalese sole, a full weaning was only achieved at 40-DAH, in 2016, it was possible to achieve full weaning at 25-DAH with survival of over 90% and growth rates above 10%/day."

Conceição's message was, "Some species may require specific diets, or may perform well on cheaper diets. However, diets must be selected on cost-effectiveness and not on price."

"..we know that fast growing fish larvae such as the yellowtail, have exceptional requirements for protein and other nutrients.." - Luís Conceição

A future with fish meal-free feeds

Dr Anant S Bharadwaj, Director of Nutrition, Integrated Aquaculture International (iAqua), USA discussed the challenges in developing fish meal-free feeds. In Asia, even the omnivores, mainly tilapia, carps and pangasius use fish meal: 2-3% fish meal in tilapia feeds, 0-30% in carp feeds (depending on life stages) and 3-10% in grow-out feeds for the pangasius.

"The push for aqua feed producers to replace fish meal with perhaps plant meals and other alternatives is because of price increases and limited supplies. There are interests as well as critical needs among feed producers to reduce fish meal or to produce fish meal-free feeds that promote similar growth performance at lower costs. It is, however, interesting that studies show that the pangasius can grow without fish meal but fish meal is still used," said Anant. Another push factor is from the retailers and consumers, wanting to promote fish fed feeds that contain no marine proteins.

"In Asia, opinions on the use of plant and land animal proteins are not very clear. Although nutritionally balanced mixtures of plant and terrestrial animal protein sources promote growth in marine species that are similar to that seen in fish fed fish meal based feeds, both feed producers and users seem reluctant to eliminate fish meal or reduce use to very low levels."

Challenges with replacing fish meal

Nevertheless, in keeping with this trend for fish meal-free feeds, Anant went on to discuss the challenges. The strategic use of fish meal has evolved to larval, brood stock and finisher feeds. In carnivorous species, it is challenging as these fish have lower tolerance for dietary carbohydrates and have higher requirements for some nutrients than omnivores.

"Fish meal is a complex ingredient and replacing it requires combinations of quality ingredients to meet the nutrient requirements of the target species. Only more recently, are such ingredients and supplements more available and less expensive, making fish meal-free feeds a distinct possibility,"

According to Anant, studies on numerous species showed that replacement of fish meal with high inclusion levels of alternate proteins have resulted in growth depression. "These were because of reduced or poor palatability, reduced feed intake, nutrient deficiencies and compromised gut integrity. In addition, the lack of detailed information on nutrient requirements of target species, composition of ingredients and nutrient digestibility of ingredients has also hampered efforts."

“Does this mean that strains with higher tolerance to some plant meals should be developed?”
- Anant S Bharadwaj

Precision formulations

Here Anant said that the aim is to reduce deficiencies when attempting to replace fish meal. “Many plant meals are attractive as sole replacement for fish meals. However, when we look at the nutrient levels of plant meals, we see excessive amounts of either lysine and methionine. Using the ingredient based approach is not precise as you may supply in excess. The nutrient based approach is more precise but in the past, the lack of information has hampered formulators. Information is needed on nutrient profiles and digestibility. But now more information is available. In addition, the availability of synthetic amino acid supplements facilitates the nutrient based approach.

“However, with synthetic amino acids versus protein bound amino acids, we have questions pertaining to faster absorption and losses from leaching; but there are strategies used to counter faster uptake and leaching such as encapsulation etc.”

Fish meal-free feeds

There has been progress with developing low fish meal or fish meal-free feeds for some Asian fish species, such as tilapia, catfish and carp species using poultry meal without affecting growth performance. Similarly, this was observed in tiger grouper fed reduced fish meal which was replaced with soybean meals. However, in feeds for the Asian seabass, feed intake decreased with reductions in fish meal.

Anant also discussed some consequences of replacement of fish meal such as enteritis of gut when fed elevated levels of soybean meal in the carp, and decreased gut enzyme activity in the gibel carp. In the tilapia, there have been minor disruption in intestinal histology and increase in goblet cells but the fish were able to adapt. In the orange spotted grouper, there was intestinal damage. The question is: would feed supplements help?

There were also indications of strain dependent differences in the degree of sensitivity to high dietary soybean meal in the rainbow trout. A genetic variation in utilisation of plant proteins was seen with a strain developed for improved utilisation. Family based difference in response to plant protein was observed in the European seabass. “Does this mean that strains with higher tolerance to some plant meals should be developed?” asked Anant.

His message was, “Despite many alternative protein and lipid sources and feed supplements increasingly available at lower prices, there are still numerous challenges to overcome to develop fish meal-free feeds on a wider scale, in particular for the marine fish.

TARS 2018 will focus on Shrimp Aquaculture and will be held on 15-16 August 2018, Chiang Mai, Thailand.

More updates at www.tarsaquaculture.com

Low inclusions of krill meal spare fish meal in diets of juvenile white shrimp cultured under high salinity

By Alberto J. P. Nunes, Hassan Sabry-Neto, Lena Burri and Esaú Aguiar Carvalho

Efficiency of fish meal-challenged feeds is enhanced starting at a 3% dietary inclusion of krill meal even under high salinity conditions.

Commercial shrimp feeds are going through major shifts in their ingredient composition, particularly in regard to the traditional sources of protein used. The inclusion of fish meal derived from pelagic fish, such as anchovy, has drastically reduced over the years. This has given place to more widely available and cheaper protein sources, including those from processing byproduct meals obtained from fisheries and aquaculture (tuna, tilapia, sardine, salmon and pangasius), agriculture meals and concentrates (soybean, canola, corn, rice and pea), and rendered animal byproduct meals (poultry byproduct, hydrolysed feather, spray-dried blood, meat and bone). Feeds containing these alternative ingredients can perform effectively, if the correct supplementation with minerals, synthetic amino acids and feeding stimulants is carried out.

Previous work has shown that low inclusions of krill meal can compensate for the effects of fish meal-challenged diets for juvenile whiteleg shrimp, *Litopenaeus vannamei*. Suresh et al. (2011) formulated feeds without fish meal with 20% poultry meal. Feeds that contained 3% krill meal significantly improved feed attractability, palatability and shrimp growth. Sá et al. (2013) working with a soy protein concentrate-based feed with only 5.0% fish meal, found that a combination of whole squid meal and krill meal starting at 0.5% enhanced shrimp final weight, with a greater effect at 2% inclusion. Sabry-Neto et al. (2016) investigating all-plant protein diets reported that already 1% krill meal was able to enhance shrimp feed intake. At 2%, there was an acceleration of growth, increase in yield and a reduction in feed conversion ratio (FCR). Moreover, Derby et al. (2016) reported that krill meal increased feed palatability by prolonging the feeding bout and the amount of feed eaten.

The aim of this study is to investigate whether low doses of krill meal can improve whiteleg shrimp growth and feed efficiency under high salinity culture conditions, when fish meal levels are challenged.

Experimental design

This study was carried out at LABOMAR aquaculture facilities, Northeast Brazil. Specific pathogen free shrimp juveniles of 1.13 ± 0.19 g were stocked in 30 outdoor tanks of 1 m^3 with stocking density of 100 animals/m^2 and raised for 71 days (Figure 1). Shrimp were fed four laboratory-made feeds using an automatic feeding device that operated 4-10 times a day between 0700 h and 1700 h. Feeds were adjusted bi-weekly by sampling and weighing individually five shrimp per rearing tank.

Figure 1. A, outdoor tanks at LABOMAR used in the study. B, juvenile shrimp at stocking.

A control (CTL) feed was formulated to contain 15% fish meal with 1% squid meal (Figure 2, Table 1). Three other feeds were prepared by reducing the fish meal in the CTL by half and supplementing it with 1, 3 and 5% krill meal (Qrill™ Antarctic krill meal, Aker BioMarine Antarctic AS, Oslo, Norway). Feeds were formulated to be nearly similar in their nutrient composition. Dietary crude protein and total lipids reached means (± standard deviation) of 38.4 ± 0.53% and 9.2 ± 0.16% (dry matter basis), respectively. Dietary methionine showed the greatest variation among analysed essential amino acids (EAA) with a mean of 0.64 ± 0.05%. All other EAA, fell within the recommended levels for farm-raised shrimp. With the reduction of fish meal level, formula costs reduced to 19.3, 12.7 and 7.1% when the CTL diet is compared with diets with 1, 3 and 5% krill meal, respectively.

Figure 2. A. Laboratory-made feeds. B. Krill meal used in the study from Aker BioMarine.

Water parameters

During shrimp culture, water salinity increased progressively from 32 to 41 ppt, with a mean of 37 ± 1.8 ppt. Water pH and temperature reached 7.6 ± 0.26 (7.0 – 8.3) and 30.5 ± 0.65 °C (27.7 – 34.1 °C), respectively. Total ammonia nitrogen, nitrite and nitrate averaged 0.38 ± 0.22 (0.20 – 0.71 mg/L), 1.30 ± 1.13 (0.10 – 3.10 mg/L), and 5.78 ± 2.91 (3.00 – 11.00 mg/L), respectively.

Attractability

At harvest, the final shrimp survival (%), body weight (g), daily growth (g), gained yield (g/m^2), amount of feed delivered per stocked shrimp (g) and FCR were calculated for each dietary treatment. To determine potential differences in feed attractability, harvested shrimp were transferred to five indoor tanks of 0.5 m^3 and stocked at 40 shrimp/tank (70 shrimp/m^2). Animals were fed twice daily for 8 days to excess. The four feeds were delivered simultaneously in equal amounts in feeding trays positioned opposite to each other in each tank. After 1 hour, trays were removed, and feed left-overs dried in a convection oven. Feed attractability was calculated by estimating the total apparent feed intake (AFI) given on a dry matter basis.

Figure 3. Indoor tanks carried four feeding trays to evaluate feed attractiveness.

> **"..under hypersalinity conditions, there is a high energy expenditure driven by osmoregulation.."**

Effect of salinity and krill meal supplementation

The final shrimp survival was high reaching an average of 96.2 ± 3.04% (Table 2). The survival was unaffected by dietary treatment ($P > 0.05$). Similarly, no effect on shrimp growth was associated with feed type. Shrimp grew slowly regardless of dietary treatment, at a daily rate of 0.10 ± 0.01 g. The high-water salinity observed during the culture appeared to have impaired growth. However, shrimp fed the CTL and the feed with 5% krill meal achieved statistically higher body weights compared to the other fish meal-challenged feeds. Dietary supplementations of krill meal at 1 and 3% were not sufficient to compensate for such a significant reduction in fish meal levels in addition to the hypersalinity conditions, where a high energy expenditure is driven by osmoregulation.

In our study, although shrimp yield progressively increased with higher levels of krill meal, means (650 ± 41 g/m^2) were not statistically different. However, the amount of feed delivered per stocked shrimp during culture was significantly lower in feeds containing 3 and 5% krill meal. This has led to an enhanced FCR for both dietary treatments. Shrimp were able to more efficiently convert dietary protein into growth, when diets contained krill at 3 and 5%, despite a reduction of fish meal by half. Assessment of feed attractiveness has shown that while diets with 1 and 3% krill meal were consumed in smaller amounts than the CTL, a 5% inclusion of krill meal led to a higher feed intake (Figure 4). Therefore, an enhancement in shrimp growth and feed efficiency may be partly explained by a higher feed attractiveness.

Table 1. Ingredient and chemical composition of experimental diets.

Ingredients	Feeds/Ingredient Composition (%, as is)			
	Control	1% Krill	3% Krill	5% Krill
Soybean meal, 48.8% CP, 1.3% fat	36.44	48.24	46.35	44.10
Wheat flour, 9.2% CP, 1.3% fat	30.51	25.00	30.00	30.35
Salmon meal, 59.4% CP, 9.4% fat	15.00	7.73	7.04	7.01
Cassava starch	3.00	5.00	2.56	3.00
Salmon oil	3.00	2.00	2.00	2.00
Lecithin oil	2.42	2.92	2.73	2.49
Wheat bran, 13.4% CP, 2.8% fat	2.00	1.39	0.00	0.00
Vital wheat gluten, 78.7% CP, 1,7% fat	2.00	1.00	1.00	1.00
Magnesium sulfate	1.20	0.31	0.00	0.00
Vitamin-mineral premix	1.00	1.00	1.00	1.00
Squid meal,	1.00	0.00	0.00	0.00
Krill meal, 57.1% CP, 18.5% fat	0.00	1.00	3.00	5.00
L-Lysine, 54.6%	0.63	0.78	0.75	0.71
DL-Methionine, 99%	0.14	0.21	0.20	0.18
L-Threonine, 98.5%	0.26	0.32	0.30	0.28
Synthetic binder	0.50	0.50	0.50	0.50
Dicalcium phosphate	0.49	1.15	1.25	1.18
Soybean oil	0.37	1.42	1.29	1.17
Stay C®, 35%	0.03	0.03	0.03	0.03
Cholesterol SF, 91%	0.01	0.00	0.00	0.00
Formula cost per tonne*	824	691	731	769
Nutrient composition (% of the diet, dry matter basis)**				
Crude protein	39.2	38.0	38.2	38.2
Fat	9.4	9.1	9.1	9.0
Ash	10.5	9.6	10.0	9.9
Crude fiber	2.0	2.9	3.1	3.1
Calcium	0.81	0.70	0.76	0.78
Phosphorous	0.91	0.93	0.93	0.92
Methionine	0.69	0.58	0.68	0.60
Lysine	2.32	2.30	2.20	2.20
Threonine	1.55	1.54	1.54	1.54

*FOB prices in US dollars, NE Brazil. **analysed values, dry matter basis. Source: Nofima Biolab (Fyllingsdalen, Norway).

Table 2. Final performance (mean ± standard deviation) of *L. vannamei* fed graded levels of krill meal in fish meal-challenged diets under high salinity culture. Different letters indicate statistically significant differences between dietary treatments according to Tukey's HSD ($P < 0.05$).

Performance	Feeds			
	Control	1% Krill	3% Krill	5% Krill
Final shrimp survival (%)	95.1 ± 4.5	96.5 ± 2.4	96.2 ± 2.6	96.9 ± 2.2
Final body weight (g)	8.14 ± 1.07a	7.81 ± 1.28b	7.96 ± 1.15bc	8.11 ± 1.18ac
Daily weight gain (g)	0.10 ± 0.01	0.09 ± 0.01	0.10 ± 0.01	0.10 ± 0.01
Gained yield (g/m²)	656 ± 33	631 ± 45	648 ± 52	667 ± 31
Feed delivered (g/shrimp)	9.57 ± 0.23a	9.23 ± 0.30a	8.66 ± 0.29b	8.64 ± 0.26b
Feed conversion ratio	1.46 ± 0.08a	1.49 ± 0.10a	1.34 ± 0.09b	1.30 ± 0.05b

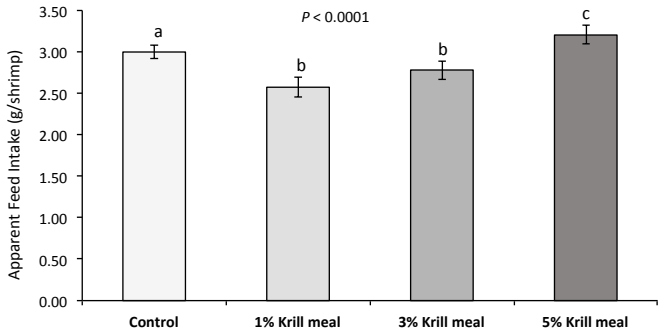

Figure 4. Apparent feed intake (AFI, g of feed/stocked shrimp) of whiteleg shrimp fed four diets simultaneously.

Conclusions

The present study showed that under high salinity a reduction of fish meal by half (from 15 to 7%) and of other costly ingredients (squid meal, cholesterol, fish oil) can be compensated for by a 5% dietary inclusion of krill meal. Feed efficiency is enhanced starting at a 3% dietary inclusion of krill meal even under high salinity conditions. A feed containing 5% krill meal and 7% fish meal is more palatable than a feed with 15% fish meal and 1% squid meal. Reduction of fish meal from 15 to 7% with the inclusion of 5% krill meal results in a 7% savings in formula costs in a grow-out feed for the whiteleg shrimp.

Alberto J. P. Nunes (left) Hassan Sabry-Neto (middle) and Esaú Aguiar Carvalho

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Genetic improvement and effective dissemination of improved Nile tilapia strain in Bangladesh

By M. Gulam Hussain, AHM, Kohinoor, M. Moshiur Rahman, M. Zillur Rahman, Abdullah Al Masum and Nguyen Hong Nguyen

GIFT strains and development of a hatchery industry contributed to the 19.5 times increase in tilapia production since 2005.

Tilapias have been proved recently as important and potential species for aquaculture throughout the South and Southeast Asia including China, Middle East, Africa and South America regions. During 1999 to 2015 there has been a tremendous progress in tilapia farming in Bangladesh. FAO (2016) reported that in 2014, Bangladesh ranked third after China and Indonesia among the top eight tilapia producing countries in the Asia-Pacific region. Production increased from 2,140 tonnes in 1999 to 377,346 tonnes in 2016.

A large hatchery industry

Meanwhile >400 tilapia hatcheries and > 15,000 small, medium and large commercial tilapia farms have been established all over the country. These hatcheries are producing >5.0 billion monosex fry every year. The majority of these fry are used for commercial farming in the country, and there is a report that >150 million tilapia fry and fingerlings are sold to farmers in the neighboring countries such as India and Nepal. The introduction of the Genetically Improved Farmed Tilapia (GIFT) strain of Nile tilapia (*Oreochromis niloticus*), provided in 1994 by WorldFish (formerly ICLARM) under the Dissemination and Evaluation of Genetically Improved Tilapia in Asia (DEGITA) project and a second introduction in 2005 from Malaysia led to the development and continuous improvement of strains by genetic selection at Bangladesh Fisheries Research Institute (BFRI). This was followed by dissemination of these improved strains and adoption of low cost and appropriate breeding and aquaculture technologies in a large number of tilapia hatcheries and farms. Within a span of 12 years (2005-2015), tilapia production increased more than 19.5 times in Bangladesh, from 19,268 tonnes in 2005 to 377,346 tonnes in 2016 (Figure 1).

Nevertheless, in private hatcheries, repeated use of the same parent population led to poor brood stock management. Additionally, no new or poor brood stock replenishment resulted in the production of inferior quality seeds and genetic drift in hatchery population inhibiting sustainable tilapia production. To mitigate the existing situation, during 2005 – 2015, BFRI conducted a well-designed family selection research in BFRI's closed tilapia breeding nucleus and during 2012 – 2016 WorldFish, Bangladesh and South Asia joined to establish and run outdoor Tilapia Breeding Nuclei (TBNs) at private sector tilapia hatcheries in Bangladesh.

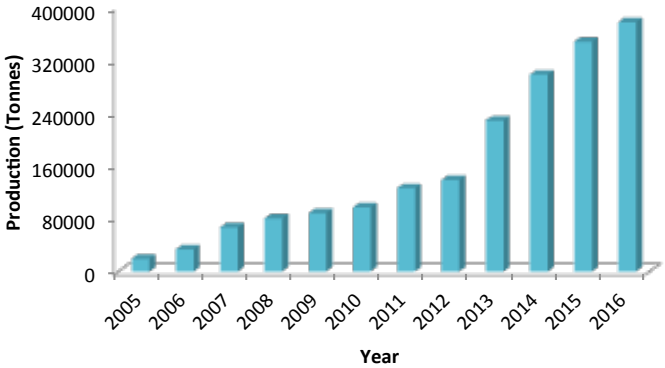

Figure 1. Tilapia production over the last 12 years (2005 – 2016) in Bangladesh

Genetic selection program at BFRI closed nucleus

At BFRI, in a closed nucleus of Nile tilapia (*Oreochromis niloticus*) genetic selection program was conducted to manage genetic gain and inbreeding over the 10 years from the establishment of the founder stocks in 2005 to the latest generation in 2015. In March 2005, the founder stock introduced from Jitra Station, Malaysia through the WorldFish Center to BFRI, which included 300 fingerlings from 30 families (10 fish/ family) of the GIFT strain. During this period (2005 -2015) progeny of each generation were produced (including the assembly of the founder stocks in 2005 and base generation in 2007) from 60 sires and 60 dams. The average harvest body weight of the population was 187g. The survival rate was rather high over the grow-out period of about 6 months (90.4%). In this study, genetic gain was measured as estimated breeding values (EBVs) for each generation of selection. Relative to the base population, the gain achieved after nine generations of selection was 36.6%, averaging 4% per year or generation (Figure 2).

Maintenance of genetic diversity

The selection program also successfully managed inbreeding to an average rate less than 1% per generation. The population still shows substantial genetic diversity, indicating that family selection effectively increased genetic gain and managed inbreeding in the present population of Nile tilapia in Bangladesh. Hence, there is scope for future selection to improve growth and other traits of economic importance.

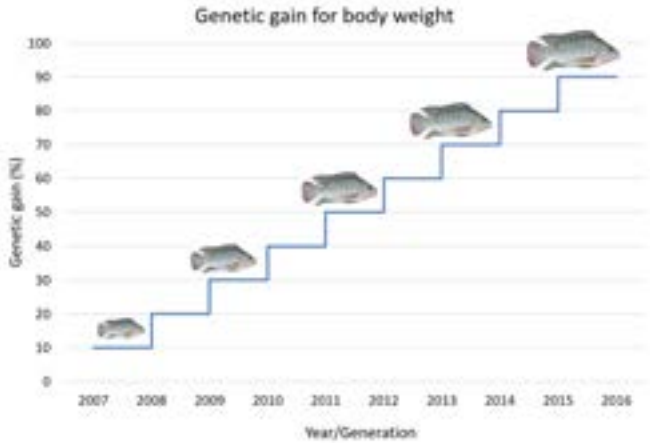

Figure 2. Genetic gain achieved from the selection program for harvest weight in GIFT strain of Nile tilapia at BFRI.

Breeding hapas at a closed breeding nucleus at BFRI, Mymensingh, Bangladesh

Tilapia egg incubation system in a commercial hatchery in Bangladesh

Outdoor Tilapia Breeding Nuclei (TBNs) of WorldFish

From 2012 to 2016, WorldFish, Bangladesh and South Asia established a number of Tilapia Breeding Nuclei (TBNs) under RFLDC/DANIDA, Aquaculture Income for Nutrition (AIN) and CSISA-BD projects. They used the 11th generation of the improved GIFT strain collected both from Jitra Station, Malaysia and Freshwater Station, BFRI, Bangladesh. A total of seven TBNs was successfully established and run in seven small, medium and large scale commercial private hatcheries in Jessore, Narail, Bagerhat, Barisal, Rangpur and Mymensing regions of the country. Both selective breeding and rotational breeding techniques have been applied in these TBNS to produce generation wise improved GIFT fry (Figure 3 and Figure 4).

In 2016, a total of 2.36 million improved GIFT fry were produced and distributed/sold from these TBNs among 47 tilapia hatcheries in Rangpur, Jessore, Narail, Fardidpur, Khulna and Barisal regions. In 2017, the target of these TBNs is to produce >3.0 million of improved GIFT fry and distribute among 70 multiplier tilapia hatcheries in southern, northern and greater Mymensingh regions as well as beyond.

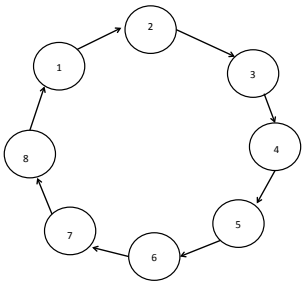

Figure 3. Rotation of males for generation 1, 3, 5 and so on

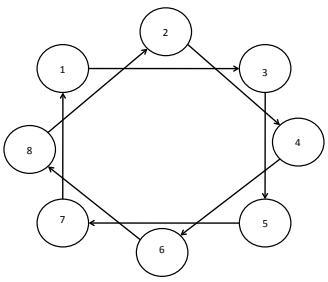

Figure 4. Rotation of males for generation 2, 4, 6 and so on

Future directions

Both BFRI and WorldFish, Bangladesh and South Asia will continue setting up a number of Satellite Breeding Nuclei (SBNs) in remote regions of Bangladesh to increase both quality and quantity of commercial seed production. Strengthening the genetic improvement program in particularly at BFRI will further promote sustainable production of tilapia in Bangladesh. Public and private hatcheries will act as the multipliers for dissemination of high quality brood stocks to adapt with a wide range of tilapia farming systems of the large group of grow-out farmers in the country. This novel attempt undoubtedly will enable most of the tilapia hatcheries located in all the regions to produce high quality tilapia seeds using these improved GIFT fry/brood stocks for continuing the sustainable progress of rapid expansion of tilapia farming in Bangladesh. It is expected that tilapia production could increase to 1 million tonnes by 2030 provided overall production system management, genetic selection and effective dissemination pathways remain perfect.

Acknowledgement

This is an update of an article recently published in Global Aquaculture Advocate (https://www.aquaculturealliance.org/advocate/bangladesh-tilapia/)

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Shrimp and tilapia genetics services at APA 2017

From left, Jørn Thodesen, Akvaforsk Genetics; Amorn Luengnaruemitchai, Managing Director of Manit Farm, Thailand; Birgitte Sørheim, Marketing Director, Benchmark Breeding & Genetics; Hernan Pizarro and Hideyoshi Segovia-Uno, Operation Manager Spring Genetics, and Oscar Hennig

Genética Spring and Spring Genetics from Benchmark Holdings' Breeding and Genetics Division were at Asian Pacific Aquaculture (APA 2017) held in Kuala Lumpur, Malaysia. Teams from both companies held a workshop and gave presentations on their shrimp and tilapia genetic programs to industry in Asia. The genetics programs of both companies are designed and supervised by a sister company Akvaforsk Genetics, located in Sunndalsøra, Norway. Genética Spring continues to expand the pioneering shrimp breeding program initiated by CENIACUA in Colombia in 1997 from the two sites; Punta Canoa on the Atlantic coast and Tumaco on the Pacific coast.

Established in 2009, Spring Genetics operates a 'combined family' and 'within family' based selective breeding programs for the Nile tilapia *Oreochromis niloticus*. The state of the art breeding nucleus is in Miami, Florida and it has multipliers and distribution centres in Latin America. It distributes fry and fingerings from hatcheries in Mexico, Central America and Brazil. On brood stock development, it works with franchisees and multiplication agreements. Hernan Pizarro, Commercial Director, Spring Genetics and Oscar Henning, Operations Director, Benchmark Breeding and Genetics discussed some recent developments.

"Spring Genetics has gone through 17 generations of selection, where of 6 new generations after the program was moved from Nicaragua, Vietnam and the Philippines (GIFT). The aim of our tilapia breeding programs is to improve the most relevant commercial traits such as growth rate, feed conversion ratio (FCR), disease resistance, fillet yield and robustness. In South America, we have developed fast growing strains, as fast as 1 kg in 6-7 months. In comparison, the common growth rate was only from 1 g to 1 kg in 8-9 months. FCR has improved too. In Latin America, we are very concerned on fillet yield," said Pizarro.

"Using the most advanced genetics methods in combination with our family breeding program, we have been able to produce brood stocks with proven high tolerance to *Streptococcus* in 2016. This followed our previous generation with high tolerance to *S. iniae* in 2015," said Pizarro. "In the case of tilapia lake virus (TiLV), it will be possible to use genetics to develop resistant strains. However, what is known is that the black or Nile tilapia is more resistant to the virus than the red strain. In the meantime, enhanced biosecurity at the hatchery level should be implemented and governments need to be strict on the movement of stocks."

Hennig, based in Hawaii, presented on the achievements to date at Genética Spring with *Litopenaeus vannamei* and its applications for the industry in Asia. "Asian hatcheries depend on SFP brood stocks, poorly adapted to local conditions and repeatedly exposed to new epidemics. To break this vicious cycle, it needs deployment of populations resistant to endemic diseases and lines selected for superior performance under specific conditions."

Hennig described the work at Genética Spring's two sites. "Since 1997, using in-between and within-family selection, we develop the Atlantic line for TSV, NHP and vibrosis resistance. The founder stock comes from eight countries. Since 2013, we selected on growth and general pond survival. This became our base line. Currently we are preparing for the 14th generation.

"The Pacific line, based on mass selection is our WSSV-resistant (SPR) line; we are currently preparing for the 9th generation of this particular line. In Bogotá, Colombia, we conduct single pathogen challenge testing for WSSV, TSV and AHNPD.

Combining the SPF and SPR approach we have successfully bred *L. vannamei* populations with high levels of resistance to major diseases affecting the shrimp industry today such as: WSSV, IHHNV, NHP, TSV and mild vibriosis.

"Crossing WSSV-R Line and Base Line stocks, we developed hybrid family lines with both characteristics, WSSV resistant and fast growing. Field trials showed robust shrimp with growth to 9.6 to 9.9 g at days of culture (DOC) 60 and 19.2-19.5 g at DOC 100," added Hennig.

"The strategy of Benchmark Holdings is to work on the different needs of the industry. Our post larvae are locally adapted to the different environments. Our strength is that we have the genetic diversity as others cannot afford to do so. When we encounter a new environment, we pull out from the gene bank and develop new lines. For example, for the post larvae farmed in low salinity, we will use genetic and environmental selection to adapt or select lines for the environment of that country."

On the expansion into Asia, both companies are looking at partnerships to develop markets. Partners need to have the same vision as Benchmark Holdings; it is not to sell fish/shrimp but focus on the total management of the species and partner with local farmers.

E-commerce in aquaculture products & farmed seafood

By Norlyana Mohamad Termidzi

This is the new route to market and is fast developing.

E-commerce in seafood is moving very fast, particularly in China's Tier 1 cities. The ability to click a link, place an order, and receive goods quickly, is of great interest to Chinese consumers, leading to higher sales of fish and seafood. In fact, China's online seafood sales grew 300% in 2016 and are expected to repeat this monumental growth in 2017, according to food-exhibitions.com.

The giants in e-commerce

In China, marketplaces rather than standalone websites, such as Microsoft and Apple, dominate the e-commerce industry. As explained in 'An Introduction to E-Commerce in China' by Sovereign (China) Limited, "An e-commerce marketplace is a platform where products are listed by multiple parties and the transactions are facilitated and processed by the marketplace operator" (Sovereign (China) Limited, 2016). Jack Ma's Alibaba Group dominates the Chinese e-commerce industry through Tmall.com (formerly known as Taobao Mall) and Taobao, the company's largest business-to consumer (B2C) and consumer-to-consumer (C2C) platforms, respectively. (See box on Alibaba's Hema experience).

During Q1 2017, Tmall and Taobao ruled China's online retail market with a combined percentage of 80.5% and over 570 million active users. The e-commerce industry in Tier 1 cities like Beijing and Shanghai may be well developed compared to their lower counterparts, but a surprising fact is that China's lower tier cities (2, 3, 4 and 5) have the potential to outspend the higher-tier cities, as they spend more of their disposable income shopping online via social media or apps such as WeChat. The lack of physical retail infrastructure and variety of products in the lower-tier cities would be beneficial to the e-commerce industry, as it can work together with different retailers to reach far away cities where it is too costly to set up physical stores.

The American e-commerce company, Amazon acquired Whole Foods for USD 3.7 billion in August 2017. Since then, the major grocery chain has undergone many changes under Amazon's supervision, one of which was the immediate slashing of prices on selected best-selling products, including responsibly farmed tilapia and salmon. In seafoodsource.com, Jeff Wilke, CEO of Amazon Worldwide Consumer, said Amazon Prime and Whole Foods Market will have a customer rewards program and continue to lower prices.

Other giant brands, namely Tesco and Wal-Mart are also expanding into e-commerce in hopes of increasing their profitability in the food and grocery industry. Tesco in the UK, for example, offered a mobile application and a website to customers so they could order their groceries online via mobile phone or computer and collect their purchases from the stores. In 2010, Tesco had a plan of making web ordering and delivery available to major cities in Czech Republic, which lead to plans of expanding overseas into China, India, Malaysia, South Korea, Thailand, Hungary, Republic of Ireland, Turkey and the United States. By way of standardizing the Tesco websites across the different countries, they came up with a template of an e-commerce platform that abides by the various laws of each region regarding the storage and usage of consumer data. In Malaysia, Tesco was the first to introduce online grocery shopping and it is expected to grow with an online shopping growth of 18% each year.

Wal-Mart CEO Doug McMillon said that they would be combining their stores' accessibility with e-commerce to provide customers with a new shopping experience. The company's online sales went up to 60% during the second quarter of 2017 and its e-commerce business is expected to grow by 40% in 2018. To expand their e-commerce presence overseas, they launched new websites in China and Latin America.

The push factor

With the current generation too busy, retail hypermarts are investing large amounts of resources to reach the segment with no time to shop by coming up with new ideas and innovations that will make their lives easier. Amazon with their technologically advanced and cashier-less stores, Amazon Go, is trying to tap into that particular segment by letting them purchase items without having to queue and check out for their items; all they need to do is 'just grab and go'. Customers are only required to use the Amazon Go app on their mobile devices to enter the store, grab the things they want (which will be automatically added to their virtual cart, then charged to their Amazon account) and 'just go'.

Seafood producers, fishermen and farmers, everywhere are trying to cut out the middleman (or processors) so they could increase profit margins by selling directly to consumers. This is because the processors usually decide unilaterally how much the latter's products are worth.

The pull factor

Millennials are known to be tech savvy and are often said to be dependent on their mobile devices to get things done, which also means that they are accustomed to online shopping. Before making their purchasing decision, millennials usually visit stores to look at the product, then they go online to compare prices, read written reviews and look for discount coupons, as they want the best yet cheapest option. With that said, this concept can be applied to purchasing products ranging from electronics to food and groceries.

Now, we live in a time where it is important for things to be fast, cheap and easily accessible for people who have no time, i.e. the won't cook/can't cook– looking for tv dinners group. This group find it unnecessary to learn how to cook as they can simply dine out or buy ready-made food like TV dinners, which only requires them to buy, reheat, and then eat. This may be because many millennials are able to afford to eat out more than the generation before. Another factor could be that as women enter the workforce to help earn additional income, many millennials do not have a stay-at-home parent to teach them the basic survival skills to live on their own.

Products

In July, German supermarket chain, Aldi introduced lower-priced seafood, causing enormous pressure on upscale grocery chains to lower their seafood pricing as well. Whole Foods responded by starting '365 by Whole Foods' and lowering its seafood prices. With regards to the sales of seafood, Whole Foods' CEO, John Mackey mentioned that the grocery chain will possibly run various limited-time offers, which include 'pre-portioning of fresh and frozen seafood into meal-sized portions for one, two, and three people'. They will also sell seafood poke bowls in certain stores as a weekly meal special. Amazon offers a free delivery service (for Amazon Prime members only) for seafood meals through Amazon Prime Now, which 'has the potential to revolutionize how seafood is sold in the United States'.

Steven Johnson from Foodservice Solutions added, "More people will be exposed to fish than ever before. More consumers will be able to buy fresh fish". Aside from its current activities, Amazon is going a step further by working on the idea of providing non-refrigerated, pre-cooked meals to consumers by 2018. "Amazon's ready-to-eat meals would be made possible by preservation technology pioneered by the military to provide food for troops called microwave-assisted thermal sterilization, the system uses microwaves to eliminate bacteria while also sealing the meal to prevent any contamination". The pre-cooked meals by Amazon will have a shelf life of 12 months.

With increasing demand for seafood, Alibaba has teamed up with Thailand's seafood giant, Thai Union. This is to directly provide consumers with the highest quality seafood products, by Chicken of the Sea via Tmall, China's major food e-commerce platform. Faisal Sheikh, Thai Union's Managing Director of Emerging Markets commented, "Chinese consumers are increasingly discerning and demanding, putting a premium on safety and quality when shopping for fresh and chilled seafood, such as lobster, shrimp and salmon". Alibaba added, "Sellers of food products on Tmall have access to the Cainiao Network, Alibaba's logistics affiliate, which gives them same day and next day delivery in more than 1,100 countries and districts in China".

Traditional hypermarkets *vs* e-commerce

With the growth of online shopping and e-commerce around the world, there is a misconception that brick-and-mortar stores are obsolete since everything, from purchasing everyday items to conducting business, is being done online. However, the truth may be the complete opposite as stores are not fading out of existence, but adapting to the current environment to give consumers a different shopping experience. Ken Morris of Boston Retail Partners said, "Stores are no longer stores, they are distribution points for products". For consumers, whether it is shopping online (e-commerce) or in physical stores, it is simply known as 'commerce'. To survive and thrive, companies 'need to fully embrace a one brand, many channels strategy'.

References are available on request

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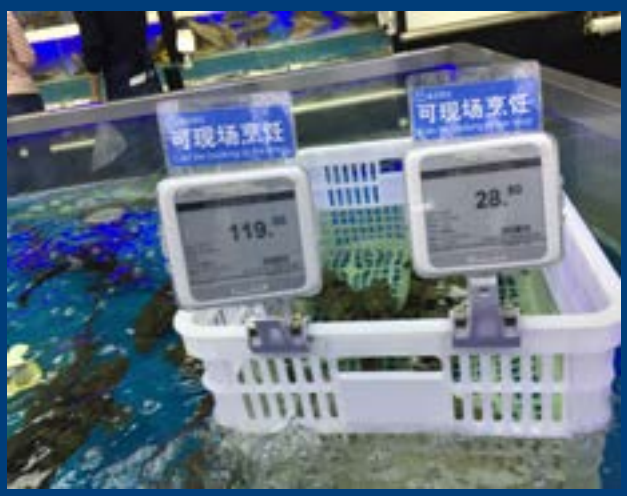
Merger of online and offline shopping

Top left corner, the conveyer system used to collect the products for packing and delivery at a Hema supermarket in Shanghai

Alibaba has merged the experience of physical shopping with an online experience. Its HEMA supermarkets with 30 locations country wide cater for all groups of shoppers: the tech savvy millennials who cannot/will cook but still want the experience of choosing their food, the older generations who want to see what they are buying, and the online shopper. It is a unique shopping experience. Of particular interest, is the range of seafood available at a store in Shanghai. In China, choosing live crabs/fish or shrimp is part of the culture. At HEMA, customers download an app, scan the product and get details such as provenance. Then they pick the seafood and pay with Alipay. Next is either to have it cooked and dine onsite or have it delivered to the home or office. At home, customers can order online and Hema staff will collect and pack the products. Delivery is around a 3-km radius and takes 30 mins. (alizila.com)



Various groupers at a Hema branch in Shanghai

Pioneering e-commerce platform for Malaysia's seafood industry

Steven W.K. Lee (centre) and Jacky Lim (right) at a Selangor Invest exhibition

In Malaysia, retail of seafood is via traditional wet markets, mini markets, hypermarkets or at fishing villages. In 2017, Steven WK Lee and Jacky Lim, started an e-commerce platform. With 25 years of experience in aquaculture and in the seafood retail trade, the team is marketing premium seafood. "With just a-click away, Malaysians can now easily buy or sell seafood and related products," said Lee.

Seafood Malaysia Marketplace provides to sellers and buyers a range of facilities. For sellers, it offers a zero-entry cost package to sell their products to a larger market and thus, the opportunity to increase presence through ongoing market promotion events and targeted advertisements, both online and offline media. It provides pick-up and delivery services as well as a secured payment gateway. These facilities mitigate current problems faced by sellers such as high cost in maintaining a physical retail stall, lack of marketing knowledge, transportation issues and billing issues.

Made in Malaysia

For consumers, Seafood Malaysia Marketplace assures that they are buying high quality seafood. All suppliers are vetted, and all products comply with stringent requirements. Seafood is sourced mostly from local Malaysian farms and fish is kept alive at their holding facility/ farm and harvest only upon receiving orders. Seafood will be cleaned, gutted, frozen and delivered to consumers in a refrigerated truck within 2 to 3 days. With this arrangement, freshness and quality are assured.

Lee believes that Seafood Malaysia Marketplace will spur the e-commerce in business for farmed and wild caught seafood in Malaysia. Consumers can rate the quality of suppliers' products and their level of work ethics to gain confidence to buy seafood or related products via internet. Suppliers will also be more vigilant to ensure that their products are of high quality. Adverse remarks on the web would greatly affect their reputation and future sales in both their online and offline businesses.

The shopping experience is important in e-commerce especially for a specialized marketplace. To be a focused and integrated platform, the team has worked hard to continuously secure more suppliers from other related products such as ornamental pet products, aquaculture equipment, fish fry, ready to cook seafood as well as aqua tourism to drive more traffic to the website. The team will continue its efforts to build new options and features to make this platform the best experience for users.

The response of this platform has been encouraging. Within 3 months of launching the pilot program, Seafood Malaysia Marketplace has already secured multiple suppliers and attracted more than 6,000 users. The team will continue to invest on advertising in both online and offline media as well as appoint more suppliers to create interest in this platform.

Transnational Foods Sdn Bhd, the company managing Seafood Malaysia Marketplace is investing and developing its IT infrastructure and system to expand coverage to Singapore and ultimately to other Southeast Asia countries including China. (seafoodmalaysia.com)

A seafood supplier for Seafood Malaysia Marketplace is Eco Blue Harvest located in Langkawi

Soon, an integrated online web platform in Indonesia

MINAPOLI is a new integrated online web platform in Indonesia focusing on the fisheries industry and related businesses. Rully Setya Purnama, CEO explained that the origin of the name, "Minapoli comes from the words mina which means fish, and poli means many. Minapoli equals to many fisheries stakeholders, fish production and even fish consumers." The project was started in May 2017. A soft launch is planned on November 21, 2017. Minapoli will be officially launched in February 2018.

There are visions for the company. "We aim to be number one and the biggest fisheries online platform in Indonesia within a year. Then, we will focus to be the leading fisheries online platform in Asia-Pacific within the next 3 years," said Rully.

The 3S for the company are synergy, strengthen and support. "We want to see the strengthening and expansion of the fisheries network for a better and stronger synergy between all stakeholders." Minapoli will support fisheries stakeholders to carry out their business; by promoting their products or to fulfill their business supply and demand. "We are also committed to educate users in aquaculture and fisheries. With regards to services, we want fast, effective, easy access and distribution process through our web-based application to connect our users with their selected business partners."

The reason for starting an e-commerce platform, arose from the challenges faced by the aquaculture and fisheries industry. According to the Minapoli team, a reliable facility to market fisheries products is not available. There is now a high cost for stakeholders to build and maintain their own website and to promote their products or services. Most aquaculture websites are not well maintained and with outdated information.

Premium segment and innovation in seafood at SIAL China 2017

Insight into what consumers in a Tier 1 city in China demand in seafood.

Catherine Lee (centre) with the Blue Archipelago Berhad team and distributors.

SIAL China is Asia's largest and the 4th biggest food innovation exhibition in the world. The 2017 edition was held at the Shanghai New International Expo Center from May 17-19. In 2017. organisers reported a record number of visitors, exhibitors and floor area. There were 3,200 exhibitors, 10% more than 2016. It covered more than 21 product sectors. In terms of seafood, it is small, with a small grouping of seafood producers and retailers. SIAL has been in China for more than 5 years and the focus is fine food, usually meat and wine.

The 5th edition of 'Seafood Fest' – Right Seafood Right Wine was held together by China Aquatic Products Processing and Marketing Alliance (CAPPMA), Global Aquaculture Alliance (GAA), Marine Stewardship Council (MSC) and Norwegian Seafood Council (NSC). With sessions dedicated to the 'right seafood' associate with "right wines", Seafood Fest' excited the palate with gourmet food products.

Sustainable seafood in the China market

The combination of certification body with seafood marketing demonstrated the new trend in China, to have sustainable and certified seafood for the middle and high-income segments of the society. As sustainability and certification are already the norm for salmon producers, marketing into China will not pose any problem. However, in the long term, CAPPMA sees that this should be a standard requirement for all seafood entering China.

Sustainably certified scallop by Zoneco and tilapia by China Hainan Qinfu.

Elvis Zhao at the Neptune booth marketing Selva shrimp

At the same time, it is working for local producers to be certified. Today, producing sustainable and certified products remain elusive for many players in China's farmed fish/shrimp industry. At SIAL there were a few local producers marketing sustainable and certified seafood, such as tilapia from Hainan's Qinfu Food.

Marketing premium shrimp

Blue Archipelago Berhad (BAB), an integrated shrimp farming business in Malaysia, was the only Asian seafood producer outside of China, present at SIAL together with its sole distributor. The focus was the PELAGOS shrimp brand, frozen head on shell on and value added with local spices. The latter is very popular in China and is available in premium supermarkets in Shanghai. "This is one of the products available through Alibaba e-commerce supermarket, Hema. It fulfils the demand of millennials who do not want to spend time preparing and cooking. They are willing to pay for this convenience," said Catherine Lee, Senior Manager – Sales & Marketing, BAB. "The product is less popular in Malaysia indicating the differences with our millennials from their counterparts in China. Our millenials usually stay with parents and do not need ready-to-eat preparations."

"Buyers and retailers market at different levels in China," said Elvis Zhao. At the Neptune booth, marketing the SELVA shrimp brand, Zhao said that they focus on selected premium buyers, i.e. those that can appreciate their unique product. The black tiger shrimp is farmed in Vietnam in mangrove ponds at a low stocking density. The shrimp, size 13/15 are packed in 500 g boxes. The company targets high-end supermarkets and restaurants in Beijing and Shanghai. "We do not sell online because an open availability of the product will dilute its uniqueness," said Zhao.

Pelagos head on shell on shrimp with three flavours is very popular in China.

According to Di Gang, CAPPMA expects China's consumers to change and demand seafood safety

CAPPMA envisions that in the future, local producers will reach standards set by international suppliers. It is working with WWF on Aquaculture Stewardship Council (ASC) certification. "We cannot push the government to have regulations. This pull will come from the demand and supply situation. We expect consumers to change and demand seafood safety, responsible and sustainable aquaculture as well as traceability. We can already see the trend with many Chinese producers changing as they target the EU and US markets. In particular, the tilapia producers in Hainan are doing well. Those in Guangzhou, Zhejiang and Guangxi are changing but at a slower pace," said Di Gang, Deputy Secretary-General, CAPPMA.

With regards to seafood, SIAL gave an insight into what a Tier 1 city, such as Shanghai demands as premium food. China is not a homogeneous market. SIAL is not a show dedicated to seafood, but it did demonstrate that whether meat or seafood, the message is premium, premium, premium. Provenance, traceability and quality create differentiation. Shanghai (population 28 million) and other Tier 1 cities with a growing affluence require not just seafood but premium seafood.

Trade at APA 2017

The three-day exhibition at the Asian Pacific Aquaculture 2017 (APA) was held from 25-27 July 2017, in Kuala Lumpur, Malaysia. The trade show had more than 170 booths. Exhibitors were from 20 countries led by Malaysia, Singapore, USA, Thailand and Taiwan. Products on display included complete feeds, feed ingredients and additives, health and diagnostic services, farming equipment and electronics, cages, tanks, liners, nets, pipes and fittings.

Gold Sponsor **Sheng Long Bio-Tech International Co Ltd** is a leading aqua feed supplier in Vietnam and also counts Malaysia and India as major export destinations for its shrimp feed. In 2016, it exported from Vietnam 15,000 tonnes of shrimp feed and 8,000 tonnes of feeds for the seabass and grouper to Malaysia. In India, Sheng Long exports almost 28,000 tonnes of shrimp feed, pending the completion of its feed mill north of Chennai. "India will be a highly competitive market as there are several new players from China such as Evergreen and New Hope," said Maple Hung, Vice President-Global Exports. Jeff Jie Cheng Chuang, General Manager, added, "Fortunately, Vietnam's shrimp feed market is back on track and demand in 2017 is higher than in 2016. The much higher shrimp price is encouraging farmers to start stocking for a second crop." www.shenglongbt.com

In Malaysia, Sheng Long supplies marine fish feed to Langkawi based **Fishance Berhad**, the most recent aquaculture business in Malaysia, pending its set-up of a 50,000 tonnes per year feed mill. At the Malaysian Farmers Day, Alexey Dorin, CEO highlighted the company's plans to develop Langkawi into a 'grouper industry hub', using a vertical approach, with an indoor hatchery, feed mill, farming in square and round cages and with the inclusion of processing facilities. On why the grouper, Dorin said, "Langkawi is unique and it is logical to focus on the production of quality groupers and grouper hybrids. There is also ongoing R&D on the second generation of hybrids to secure fast weight gain." The company has started production with 100 cages, and by 2019, aims to have 10,000 cages and produce various species of groupers and marine fish. It also plans to move further off shore with 20 and 60 m diameter round cages. www.fishance.com

Green Island Feed Mills Sdn Bhd's team and guests, from left; Allan Goh, Ahmad Hazizi Aziz (guest), Dato Goh Cheng Liang, Dr Roger Chan, Aqua Ceria, Liang Wu and Wen-Fu Tsai (right).

After a long absence at regional trade shows, Japan's **Higashimaru Co Ltd**, is now back, offering several types of larval feed for the marine shrimp (*vannamei*, *monodon* and *japonicus*) and marine fish. Products of several years in development, the company's larval feeds are recognized among users for their high quality and efficiency. www.k-higashimaru.co.jp

Based in Yokohama, Japan, **Feed One** is a new company formed at the end of 2015, but boasts a long history with its two predecessor companies, Kyodo Shiryo Co Ltd and Nippon Formula Feed Mfg Co Ltd. In aquaculture, the company will bring from Japan the pioneering technology in aquafeed production of Nippon Formula Feed. Some developments by the company include the move to reduce fish meal in its feeds since 2007. By focusing on constraints faced with the reduction of fish meal, the company said that it has achieved growth rates similar to traditional feed products. In future it will gradually reduce fish

The Sheng Long and Guangdong Hisenor team led by Jie-Cheng Chuang (fourth right) with speakers/chairpersons of the Shrimp Industry Session; from centre left, Dr Tran Huu Loc Nong Lam University, Vietnam; Dr Shi-Yen Shiau, Dr Grace Chu-Fang Lo and Dr Han Ching Wang, National Cheng Kung University, Taiwan and Dr Yu-Hung Lin, National Pingtung University of Science and Technology, Taiwan.

Daiji Koga, at the Feed One Co Ltd booth.

The THK team, from left, Tee Hock Seong, Tee Hock Koon, Tee Hock Keong and Tracy Tee

Raj Pillai, Associate Director and Steven Suresh (right) at the Gills n Claws booth with Professor Aziz Arshad, Universiti Putra Malaysia (centre).

meal levels with plant meals. In the 1980s, Nippon Formula Feed Mfg developed microencapsulated artificial plankton BP which was highly regarded in the black tiger shrimp hatchery industry in Taiwan. Production was suspended and now Feed One has upgraded the product and is bringing it back into the market. Two other products are Ambrose, taurine enhanced soft granulated feed for larval fish and PL-Feed designed for the kuruma shrimp. www.feed-one.co.jp

China's leading shrimp feed producer, Guangdong Evergreen Feed Industry is the latest entrant into the Malaysia's aqua feed market. By the end of the year it will be producing both shrimp and fish feeds with its joint venture partner, GST Sdn Bhd, a leading marine fish producer. The new feed mill **Green Island Feed Mills Sdn Bhd** will be based in Penang. It will produce floating and slow sinking marine fish feeds. It will also produce feeds for the monodon and vannamei shrimp. www.evergreenfeedindustry.com

Malaysian aquaculture supplier, **THK Sales & Service** was founded in 2002. This family company, set up by Tee Hock Koon has, over the years, expanded and improved its products to meet industry demands. It has been keeping abreast with technology as the industry expands. In Malaysia, Tee was the first to develop and introduce autofeeders to shrimp farmers. With a dynamic team, THK has now expanded into regional markets. Current product range includes a new generation of autofeeders, paddlewheels, water pumps, HDPE liners and LDPE sheets. The company also provides consultations in designing and constructing farm structures. THK also provides services such as construction of HDPE nursery/culture tank and liner installation. www.thk.com.my

Singapore based **Gills n Claws Aquaculture Pte Ltd** is a market leader in the farming of mud crabs. The business started in 2009 with R&D which was completed in 2014. Today, it carries out the fattening of crabs hatched in Sri Lanka at its vertical farming facility at the crab farm in Kranji. At full capacity, the farm can rear 40,000 crabs at one go and produce about 200 tonnes/year. At the booth, Steven Suresh, CEO, was there to offer business opportunities to farmers interested in mud crab farming. "There is a growing demand for mud crab in the Asia Pacific region. We are one of the leading suppliers of fresh mud crabs and fish to Singapore restaurants and supermarkets." gillnclaws.com

Participants from Malaysia and India; from left, Thanabal; Giva Kuppasamy, GK Aqua Sdn Bhd; S. Santhana Krishnan, Marine Technologies; and Sandip Ahirrao, Growel Feeds Private Limited, India.

Yosuke (Yoshi) Hirono (centre) and team at the Higashimaru booth. On the right is Satit Phanich, Marine Leader, Thailand

From left; Tan Boon Fei, Ning Shinny Widjaja, Jimmy Wichawet, Kemin Industries, Singapore and Thailand with Benjamin Dong, Guangzhou Nutriera Biotechnology Co. Ltd, China (second right)

Launch of products to support tilapia farming in Thailand

Amorn Luengnaruemitchai and family (centre), Saran Kayankarnnavee (third left), Olivier Decamp and Mario Hoffmann (centre, top row).

In September, **Manit Farm** organised a major commercial event for the Thai tilapia industry. The occasion was to introduce farmers to the partnership between Manit Farm and INVE Aquaculture, signed earlier this year and to launch new product lines. It was attended by 450 farmers and their families from all over Thailand. The half day program included technical presentations and a dialogue session on challenges faced, from fish health to financing.

Amorn Luengnaruemitchai, Managing Director, Manit Farm, the second generation in this family business, led the day's program. Managers from both companies attended the event, Wilawan Harsup, CEO of Manit Farm; Mario Hoffmann, Regional Key Account Manager and Saran Kayankarnnavee, Area Manager Thailand, INVE Aquaculture.

Manit Farm is among the top three tilapia breeding and hatchery companies in Thailand providing fry and fingerlings to farms in Thailand and the region. Thailand's tilapia production is estimated at 250,000 tonnes annually, mainly from cage farms in river systems. The company supplies high quality tilapia fry (Superblack Nile tilapia and Superred red tilapia) with attributes of high survival rates and fast growth. Both strains were developed at the Genetics Center established in 2007 with the collaboration of Akvaforsk Genetics Center from Norway (now part of the Breeding and Genetics Division, Benchmark Holdings). Now, in collaboration with aqua feed producer, Lee Pattana PLC, Manit Farm has formulated a special feed for fry to optimize growth in the hatchery. Next, the objectives are to bring out the potential of both the tilapia strains during grow-out in farmers' farms, and also to produce grow-out feeds.

In the panel discussion, from left, Dr Win Surachetpong, Khun Amorn and farmer, Khun Sukan Klin-puang.

Bringing science to industry

The two key speakers were Dr Wara Taparhudee and Dr Skorn Koonawootrittriron. Both are attached to Kasetsart University. Khun Wara introduced his 'Fish Smart Kit', an app (now only on android) which will help farmers with advice on farming situations depending on parameters such as water temperature, pH, dissolved oxygen etc. It will also calculate the best price based on stocking density and performance. He will be developing an iphone version soon. Khun Skorn discussed 'omics technology' in the tilapia. In discussing genomics, he commented that the cost per genome has been reduced drastically such that research into genome of various tilapia can be carried out cheaply.

Dr Olivier Decamp, INVE Aquaculture's Product Manager Farm & Feedmill presented on probiotics in tilapia farming. Decamp discussed aspects from nursery to critical stages during grow-out. In particular, he emphasized on the control of waste to prevent algal blooms and fish losses. He gave examples on work done in Thailand on ammonia concentrations at different water depths. There was also a discussion on gut health and the need for villi health to facilitate absorption of nutrients. Decamp also detailed the benefits of selected *Bacillus* sp. Together with Manit Farm, INVE Aquaculture is distributing probiotic lines for pond water (Secure Pond) and to coat feed (Secure Yield). Khun Amorn explained the economics of using these probiotics and how farmers should focus on CFU units on the label of probiotics and not just on cost/kg of probiotics.

Key issues

These are the management of water and sediment quality or the benefit of microbial additives on growth and survival. The program also included testimonials from farmers, and discussions on major issues faced by Thai tilapia farmers. In the panel were Dr Win Surachetpong, Kasetsart University, an expert on tilapia lake virus (TiLV), Khun Amorn and farmer, Khun Sukan Klin-puang.

The key message to the farming community was: a cost-efficient production of quality fish requires the combination of fry genetics, quality feed, biosecurity measures and specific management protocols. www.manitfarm.com; www.inveaquaculture.com

One Disruption Dinner

During APA 2017, the Alltech Malaysia team organized a by-invitation dinner for industry. The aim was to explore disruptive ways to improve the aquaculture business. The evening started with an introduction by General Manager, Alltech Malaysia, Henry Wong on some updates at Alltech such as the acquisition of Coppens International, a premium feed company based in the Netherlands complete with a well-recognized R&D centre on aqua feeds technology and ingredients and projects to reduce mineral pollution.

Presentations were by Asia Pacific Mineral Manager, Tara Tiller and Dr Renato E. Kitagima, responsible for the research alliance between Alltech and Kochi University on formulating sustainable diets incorporating Alltech products in Japan.

According to Kitagima, trends indicate that certified fish and feed will become more popular in the market as big retailers and young consumers care more about how their food is produced. "The Tokyo Olympics will demand seafood certified to ASC (Aquaculture Stewardship Council) standards." The industry will need to face fishmeal/fish oil replacement challenges by using sustainable ingredients or byproducts. With plant proteins and oils, a constraint will be feed with lower levels of omega-3 fatty acids (DHA and EPA), selenium and taurine. Alltech has the solutions with organic trace minerals (Bioplex® and Sel-Plex®) and DHA algae (FORPlus™) which not only provide good fish growth but enrich fish with DHA or selenium when necessary.

At the Alltech Disruption Dinner, Renato E. Kitagima (left) and Sean Tang, TSK.

The synergy with Coppens allows Alltech to promote innovation such as algae, yeast fermentation, enzymes and Bioplex organic trace minerals to the aqua feed sector. It can deliver these technologies to farms, thus improving fish health and profitability for farmers and aquaculture producers. Products mentioned were Bio-Mos®, Actigen®, Aquate® to help farmers reduce the negative impacts of parasites and bacterial diseases. They do this by increasing mucus production, and improving the development of intestinal villi.

Aqua Culture Asia Pacific in 2018

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Issue focus *Trending issues and challenges for the next step*	Nursery Technology	Health Management	Sustainable & Responsible Aquaculture	Disease Management	Genetics & Genomics	Integration and supply chain
Industry Review *Trends and outlook, demand & supply*	Marine Shrimp	Marine Fish	Aqua Feed Production	Tilapia	Monodon shrimp	Catfish/General Freshwater
Feeds & Processing Technology *Technical contributions from feed industry*	Fish meal Replacements Feed Enzymes	Feed Additives Fish oil replacements/ omega 3 oils	Extrusion & Processing Functional Feeds	Lipids & Minerals Nutrition	Feed Safety and Hygiene	Functional Feeds
Production Technology *Technical information and ideas*	Controlled systems/ RAS	Finfish Industrialisation	Hatchery Technology	SPF/SPR/SPT shrimp	Post-Harvest Technology	Organic Aquaculture
Market and product developments, market access, certifications, branding, food safety etc)	Shrimp	EU	Tilapia	China	USA	Catfish
Aqua business *Feature articles*	Experiences from industry and opinion article covering role models, benchmarking, health management, SOPs, social investments, CSR, ancillary services, self-regulation etc					
Company/Product news	News from industry including local and regional trade shows					
Deadlines for Technical articles	**November 17, 2017**	**January 19**	**March 16**	**May 18**	**July 13**	**September 14**
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Show Issue & Distribution at these events as well as local and regional meetings ****Show preview***	**Aqua India 2018** Feb 2-3 Chennai, India **Vietnam Aquaculture 2018** March 14-16, Ho Chi Minh City **Victam Asia** March 27-29, Bangkok, Thailand	***Asian Pacific Aquaculture 2018** April 23-26, Taipei, Taiwan **Seafood Expo Global 2018** April 24-26 Brussels, Belgium		**Aqua 2018** August 25-29 Montpellier, France ***TARS 2018 Shrimp Aquaculture** August 15-16 Chiang Mai, Thailand **Vietfish 2018** August 22-24 Ho Chi Minh City, Vietnam		

Launch of innovation in intensive shrimp farming in Vietnam

Ribbon cutting at the launch. From left, Neovia CEO Hubert de Roquefeuil, Christophe Guillaume, General Manager, Neovia Vietnam, Tran Cong Khoi, Deputy Director, Directorate of Fisheries, Vietnam, Thomas Raynaud, Marketing and Technical Director, Neovia Vietnam and Eric Nojac, Vice President, Neovia Asia.

In September, **Neovia Vietnam** officially launched BIOSIPEC (or Bio-Security Intensive Production Environmental Control), an innovation in intensive shrimp farming. The project is a tool from Neovia, a world leader in animal nutrition and health, to innovate shrimp farming in Vietnam with a focus on biosecurity, water treatment, aeration, feeding and digital technology. This new project reinforces Neovia's commitment to a sustainable development of shrimp aquaculture in Vietnam. The farming concept was introduced to distributors, suppliers, farmer clients and local officials after an on-site ribbon cutting ceremony.

Neovia CEO Hubert de Roquefeuil who officiated the launch of the pilot scale farming project, said, "Neovia is in the science to feed the human population. In 10 years, the demand for fish protein will rise and aquaculture must meet this demand. This is the reason for countries in Asia investing in aquaculture. This is also the reason why Neovia is also investing in new technologies in aquaculture. At the group level, Neovia is investing in innovation-based tools (big data and digital technology). Today, consumers are very discerning and demand traceable products and that the production should not use any medications or chemicals. Our research team is responding to this demand. Through this project we are investing in the farm for the future, connecting the animal, pond, environment.

"Intensive shrimp farms as we see all over Asia today, cannot respond to the future needs of the industry. We have seen a similar trend in terrestrial animals which has moved towards super intensive farms using knowledge of genetics, nutrition, environment etc. Biosipec is the total solution we are offering for the shrimp industry in Vietnam. To reach this stage, we have combined competences within Neovia and our partners to come up with this solution."

Christophe Guillaume, General Manager of Neovia Vietnam added, "The target is to produce shrimp of the best quality by reducing stress during the farming process with good quality and well oxygenated water. Biosipec also responds to the demand of consumers: clean shrimp."

This Biosipec program was developed by Dr Raynaud, Marketing and Technical, working closely with the R&D team. Innovative technologies were:

- Mobile water treatment system to improve biosecurity
- Energy efficient aeration system to move water around and aerate water
- Sound feeding system to reduce feed conversion rate.

In its development, expertise from eight partners came together, some external and some within the Neovia group: Ocialis provided the starter and grow-out feeds; Bernaqua with special larval and nursery feeds; Qalian provided health and hygiene products; Acui-T developed the water filtration, aeration and water management; Upscience, an independent laboratory monitored disease and water quality; farm management software came from Inmyfarm; feed additives came from Pancosma and premix from Wisium. The feeding system used was from AQ1. (More details on the system on pages 17-20).

"This innovation differs from the traditional culture system in that we have water treatment to improve biosecurity and prevent diseases, low energy aeration systems and sound feeding to decrease feed conversion rate. The system with 3-phase culture up to harvested stock increases the number of cycles to 5 per year compared with only 2.5 cycles/year in traditional pond systems with direct stocking of post larval (PL10). The production can reach 30 tonnes/ha/cycle as opposed to 5 tonnes/ha/cycle," said Raynaud.

"Our idea is create a showroom for controlled shrimp farming. We have been running this for over 6 months and we are now ready to promote this type of farming in India, Indonesia, Mexico, Brazil, Australia, Myanmar and Philippines." www.ocialis.asia

Strategies to become a total aquaculture company

On the sidelines of the launch, Patrick Waty, Head, Aquaculture Business Unit, Neovia, and General Manager, Bernaqua, discussed the aquaculture division's acquisitions as it moves to be a total aquaculture company. "Although our core business is feed, we have decided to be present in the aquaculture value chain; from hatchery and maturation to feed production. This is our contribution to the industry. In terrestrial animal production, Neovia has developed competences along the value chain and this is the plan for aquaculture too.

"Within aquaculture, the group has developed its competence in grow-out feed (Ocialis), very well. By adding larval and maturation feeds (Bernaqua), we can then offer to meet all the requirements of the farmer. Then, to be active in aquaculture and offer total solutions, we need to know the rest. We then acquired Acui-T with expertise in aquaculture technologies. It can design hatchery, recirculation aquaculture systems or solutions with ozone and UV," said Waty.

"In aquaculture, disease remains a major threat in production and if we want to be active in aquaculture, we need to handle fish and shrimp health too. There are already solutions in the terrestrial arena which we can use in the future. We are developing the concept of mobile laboratories with simple analysis on the spot. We have one in the Amazonia and will launch one in Indonesia. In genetics, we are already working with one company where we are adapting the feeds to the grow-out lines, whether SPF or resistant lines, i.e. feeds formulated with additives which will come from within the group. It is important that we are making custom-made feeds for one type of growth line."

In 2007, Neovia (then Invivo NSA), began the acquisition of Bernaqua which was 100% completed in 2014. Neovia will continue the R&D in larval nutrition and feeds, at a global level in Latin America and Asia. In 2016, it acquired Aqui-T.

Patrick Waty (centre) with Hubert Crieloue, Bernaqua (right) and Thomas Raynaud, Marketing and Technical Director, Neovia Vietnam

"It has contributed to this project by developing an ozone regeneration and water treatment system, drawing upon its company experiences in NAQUA in Saudi Arabia. Here in Vietnam, we decided on a mobile system to save costs and make this a plug and play system for the farmer."

Inmyfarm has apps to help shrimp and fish farmers solve day to day issues. "This helps the farmer benchmark with his neighbours and also with neighbouring countries. This was launched in Mexico and Brazil and will come to Indonesia and rest of Asia soon. However, we will need to adapt to the different conditions here in Asia."

Waty reminded that Neovia Aquaculture has not forgotten the fish sector. It is the market leader for marine fish feeds in Vietnam and will continue to capitalize on its strength in the marine fish sector in Europe and bring over knowledge and ideas to further develop the industry in Vietnam and Asia. A new activity will be a RAS rotifer system in Vietnam. "This is the advantage of being a truly international company."

Partnership to accelerate breeding program based in Hawaii and Malaysia

Hendrix Genetics has completed a deal with Integrated Aquaculture International LLC (iAqua) to participate in the breeding and production of shrimp for the global industry. iAqua is an aquaculture technology company on the Hawaiian island of Kauai. Its breeding centre produces genetically-improved Pacific white shrimp (*Litopenaeus vannamei*) broodstock under the Kona Bay brand and will soon launch its line of specific pathogen SPF black tiger shrimp (*Penaeus monodon*).

The participation by Hendrix Genetics will accelerate iAqua's shrimp breeding program by introducing advanced genetic and genomic technologies developed by Hendrix Genetics. The deal will also provide the capital necessary for the development of state-of-the-art breeding facilities for both shrimp species in Kauai, as well as the development of model hatcheries for the production of quality post larvae in key market regions around the world. In addition, a comprehensive program for specific disease resistance will be implemented to further enhance the quality of Kona Bay broodstock. www.hendrix-genetics.com

New innovation campus

Bühler held a ground-breaking ceremony for its Innovation Campus in Uzwil, Switzerland. Completion of the building is expected in the first quarter of 2019. “This innovation campus will reinforce our innovation power and market leadership. It will help us bring together the smartest minds of the industry to create innovations for a better world”, said Stefan Scheiber, CEO of Bühler, at the ground-breaking. The innovation campus consists of two key elements: the upgraded technology labs and the new innovation building. The new building will build a bridge between the engineering and business world in the existing towers and the upgraded application labs. On three levels, the modern building will be the home for project teams of employees, clients, start-ups, students, and apprentices. It will feature an auditorium for up to 300 participants for large events. Bühler’s apprentices benefit from a dedicated apprentice center featuring several training rooms.

From left to right: Elvis Pidic (Bühler Architect), Johannes Wick (CEO Grains & Food), Carlos Martinez (Architect), Stefan Scheiber (Group CEO), Ian Roberts (CTO), Samuel Schär (CEO Advanced Materials), Andreas Herzog (CFO), Burkhard Böndel (Head of Corporate Communications)

Reflecting Bühler’s strong focus on the food processing industry, open living spaces with a central coffee bar, a tea lounge and adjacent thinking spaces complete the building, making it a state-of-the-art workplace. “This building is focused on collaborative innovation,” says Ian Roberts, Chief Technology Officer at Bühler. “We are creating a collaborative space for all functions, all ages, and all knowledge holders. It will allow us to live and foster our innovation culture and test future work practices.” The new building will bring together Bühler’s network of partners, be they customers, start-ups, academics, apprentices, or suppliers, and create a link to the technology labs. “We are creating a space that brings together visionaries and long-term thinkers of the start-up scene and universities with engineering teams that hold Bühler’s long-standing applied and tested know-how in processing technology. By combining both, we can truly create innovations for a better world.” www.buhlergroup.com

Hatchery Business Unit

BioMar Group has identified the hatchery feed business as one of the areas which has a significant potential to develop and expand its business. Therefore, BioMar has consolidated a strong team of dedicated hatchery specialists in order to further develop BioMar hatchery products, based on fundamental research on nutritional requirements as well as processing technology. Team members are as follow;

Chris Dinneweth, Hatchery Business Unit Manager: Chris has worked in both fish and shrimp aquaculture businesses as a researcher and in different managerial positions located in many different parts of the world.

Joana Amaral, Product Manager, Marine fish hatcheries: Joana has a solid background in the hatchery segment due to her previous positions as operations manager for sea bass and sea bream cage-culture in one of the largest fish farming companies in the Mediterranean area and as a board member of a sole farm in Spain, advising the technical and R&D teams. Her consultancy experience for sea cage farms and hatcheries for warm water species tops up Joana’s expertise in the field.

Jef Peeters, Product Manager, Shrimp hatcheries: In his previous position as a nutritional engineer, Jef acquired ample experience developing shrimp hatchery feeds in many parts of the world from Spain to Ecuador. He also delivered technical support to feed factories and shrimp farms for a premix producer in his past. www.biomar.com

From left: Joana Amaral, Jef Peeters and Chris Dinneweth

Full speed ahead into shrimp

The acquisition of Alimentsa as announced in June is now completed. All necessary approvals have now been obtained and Alimentsa is now part of the **BioMar** Group. The acquisition will position BioMar among the leading shrimp feed producers in Latin America creating synergies with its existing business. The CEO of BioMar Group, Carlos Diaz explains the rationale behind the acquisition as a unique possibility to create synergies in regards to development and delivery of high-end products and services to the Ecuadorian shrimp farmers, complementing the existing BioMar footprint in Latin Americas set by the business unit in Costa Rica.

"It is our strong belief that we, through an integration of Alimentsa in BioMar Group will be able to deliver a new high-end value proposition to the Latin American farmers by merging the highly recognised products and technical services from Alimentsa with our innovative and proven approach to R&D, sustainability and feed efficiency. We have in BioMar during recent years built a strong knowledge base within feed for shrimp and we can furthermore contribute with extensive research and experience from other species such as tilapia and marine species", said Carlos Diaz.

"We are confident that synergies can be harvested following the acquisition. With Alimentsa as part of BioMar Group, we can immediately deliver an attractive value proposition to shrimp farmers in Ecuador. We believe that in the future, together with the employees in Alimentsa and the customers, we can develop new product solutions based upon our shared interest in sustainability, innovation and cooperation with the customers." www.biomar.com

GSSI strengthens global partnership in Asia

AEON Co., Ltd., the largest retailer in Asia, announced it will be joining The Global Sustainable Seafood Initiative (**GSSI**) as a funding partner. AEON is the first Asia-based retailer to join GSSI's global partnership. Furthermore, Seafood Legacy Co., Ltd. joined GSSI as an affiliated partner and its Managing Director, Wakao Hanaoka, has joined the GSSI Steering Board. Tokyo-based Seafood Legacy is a consulting firm that supports sustainable seafood businesses and environmental organizations in Japan and around the world. It builds win-win partnerships that promote healthy ocean ecosystems.

"Seafood Legacy is delighted to join GSSI as an Affiliated Partner and I am honored to join the GSSI Steering Board. In the lead-up to the Olympic and Paralympic Summer Games in Tokyo in 2020, awareness around seafood sustainability is rapidly increasing in Japan. I believe GSSI is a unique platform to help push the sustainability conversation forward within the seafood industry in Japan, as well as, help regional certification schemes align with international accepted best practices." said Wakao Hanaoka.

These developments further strengthen GSSI's presence in the region after the Tokyo Organizing Committee of the Olympic and Paralympic Games announced earlier this year that they utilize GSSI's Benchmark Tool to develop the Tokyo 2020 Olympic and Paralympic Games Sustainable Sourcing Code (1stEd.). www.seafoodlegacy.com/en/ and www.ourgssi.org

Winner of G-Startup Indonesia 2017

Global startup competition **G-Startup** Worldwide announced aquaculture investment platform GrowPal as the first-place winner of G-Startup Indonesia 2017. Growpal is a P2P lending platform that aims to help freshwater fishermen raise funding for their business. The startup is currently working with fishermen in Pacitan, Situbondo, Karimun Jawa island and Makassar.

Founded by Paundra, GrowPal claimed to be profitable with USD 1.5 million GMV. It monetises by taking 15% of every investment. It partners with export companies which ship the fish products to the US, France, and Russia with grouper and shrimp being the most popular seafood product in the platform. Apart from winning a USD 150,000 investment from GWC Innovator Fund and Kejora Ventures, GrowPal will also represent Indonesia at the G-Startup Worldwide final round in Silicon Valley.

The G-Startup Worldwide is a global startup competition that aims to find 'the most innovative' early stage startups and enable them to change the world. The final round of the competition was held during the Global Mobile Internet Conference (GMIC) Indonesia 2017 in Serpong. The one-day event invited tech industry players across Southeast Asia to connect and share insights about the industry. www. e27.co/anisa.menur.a..maulani

Appointments

Karen de Ridder

Business Development Manager

Multinational feed additives producer Nutriad announced the appointment of **Karen de Ridder** as Business Development Manager Preservation & Functional Ingredients. Karen de Ridder graduated a Bio-Engineer from the University of Ghent and brings with her several years of experience within the feed additives industry.

Nutriad CEO Erik Visser said, "The choice of raw materials, and especially their chemical and microbiological quality, is essential for the successful production of safe and high quality feed. To further support our customers across the world we continue to invest in the development of new concepts and in-market technical support. This appointment follows from that strategy." www.nutriad.com

Serge Corneillie

Marilyn Sim

Expansion with expertise in aquaculture and global team

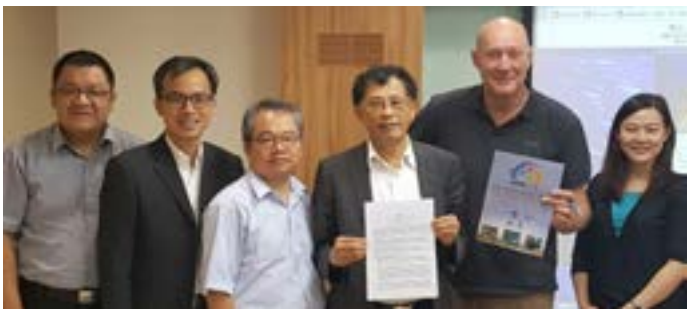
Diamond V is expanding its expertise in aquaculture with **Dr Serge Corneillie**, who joins the team as Senior Consultant, Technical and Business Development, Asia.

JC Filippi, Managing Director for Asia, "Serge has more than 30 years of experience in aquaculture research and business development in Asia. In his new role, Serge will oversee Diamond V businesses in Japan and South Korea and will be leading our growth efforts and support to our aqua business in Asia."

Based in Tokyo, Japan, Corneillie has a PhD in Fish Nutrition from the University of Leuven, Belgium. Early in his professional career, he worked in the Mediterranean marine fish farming industry and later for Nutreco/Marine Harvest in the Mediterranean region and in Asia.

Marilyn Sim has joined Diamond V's global team as Senior Consultant for Business Development, Malaysia, Indonesia, and Taiwan. Filippi said, "Her in-depth knowledge of our industry and her extensive business network will be of great value in driving further growth in the Asia region." Prior to joining Diamond V, Sim worked as head of animal nutrition at Behn Meyer in Malaysia. She is based in Kuala Lumpur, Malaysia. www.DiamondV.com

Asian-Pacific Aquaculture 2018



At the APA 2017 meeting, from left; Dr Yu-Hung Lin, National Pintung University of Science and Technology, Allen Wu; Jin-Shiung Yeh, Taiwan Fisheries Agency; Dr Ching Fong Chang, President of NTOU and Mario Stael.

Following the success of the APA17 in Kuala Lumpur, Malaysia which was attended by more than 2,800 people, the World Aquaculture Society (WAS) and the Asian Pacific Chapter (APC) have agreed to organize the next APA conference (APA18) and exhibition from April 23-26 in Taipei, Taiwan together with the help of National Taiwan Ocean University (NTOU) and local partners, Taiwan Fisheries Agency, Council of Agriculture (FA), National Pingtung University, FBAT, and Fisheries Research Institute.

The Steering Committee chaired by Professor Ching-Fong Chang (President of NTOU) and Dr Guillaume Drillet (President of WAS-APC) had its first meeting during APA17. "We are now 8 months ahead from the conference and therefore the activity of the steering committee is increasing every day to ensure a very successful event both for scientists and industry partners," said Chang.

The program committee led by Professor Ming-Wei Lu (NTOU) and Associate Professor Pham Quoc Hung (Nha Trang University) have set a deadline for **abstract submission on January 31st**, and online abstract submission is encouraged at www.was.org. The theme of the conference has been chosen to be "Innovation for aquaculture sustainability and food safety".

Asian-Pacific Aquaculture 2018 (APA18) is the mega event on aquaculture in the Asian Pacific Region. There will be special sessions and workshops covering all aspects of aquaculture in Taiwan and Southeast Asia on marine and freshwater fish culture, production system, seaweed and algae, food safety, and many more. Plenary topics will include trends and prospects of Taiwanese aquaculture and biotechnology applications in the aquaculture industry. The conference will include three days of topics-based parallel sessions. (see box)

Exhibition

The three- day exhibition featuring international and Taiwanese companies will showcase the latest products, services, instruments and equipment for aquaculture management and all aquaculture related information to encourage sustainable aquaculture practices within the industry.

Farm Tours

During the APA 18 there will be two farm tours, both on April 28, 2018.

Tour 1: West of Taipei, will visit a Koi Farm, Fisheries Research and Lukang Old Street. Sing Chang Koi Farm stretches over an area of 3 ha with over 100,000 amazing koi. It represents Taiwan Koi aquaculture as an industry leading model.

Tour 2: East of Taipei, will visit National Museum of Marine Science & Technology (NMMST), National Taiwan Ocean University and King Car Group – Shrimp farm. The National Museum of Marine Science & Technology is the the world's first exhibition hall to showcase the diverse fields of marine science, technology, ecology, culture, and environmental affairs, in order to help enhance public knowledge and consciousness about the sea.

Technical sessions

Grouper • *Breeding and Genetics • Nutrition • Disease and Health Management*

Ornamentals • *Breeding and Genetics • New Strains • Transport Technology*

Seaweeds and Live feed • *Production • Processing • Algae • Zooplankton*

Fish Culture • *Carps • Tilapia • Milkfish • Eels, Trout, Sturgeons • Tuna, cobia and yellowtails, Flounder • Snappers • Salmonids • Mullets • Other fish*

Mollusks • *Abalone • Mussel • Oyster*

Crustaceans • *Shrimp • Crabs • Lobsters*

Ecology & Environment • *Environment, Biodiversity and Climate change • Sustainable development of aquaculture • Aquaculture standards & certification*

Production system • *Cage-culture • Recirculation systems • Technology and Equipment*

Poly culture (IMTA) & Aquaponics Food safety • Policy & *regulations • Inspection • Good Agricultural Practice • Processing (Valueadded)*

Aquatic Animal Health • *Fish Disease • Probiotics*

Shrimp Health & Disease • *Microbiome at aquatic organism & probiotics*

Aqua-feeds • *Functional feeds • Nutrition*

Alternative Ingredients

Other topics • *Aquaculture economics & Management • Development, welfare and poverty • Marketing & Trade • Policy & regulations • Education, extension, and technology transfer • Emerging issues in aquaculture • Development*

More information: www.was.org/www.was-apc.org
For conference and registration, contact worldaqua@was.org
Trade show and sponsorship, contact mario@marevent. com; WAS-APC office: apcsec@was.org

Asian Pacific Aquaculture 2018

April 24-26

APA 18

Taipei - Taiwan

All info: www.was.org

Conference management: worldaqua@was.org

Trade show & Sponsorship: mario@marevent.com

Practical short course on feeds & pet food extrusion

January 21-26, 2018
Texas A&M University, USA

A one-week Practical Short Course on Feeds & Pet Food Extrusion will be conducted from January 21-26, 2018 at Texas A&M University by staff, industry representatives, and consultants. The program will cover information on designing new feed mills and selecting conveying, drying, grinding, conditioning and feed mixing equipment. Current practices for production of pet foods, preparing full-fat soy meal; recycling fisheries by-products, raw animal products, and secondary resources; extrusion of floating, sinking, and high fat feeds; spraying and coating fats, digests and preservatives; use of encapsulated ingredients and preparation of premixes, and least cost formulation are reviewed. Practical demonstration of pet food, vacuum coating, and several others are demonstrated on four major types of extruders - (dry, interrupted flights, single and twin screw), using various shaping dies. Reservations are accepted on a first-come basis.

For more information: Mian N. Riaz, Ph.D, CFS, Director, Process Engineering R& D Center. Web: https://perdc.tamu.edu/; https://perdc.tamu.edu/extrusion/

11th Aquafeed Horizons Asia 2018

Advances in Aquafeed Processing & Formulation
March 27, 2018, BITEC, Bangkok, Thailand

This is an aquafeed.com conference, held in association with Victam International. The Aquafeed Horizons series of conferences has been arming delegates with the latest processing and formulation solutions to help keep ahead of the trends and changes in the industry since 2006. The conference focuses on practical information related to advances in formulation and processing. Aquafeed Horizons has become a recognized event in the calendar for commercial aquafeed manufacturers. Web: www.feedconferences.com

2018

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

January 21-26
Practical Short Course on Feeds & Pet Food Extrusion
Texas A&M, USA University
https://perdc.tamu.edu/;
https://perdc.tamu.edu/extrusion/

February 2-3
AquaIndia 2018
Chennai
Email: contact@aquaprofessional.org/
aquaindia.sap@aquaprofessional.org
www.aquaprofessional.org/

February 19-22
Aquaculture 2018
Las Vegas, USA
www.was.org

March 27-29
Victam Asia 2018
Bangkok, Thailand
www.victam-asia.com

March 27
11th Aquafeed Horizons Asia 2018
Advances in Aquafeed Processing and Formulation
Bangkok, Thailand
www.feedconferences.com

April 19-21
Aquaculture Asia 2018 Expo and Forum
Kuala Lumpur, Malaysia
www.livestockasia.com

April 23-26
Asia Pacific Aquaculture 2018
Taipei, Taiwan
www.was.org

April 24-26
Seafood Expo Global
Brussels, Belgium
www.seafoodexpo.com/global/

April 27-29
Vietshrimp 2018
Bac Lieu, Vietnam
www.vietshrimp.net

May 15 -17
Offshore Mariculture conference Asia
Singapore
www.mercatormedia.com

June 3-7
18 th International Symposium on Fish Nutrition and Feeding (ISFNF)
Las Palmas de Gran Canaria
Canary Island, Spain
www.isfnf2018.com

August 15-16
The Aquaculture Roundtable Series (TARS): Shrimp Aquaculture in Asia
Chiang Mai, Thailand
www.tarsaquaculture.com

VICTAM Asia 2018

FIAAP grapas

27 – 29 MARCH 2018 · BITEC EXHIBITION HALLS, BANGKOK, THAILAND

Asia's largest feed and grain event

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What's on show at VICTAM Asia 2018?
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• Auxiliary equipment

What's on show at FIAAP Asia 2018?
• Ingredients • Additives • Formulation • Laboratory equipment
• Quality control

What's on show at GRAPAS Asia 2018?
• Rice milling and sorting technology • Flour milling technology
• Flakers, extruders • Grain processing systems • Additives

Industry conferences
• The FIAAP Asia Animal Nutrition Conference 2018
• Petfood Forum Asia 2018 • Aquafeed Horizons Asia 2018
• Proagrica Feed Efficiency Conference Asia 2018
• GRAPAS & Global Milling Conference Asia 2018 • GMP+ Seminar

Supported by
• The Feedstuff Users Promotion Association • Thai Feed Mill Association • The Animal Husbandry Association of Thailand
• Animal Health Products Association • Department of Fisheries
• Ministry of Industry • The Thai Chamber of Commerce
• Thailand Convention and Exhibition Bureau

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