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A s i a P a c i f i c

TARS 2017:
Hard Talk with
Finfish Farmers

Farming Shrimp the
Right Way in India

Young Aquaculture
Entrepreneur

Farming Barramundi
alongside Pathogens

Sea Lice in Snappers
in Malaysia

Optimising Productivity
of Live Feed



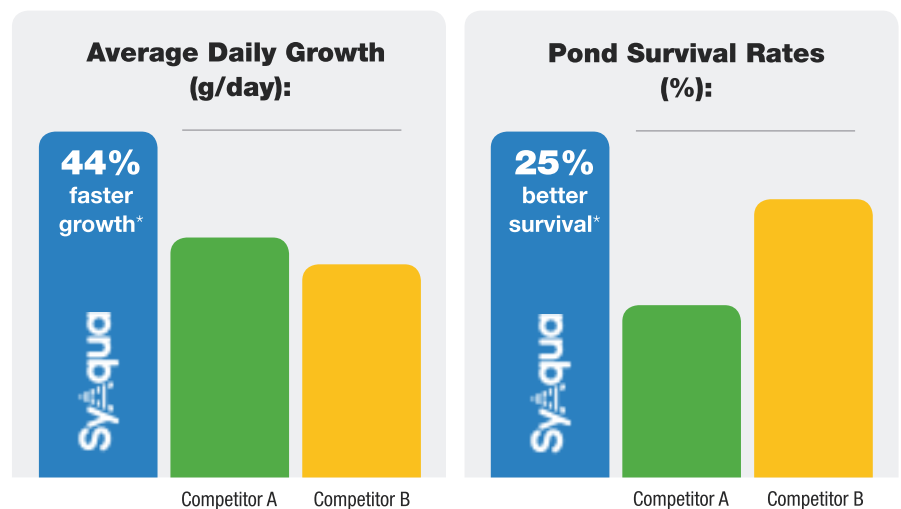
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Zuridah Merican

Asian Financial Crisis and Finfish Aquaculture

The 7th annual Aquaculture Roundtable Series (TARS) 2017 on Finfish Aquaculture coincided with the 20th anniversary of the Asian Financial Crisis. Two decades have passed since credit and easy money stopped flowing, Asian currencies depreciated against the dollar while commodity prices remained strong. What have we learnt and are we better placed today to ride through a similar crisis? The shrimp industry exported its way out of the crisis in 1997/1998. Let us look at the finfish aquaculture industry and our learnings from TARS 2017.

In the State of the Industry address, Dr Einar Wathne of Cargill introduced Reputation Management. Although reputation management is not a new concept, it is a critical bottleneck in Asia and no one knows how to approach this. Exported food items, from Chinese tilapia to Vietnamese pangasius, have received such bad references on social media but the industry has been slow to act, if there was any action at all. Faced with a similar financial crisis, we will not be able to export our way out as the model would be to sell cheap - reinforcing the perception of a poor product with poor reputation. Is there any customer focus and have we even considered the millennial generation? Millennials rely strongly on social media, believing in everything shared as if it were the gospel truth.

The pangasius has come a long way to become an international product farmed and processed under certified standards with modern processing techniques. Jonathan Wilson of Godaco Seafood stressed that "we are no longer in the frozen fish business but in the *frozen food* business which is a bigger pond of profits". The pangasius can move up the white fish ladder but the industry needs to focus on product innovation in terms of profit generation rather than economies of scale for fish production. Value adding provides producers with a stronger hand during negotiations with buyers from economies who focus on consumers asking for a 'ready to cook' product.

To survive a financial crisis, operational efficiency is equally important and to emphasize this, benchmarking against the salmon model will illustrate the point. Barramundi (Asian sea bass) farmers have been crying for better genetics strains and improved growth rates. Genetic improvement requires numerous generations that involves time and money in

terms of holding costs without dividends. The Asian barramundi industry was pioneered by small and medium enterprises who are already suffering from cash flow issues resulting from a holding the fish for 18 months to reach marketable size. Like the salmon, it is the role of the government and research institutions to invest and make the genetics available to farmers.

A strong take-away message from TARS is the lack of performance feeds today. The industry KPIs are still feed price and FCR and not feed costs per kg of fillet produced. There are no feeds specific to meet the nutrient requirements of the species, and reliance on trash fish is extremely high. There is no value creation in feeds and there is no ability for least cost formulation. Niels Alsted from Biomar reminds us not to equate least-cost formulation with cheap feeds. This feed model with poor operational efficiency may not be able to withstand another crisis.

To move the industry forward, we have to rethink our strategy and this begs the question - Do we continue to rely on *laissez-faire* development or look to government regulation? Water is becoming a limited resource and aquaculture has to compete with tourism for the water body. Aquaculture has to prove that it is a responsible and sustainable industry which leads to capacity building and environmental protection. A school of thought argues that the salmon model developed due to government regulation and guidance. All the segments of industry, from research organisations and competent authorities, to farmers and feed companies, worked together across all the northern European countries to contribute to growth of the finfish sector.

Where is the collaboration in Asia? We tend to suffer from trust and cooperation deficiency - not only within the supply chain but also between countries.

Will the Asian finfish industry be able to withstand another financial crisis? I think the answer is a resounding NO. Perhaps a crisis is what is required to push for creative destruction in order to develop a totally new paradigm.

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State of the finfish aquaculture industry in Asia

The license to grow Asia's farmed white fish includes reputation management above all else.

The 7th Aquaculture Roundtable Series (TARS) 2017 was held in Bali, Indonesia, from 16-17 August 2017. There were 180 participants, with 27% from Indonesia. While TARS 2013 reviewed issues related to production and supply chain for this industry, this year the meeting addressed growth prospects, trends, opportunities and challenges. TARS 2017 also featured a hard talk with finfish farmers (see pages 18-22). The welcome address was presented by **Dr Coco Kokarkin Soetrismo**, Director of Seed Development at the Directorate General of Aquaculture, Ministry of Marine Affairs and Fisheries, the authority in charge of aquaculture planning, R&D, extension and regulatory affairs throughout the archipelago.

The state of industry in Asia address is a signature of TARS to set the stage for the plenary session. **Dr Einar Wathne**, President and CEO of Cargill Aqua Nutrition (CQN) presented on developments, bottlenecks, directions and challenges based on his subjective experiences and learning after more than 30 years in the aquaculture industry. He started with an insight on a consumer survey on the white fish in the US which Cargill conducted in May/June 2017. The results of the survey revealed:

- 72% of the US consumers believe seafood is important for their health and nutrition;
- 88% are likely to buy and pay more for seafood certified as sustainable and responsibly sourced;
- 70% said that where the seafood is sourced impacts their purchasing decision; and
- 50% prefer to buy wild caught fish instead of farmed fish.

"Our challenge is the last point and that in terms of species, many (27%) recognise salmon whilst only 8% recognise tilapia as a species on the seafood plate," said Einar.

Production and markets

In his overview on the main commercial white fish species, Einar showed that the major wild caught white fish, the Alaskan pollock and hake compete with farmed tilapia and pangasius. The white fish is the largest aquaculture product at 8-9 million tonnes annually. This is more than twice the shrimp production and more than three times for the salmon. "Tilapia is globally produced in 140 countries and production is dominated by China, Indonesia and Egypt. There is a tremendous growth potential for the tilapia in Brazil for us to watch out," said Einar.

A comparison of markets for tilapia and the salmon showed that international trade for the tilapia is still much smaller than that of the salmon which means that there is a high local consumption. There is a high potential in Western markets for the tilapia, although currently, it does not feature in the EU market. Even in America, the penetration of tilapia is small but as Americans consume less than 1 kg fish/capita/year, there is a high potential for this fish in this market. However, China is now a growth leader in the whitefish market.



Dr Coco Kokarkin Soetrismo, gave the welcome remarks

"It may make a turnaround from being a net exporter to a net importer of white fish with a strong demand for imported seafood. Its internal policy is weakening its role as a net exporter. While supply will grow from Southeast Asian farms, here too demand is high and domestic consumption is rising. Latin America and especially Brazil has a cost advantage in feed and access to natural resources. In the future, we believe that Brazil might fulfil the needs of China."

Fundamentals in production

There are three pillars in production: health, nutrition and genetics and breeding.

Health

Fish health is fundamental to market access and license to grow, and for the industry to deliver the expectations of the society. Diseases restrain aquaculture growth for nearly all species and increase production costs. To fulfil our promise to supply seafood to the world, we will need to manage health issues.



“ Fish health affects more than production cost; it is fundamental for market access and license to grow.. ”
- Einar Wathne

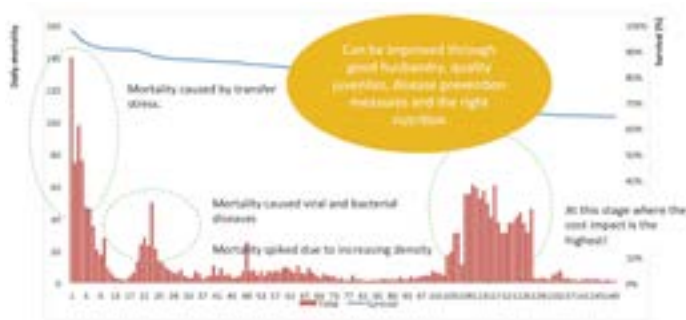


Figure 1. Mortality of a typical high intensive tilapia farm

This is a global issue illustrated by the recent tilapia lake virus outbreaks in Israel, since 2014 and showed how quickly it has spread to many countries including Colombia, Ecuador, Egypt and Thailand. In the case of the tilapia, a consensus on an acceptable mortality rate is needed. “We know that the tilapia is a robust species and yet average mortality in a life cycle is more than 35%. It is also clear that the peak of mortality is at the end of the cycle which could be environmentally induced (Figure 1). Over stocking is common for higher harvest for higher biomass as juveniles are cheap. Farmers see this numbers game and choose to invest in juveniles instead of nutrition and health to reduce mortalities,” said Einar.

Nutrition

This is familiar to Einar with his experiences in feed production. There are three aspects of nutrition which together will bring feed costs down, fish quality and feed performance up.

- Precision nutrition uses science. There are two sides of precision nutrition, which involves nutrient supply and nutrient demand. Nutrient supply of the various ingredient matrix should precisely match nutrient demand of fish farmed in different environments.
- Smart feeding is applying technology and using information on demand with different species, environments and life stages.
- Novel ingredients involve industrial innovation.

“So far feeding has been subjective based on the judgment of the farmers and operators. Today we can use technology as the extra eyes; sensors and devices that can be added cheaply. We can start learning on how to change the industry as we go along. This technology and practice should be in place to help farmers make objective and smart decisions,” added Einar.

Fish meal and soybean meal are present in most fish feeds but nowadays, novel ingredients will take the feed industry to a new level to improve feed value and address the sustainability issue. Cargill has a feed protease Emphyreal, omega 3 fatty acids sources (algae oil and high omega-3 canola oil) and is partnering with Calysta to produce the new microbial protein, Feedkind.

Genetics and breeding

Einar’s take on genetics and breeding is, “One difference between aquaculture and livestock is that we have genetic programs at the species level and there are 240 species being farmed and only 13 species with more than 1 million tonnes production. We need to make a choice which are the species to tackle as we cannot do a genetics program for all. We have seen genetic gains in growth, disease resistance and survival. We know it has brought success to the salmon industry.

“Sound genetic work is high tech and is not for everyone as it requires huge investments. There are already large global players and local players in Asia itself. Maturing industries are expected to be dominated by relatively few providers of improved seed, with highly specialised competence in genetics and selection. There are decisions to be made on the traits to select too,” added Einar.

Sustainability and traceability

The emphasis was on the need to address the whole value chain. There are three components: economic, environmental which is doing more with less, and social licence which may be the most difficult. “Aquaculture is not just about fish production, it is about satisfying consumers. More and more people care about food not only to sustain life, but for health, joy and wellbeing. People want to know more about their food: what it is made from, where it is made and how it is made. This is no longer a demand from affluent western markets, but spreading to all consumer markets,” said Einar.

“My message is that sustainability and traceability are prerequisites from feed to plate.”

Reputation management

As an industry, we need to manage our reputation well. Einar emphasised, “This is our asset. However, first we need to recognise that we are in a transparent market today and there is speed in information.” Einar illustrated this with some reputational issues with the tilapia and pangasius available via an internet search, which turned out articles which carried fake news such as ‘the reason why tilapia is dangerous to eat, and why tilapia is bad for you’.

“What is done in one country affects another country. There should be industry collaboration and we need the critical skill to manage our reputation in a transparent market with speedy and borderless information.”

His key takeaway was, “We need to acknowledge the issue. Transparency, communication and industry collaboration are key elements.”



The breakout roundtable groups discussed key challenges in today’s farmed finfish industry and developed strategies for growth within three focus areas: Marketing Image and Sustainability (MIS), Production Efficiency and Industrialization (PEI) and Performance and Functional Feeds (PFF). See pages 18-34 for more reports on Hardtalk with Finfish Farmers and on plenary presentations.

F3 Challenge surpasses 100,000 tonnes

Over 100,000 tonnes of fish-free feed have been sold by contestants of the F3 (Fish-Free Feed) Challenge since the sales contest to encourage innovation of alternative ingredients for aquafeeds began in May 2016. The amount of fish-free aqua feeds sold during the contest thus far is estimated to be equivalent to nearly 100 million forage fish from the ocean. In first place is Guangdong Evergreen Feed Industry Co., Ltd with 66,515 tonnes of feed sold. In second place, with 31,600 tonnes is the team of Myanmar-based Htoo Thit Co and global animal nutrition company Biomin.

Five teams from China, United States, Austria, Myanmar, South Africa, and Pakistan are advancing to the final sale reporting deadline on September 15, 2017. A USD 100,000 grand prize will be awarded to the winner at GOAL 2017 in Dublin, Ireland. Contestants are using everything from insects to algae as a base to develop a fish-free aquafeed. The winning team must prove their recipe can be scaled up by targeting sales of 100,000 tonnes or be the furthest along by the challenge end date. F3 Challenge judges have tested and verified that all contestant feeds as fish free.

The F3 Challenge is intended to spark innovation in the aquafeed industry to find viable, cost-competitive aqua feeds free of fishmeal and fish oils. Sustainable alternative protein sources can reduce pressure on ocean ecosystems to supply aquaculture fish feed components and help meet growing demand for fish in the future.

IFFO response on antibiotic resistant genes found in fishmeal

IFFO has published a letter to The Economist and position paper in response to a scientific paper indicating there is a potential for fishmeal used in aqua feed to be a vector for antibiotic resistant genes. The scientific paper by Ying Han et al was published in Environmental Science & Technology. In its response, IFFO advised to exercise caution in how the results are interpreted without further confirmation of the findings. The work has been undertaken on a very limited sample number (5 fishmeal products; 2 terrestrial animal products), and as such is not an extensive investigation. While antibiotic resistance is a concern in any food stuff, (and IFFO recognises the importance of managing antibiotics in order to protect the availability of treatments for human health), the paper raises several questions. IFFO made several observations. Among them are; "The majority of fishmeal is produced from whole fish caught in the wild where there is no contact with antibiotics, nor are antibiotics used in the manufacturing process. Some fishmeal is produced from recycled fish trimmings. IFFO estimates that approximately 33% of the total annual volume comes from this raw material, and although some of the source of this raw material will be aquaculture byproduct, the majority is wild capture byproduct and, again, would not come into contact with antibiotics. In general, aquafeed companies have quality management systems in place to check the integrity of the ingredients that are used in their feed manufacture". The full response is available at www.iffonet

Insect-based animal feed company wins first AIC

Experts have judged Entobel as the innovation with the most potential in the finals of the Aquaculture Innovation Challenge (AIC) held in September in Ho Chi Minh City, Vietnam. Entobel uses food industry waste as feed for the production of black soldier fly. These plentiful insects are then used to produce fish-feed, as well as fertilizer. The jury said that Entobel "has a really good business approach, has been proven to be successful in the world already and is part of the race for a sustainable protein supply". The winning team received the USD 10,000 cash prize and met with investors, both of which will help them scale up their business.

Gaetan Crielaard, representative of the Entobel team, said, "For four years in Vietnam, we all worked very hard. This will help us to run the pilot for a few more weeks or months, allowing us to focus more on investors to build this factory. The plan is quite ambitious. While we want to start with one factory, the goal is to build more, first in South Vietnam, then the North, and then other tropical countries with a focus on Southeast Asia, but [eventually] Africa and South America. We believe that what we have built here is really relevant for tropical countries." Seafood Trade Intelligence Portal, Solidaridad and Fresh Studio are organizers of the AIC. The aim is to grow interests in new partnerships that will shape and improve the aquaculture sector in Vietnam in the near future.

Clarification for Table 4 (page 20), in the article 'Is 100% replacement of Artemia possible' in issue May/June 2017, p18-23.

Table 4 depicts an actual situation at a hatchery in Latin America. By replacing *Artemia* cysts with EZ *Artemia* and improving hatchery sanitation, the hatchery improved survivals from less than 10% to 65 - 90%. All of the tanks in this data set were managed with EZ *Artemia* rather than *Artemia*. In the last two days before harvest, the hatchery fed several larval tanks *Artemia* for two days to boost lipid levels. The data compared bacteria counts in the tanks in which *Artemia* was added the last two days to those which did not receive any *Artemia*. The low consumption of *Artemia* at only 0.22 kg/million reflects the fact these tanks only received *Artemia* for two days before harvest.

Table 4. Comparison of bacterial counts (in colony forming units, CFU) in culture water and larvae for larval tanks fed synthetic *Artemia* or *Artemia* nauplii. The consumption of synthetic *Artemia* was 3.8 kg/million PL; and 0.22 kg/million PL.*

Diet	Total bacteria (CFU)		Vibrio alginolyticus (CFU)		Vibrio parahaemolyticus (CFU)	
	Culture water	Larvae	Culture water	Larvae	Culture water	Larvae
Synthetic <i>Artemia</i>	2×10^5	1×10^5	5×10^4	1.8×10^3	2×10^5	4×10^2
<i>Artemia</i> Nauplii	2.8×10^5	1.5×10^5	2.1×10^5	3.2×10^3	4.2×10^3	2.6×10^3



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In India, are we farming shrimp the right way?

By Manoj M. Sharma

From pond carrying capacity to organic waste discharge, are farming practices keeping up with intensification?

For many years, farmers in India and in many other parts of Asia were farming the black tiger shrimp *Penaeus monodon*. All our culture systems were developed for this shrimp, a docile shrimp staying at the lower part of the pond ecosystem. Black tiger shrimp was the mainstay of shrimp farming in India and we were very proud of it. In India, we called it the Indian Black Tiger. We farmed this shrimp for more than 25 years until production stagnated due to repeated disease outbreaks and poor quality post larvae.

To support Indian small farmers, the Coastal Aquaculture Authority agreed on the introduction of *Penaeus vannamei*. The lead attraction was domesticated broodstock, in particular, specific pathogen free (SPF) broodstock. The other pull was the potential for a high production capacity. Within 4-5 years, we raised our national production four times. Vannamei shrimp farming catalysed other industries: hatcheries, feed mills, aqua pharmaceuticals and chemicals, processing companies, and brokers.

However, did the introduction of the vannamei shrimp fulfil its main purpose, namely that of supporting small farmers? Were we ready with the required infrastructure for a higher density culture? Table 1 shows how, as the years went by, the success rate for vannamei shrimp farming went down. It was clear that we were trying to use a Ferrari engine to run a Suzuki car. The main reason for the lower rate of success is due to limited adoption and adaptation of culture practices. You can see the gradual fall from 85% success to just under 40%, where farmers attempted to produce more without fully understanding the carrying capacities of the ponds and creeks.

Table 1. Production trends and success rate in farming *P. vannamei*

Year	Total seed production (in billions)	Total shrimp production (in tonnes)	% of success
2010	2.2	47 000	86
2011	4.5	83 000	74
2012	9.0	145 000	64
2013	18	247 000	55
2014	23	317 000	55
2015	32	280 000	35
2016	40	425 000	40

Note: calculated shrimp count @ 40 pcs/kg

Major culture issues

A number of issues have affected the supply chain since 2015. Abrupt phytoplankton blooms, poor water colour, and low or unstable productivity have affected post larvae survival. In ponds, issues include: high feed conversion ratios (FCR) and slow growth, brown and black gills, clogging of gills, and body deformities such as cramping and bamboo shrimp. In terms of diseases, we have outbreaks of almost all diseases. Running mortality syndrome,

white gut disease, white faeces syndrome, *Enterocytozoon hepatopenaei* (EHP), and white spot syndrome virus (WSSV) all remain major threats.

“ .. Often sludge is returned to the same water source. This is not a responsible or safe practice.. ”

Pond and water source carrying capacity

Based on my 20 years in shrimp farming, I attribute these problems in pond production to pond carrying capacity. The area available for production is also related to the carrying capacity of the water source. The number of ponds using the same water sources affects the carrying capacity of ponds. For example, in Gujarat state, we can see that the most successful factor for a farm is to be near a water source and those nearer to the water source have been showing good yields consistently. Then we have those in areas densely populated with ponds with poor harvest results. This applies not only in India but elsewhere.

Farming protocol

Although we are using domesticated and clean stocks, we need to remember that the vannamei shrimp is not a super shrimp. Pond preparation practices used during the farming of the black tiger should not be left aside. Furthermore, the trend is towards more intensive farming methods and this makes it very critical to follow established pond preparation protocols. Proper drying of old culture ponds, proper ploughing for effective oxidation of pond bottom spoils, compaction after proper ploughing merely take 3 weeks and do not cost a lot. Monitoring the calcium:potassium ratio and keeping to the right water quality parameters are critical.

The trend towards intensive farming models must be matched with the appropriate conditions. For example, some farmers have started to stock post larvae (PL7-8) instead of PL 12, based on practices in Mexico. However, in Mexico, their hatchery and nursery technology and protocols and post larvae quality are different. Farmers should insist on PL 12-15 until they are happy that the hatchery protocols support strong post larvae quality.



Production performance at MAPL's 56 ponds have been stable. Their approach in the production of both vannamei and black tiger shrimp is optimum stocking density (25 PL/m²) for 8.3 tonnes/ha/crop of size 20-28/kg in 2016. Survival was 80% and FCR 1.38

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Table 2. Optimum water quality parameters.

General parameters	Mineral profile	Vibrio count
Dissolved oxygen > 5 ppm	Ca : Mg - 1:3	Green colony < 30 CFU/mL
pH 7.5 - 8.5	Cl : Na: Mg - 16:9:1	Yellow colony < 300 CFU/mL
Transparency 35-45 cm	Mg: Ca: K - 3:1:1	
Alkalinity > 100 ppm	Na: K - 40:1	
Salinity 15-30 ‰	Chloride > 500 ppm	
Temperature 28-31 °C		
Water depth 1.8 m (average)		



The future will be autofeeders for economical feed management

Feed management

Feed management is the paramount factor for success. It accounts for up to 65% of the total cost of production and incorrect feed management is the 'mother' of all problems leading to algal blooms, high *Vibrio* loads, and other issues. In India, there is the mindset carried over from farming black tiger that a production target of 2.5 tonnes/ha requires 10 kg of feed per day. In high stocking ponds (>40 PL/m²) the percentage of feeding relative to quantity of feeding frequency of feeding plays a vital role. The suggested feeding regime is given in Table 3. The vannamei shrimp loves to eat often.

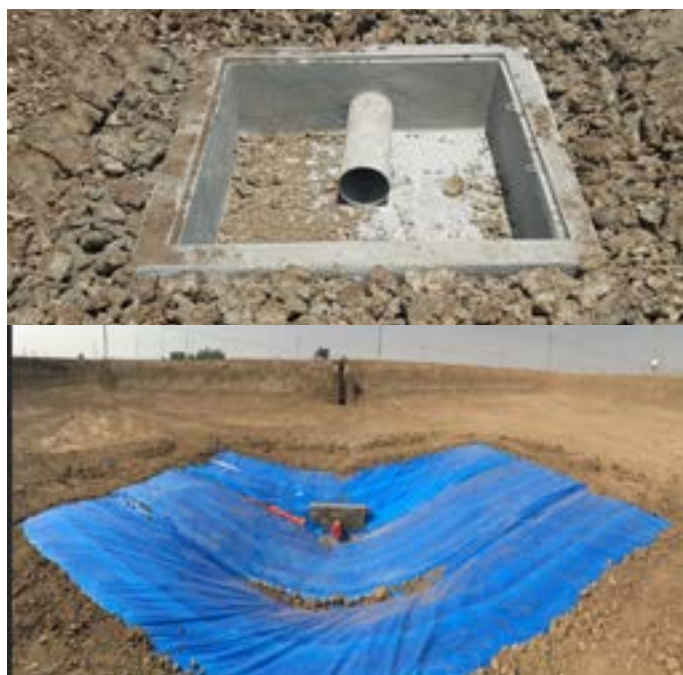
In summer, a 1 °C change in temperature can result in erratic feeding behaviour among vannamei shrimp. Consumption increase and gut retention time also decrease with an increase in water temperature. It is very important not to over feed the shrimp in the summer by observing the check trays as the percentage of feed in accordance to biomass is very decisive. Just checking the feeding tray and supplementing more feed if the tray is empty cannot be applied to the vannamei shrimp in summer. During peak summer months, feeding shrimp from afternoon to evening should be avoided. Organic load is directly proportional to feed waste and triggers bacterial load especially *Vibrio* spp. during summer. Underfeeding is still manageable compared to issues resulting from overfeeding.

Organic waste and the shrimp toilet

Organic loads represent a major problem in intensive shrimp farming. Carrying capacity of the ponds is directly related to organic load. In intensive systems with wrong or bad feed management, the organic load can be problematic. Organic loads are high if we follow the black tiger way to feed vannamei shrimp. Usually the onset of problems related to organic loads happens at days of culture 60-65.

Today, sludge is the biggest contributor to organic waste. For shrimp farming, water intake and water exchange is a continuous process. In India, farmers have devised different tools to manage

organic loads from monk type sluice gates to shrimp toilets to renovation of the central drainage system. Often sludge is returned to the same water source. This is not a responsible or safe practice, particularly in cases where an intensive farm discharges its sludge with water into the same creek it shares with an extensive farm. Further compounding the issue is when both farms then use the same source for water intake. My recommendation is to have separate areas for the sludge bed and its treatment. Proper care should be taken during disposing or recycling.



Two version of the shrimp toilet. In the bottom picture, the blue plastic works efficiently to keep sludge away from the soil and makes it easy to siphon out sludge. In new ponds, we will have a separate area for this sludge bed and its treatment.

Table 3. Recommended feed management for 100,000 post larvae.

Initial stocking post larvae	100,000 PL
No of Shrimp calculated at 80% survival at end of culture	80,000
Total feed during peak (max nos of feed pellets)	35 kg (ABW: 15-20 g)
Consumption by single shrimp	4-5 pellet per meal
Total pellets required per feed	320,000
Pellets/kg of feed (grow/finisher)	70,000 (@70 pellets/g)
Feed per meal	Max 5-6 kg
Feeding frequency per day	6 times



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AQUATIC ECO-SYSTEMS

A young aquaculture entrepreneur in the making

By Zuridah Merican

Garnering experience with broodstock rearing technology of neo females to produce all male giant freshwater prawn post larvae and a founder population for marker assisted selection.



Giva Kuppasamy in the hatchery and nursery sections with circular 2-tonne larva and nursery tanks.

Nestled at the foothills of the main range of Peninsular Malaysia in the small village of Broga, is GK AQUA Sdn Bhd, a biotechnology company set to bring into the Malaysian industry recent innovations in the breeding of the freshwater giant prawn *Macrobrachium rosenbergii*. Its founder and CEO is a young entrepreneur **Giva Kuppasamy**.

GK Aqua was established in May 2016 and Giva's vision is to revive Malaysia's freshwater prawn industry, once the pride of the nation where the first breeding success was achieved in the late 1960s in Penang. The strategy is first to build up the market share in the post larvae supply and then to focus on developing the founder stocks. With the former, Giva opted to directly import neo females post larvae and to grow them into broodstocks. By mating the neo females with the local male broodstocks, all male post larvae will be produced for sale to local farms.

Concurrently, GK Aqua has already embarked in marker assisted selection using cutting edge molecular genetic technology to design and build good founding stock for this species in Malaysia. In a proposed collaboration with the Malaysian Bioeconomy Development Corporation, Centre for Marker Discovery and Validation (CMDV) and AIMST University in Kedah, Malaysia, the target is to domesticate the freshwater prawn to yield fast growing and SPF broodstocks. In July 2017, GK Aqua was awarded the BioNexus status which comes with fiscal incentives and support for further improved growth. BioNexus is a special status awarded by the Malaysian Bioeconomy Development Corporation to qualified international and Malaysian biotechnology companies.

Dedicated to the giant prawn

Giva has a fascination for *M. rosenbergii* ever since he was a research assistant in University Malaya working on a national project, "Genetic improvement of the Malaysian giant freshwater prawn". After graduation, he gained experience in breeding and farming at SRMM Aquaculture, which is also a BioNexus status

An advertisement for I&V BIO products. The background is a light blue gradient with faint, stylized letters. At the top left is the I&V BIO logo. Below it, three hands are shown holding different product trays. The first tray is labeled 'INSTANT ARTEMIA' in large blue and red letters, with 'INSTART 1' and 'LIVE INSTANT ARTEMIA Easy and Consistency' below it. The second tray is labeled 'INSTART E Enriched' in large blue and red letters, with 'LIVE INSTANT ARTEMIA ENRICHED Enriched with Selco®' below it. The third tray is labeled 'M-Bryo' in large blue and red letters, with 'FRESH DECAPSULATED ARTEMIA CYSTS Intact membrane and No leaching' below it. At the bottom, there are two checkmarks with the text 'Ready to feed' and 'Vibrio free'. The website 'www.iandv-bio.com' and email 'E-mail: sales@iandv-bio.com' are at the bottom left.

company for the breeding and farming of freshwater prawns. He pursued his passion in aquaculture by joining Crops for the Future as Research Programme Manager to manage the FishPLUS programme which focuses on the research on alternative aquaculture ingredients replacing fish meal and fish oil.

He recently completed the Community Solutions Programme, a professional development programme for global community leaders working on various environmental issues. His practicum was at the University of Georgia, Athens (UGA), USA where he studies various aspects of the breeding and farming of the monosex giant prawn. He also worked on a couple of extension projects with the Marine Extension, UGA. To gain deeper knowledge in aquaculture, Giva is presently enrolled in the Master's degree in Sustainable Aquaculture via a distance learning programme with St. Andrews University, Scotland.

“The culture of single-sex prawns is economically superior. I want to be the one to bring about this change..”
- Giva Kuppasamy

Why all male post larvae

In the farming of the cannibalistic freshwater prawn, males grow about 60% faster than in a mixed population. Malaysian farmers begin harvesting after 6 months of the grow-out phase. During the culture cycle, farmers either separate the larger male prawns for sale at 6 months and leave the smaller female prawns to be harvested later, or they carry out a total harvest. The species, locally known as *udang galah*, is a very popular live item in seafood restaurants.

“The demand is for large-sized prawns at 10/kg and with low supply, ex-farm prices have risen to as high as MYR 90/kg (USD 21/kg) for this size. In a mixed culture, this preferred size is obtained after 6 months for male prawns while female prawns reach only size 40/kg. In a normal pond culture, females comprise 75% of the population,” said Giva.

“The culture of single-sex prawns is economically superior. I want to be the one to bring about this change. Mono-sex culture minimises fighting associated with mating of the prawns. The resultant energy gained from feeding increases the biomass of the prawn. Early industry data from Vietnam and China indicated that a farmer benefits from 134% greater yield per annum from single-sex culture compared to a typical mixed sex freshwater prawn culture.

“Imported broodstock were too costly for me at MYR 150 (USD 35)/broodstock. Domesticated broodstocks are available from international services providers and our local research centre which has the 3rd generation of broodstocks. All these do not match my goal of producing all male post larvae. This is what the prawn farmers are demanding. In an all-male culture, 3-4 cycles/year, each of 3-4 months, can be achieved instead of 6 months in a mixed culture system,” added Giva.

Neo-female broodstocks

GK Aqua imports neo females post larvae from hatcheries in China and Vietnam; these post larvae are produced by using the gene silencing technology developed at the National Institute of Biotechnology at Ben Gurion University of the Negev (BGU). This technology brings about a complete sex reversal of males of a fast growing BGU *M. rosenbergii* line into functional neo-females. Prawns are not genetically modified (GM) as no hormones or chemicals are used. As the intervention is temporal, it is not transmissible to the next generation (Aqua Culture Asia Pacific, 2013).

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*Documentation provided in support of the authorisation showed improved growth performance and survival with specifically a decreased level of *Vibrio* in the shrimp intestinal track with the use of probiotic Bactocell® developed by Lallemand.



The 4,000 m² facility is divided into a maturation room and hatchery/nursery facility. On the right, neo-female broodstock in the maturation room

“Due to chromosome pairings during mating, these neo-female prawns produce 100% male offspring. We buy neo females at the post larval stage at USD 5/PL and grow them into broodstocks over a duration of 120 days in shallow tanks in a biosecure facility. Broodstocks are fed a combination of broodstock feeds produced by Zeigler Feeds, USA and fresh squid. Mating of the neo females is natural with male broodstocks sourced locally and screened for diseases to produce the F1 generation. A 40 g neo female broodstock produces 28,000 eggs (700 eggs/g). By the time these prawns reach maturation, feeding and maintenance costs would have risen to MYR 40 (USD 9.34) per broodstock.

“Neo-female broodstocks can be used over a two-year period. However, as these prawns have gone through the gene silencing technology, I have to ensure proper disposal after use and prevent escapees into local water bodies,” said Giva.

“My challenge is to improve the survival rate of these post larvae as I grow them to broodstock. I now have only 150 left of the initial 300 post larvae bought for the first trial culture and R&D work. The process of silencing the gene is done at the post larval stage and so I cannot buy eggs. We screen all broodstocks for disease. Today, these are white spot syndrome virus (WSSV), infectious hypodermal and hematopoietic necrosis virus (IHHNV), *M. rosenbergii* nodavirus (MrNV) and extra small *Vibrio*. These add to the cost of production.”

Post larvae production

“The hatchery has a small number of employees, with only three staff to manage the 42 larval and 4 nursery tanks in the small foot print (4,000 m²) maturation/hatchery/nursery facility. The main challenge is bringing in the seawater required for larval rearing. Every 40 days, sea water is transported from the coast at Batang Berjuntai in 40- tonne tankers. Although Port Dickson is closer for us to transport seawater, the water has high heavy metal content,” said Giva.

“Currently, our capacity is 2.5 million of PL 10-15. From each mature neo female, we can obtain 10,000 to 15,000 post larvae at a survival rate of 30%. So far, we have managed to produce 0.5 million PL 10. The survival rates from the larval to post larval stage range from 25 to 35% and I would like to increase this to 40%. We maintain a stocking density of 20,000 post larvae for each 2-tonne tank. I sell post larvae (PL 10- PL 20) at MYR 0.10-0.15 each (USD 23.3-35/1000 PL) to a nursery, which is much higher than the current market price of MYR 0.07-0.08/PL (USD 16.3-18.6/1,000 PL). Today, with the high demand for post larvae, farmers are willing to buy 2 g juveniles at MYR 0.80 - 1 each (USD 186-233/1,000 PL). Average survival rate is 70% and there is a lot of interest in nursery phase operations.

“To be profitable, I will need to improve the survival rate to at least 50%. Other hatcheries reported 40-50% survivals from eggs to post larvae (PL 10). I am using the best feeds available. Our larval rearing costs are high as we use feeds such as the Biomarine USA (Artemac 4 of size 300 to 400 µ). Here, I also rear post larvae to 2-4 g juveniles over 45 days to be sold to farmers.

To date, the hatchery sold 200,000 juveniles to farms in Johor, in the south. Harvest results showed that all-male prawns achieved an average of 35 g within 50 days. The size range was 30 to 54 g. Usually farms use shrimp feeds as dedicated feeds for the species are not available in Malaysia. Feed conversion ratio is 1.5. Thus, having locally made sustainable non-fish meal based diet will boost the industry with lower production cost,” added Giva.

Targets

Passion, notwithstanding, Giva acknowledges that running a maturation and hatchery facility is not easy. The learning curve has been steep. There is the issue of retaining dedicated staff, even for simple duties such as feeding.

“My aim now is to develop standard operation practices so that I could bring in fresh graduates and get them interested in the hatchery and nursery business. At the scientific level, we may need to use metagenomics to look at traits and perhaps try





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to find ways to solve the size variation for these all male post larvae,” said Giva.

With regards to the grow-out of the all-male prawns, GK has the following targets: an initial group of 20 contract farmers producing a total of 200 tonnes/year in the first year, based on a production target of 800 kg/acre (2 tonnes/ha). Within 5 years, this will increase to 100 contract farmers and a production of 1,000 tonnes /year based on yields of 1,200 kg/acre (3 tonnes/ha; Kuppasamy, 2017).

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- Aqua Culture Asia Pacific, 2013. Monosex culture of prawns. January/February 2013, p 56.
- Kuppasamy, G 2017. All-male prawn technology for definite economic gain in Malaysia, Abstract presented at Asian Pacific Aquaculture 2017, July 2017, Kuala Lumpur, Malaysia, World Aquaculture Society.



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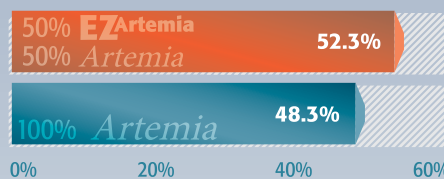


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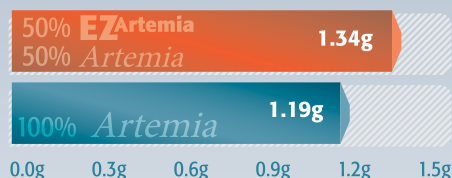


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Hard Talk with finfish farmers

Three farmers openly share their experiences in managing fish farms and a hatchery and identify the weakest links in their supply chain.



The Aquaculture Roundtable Series (TARS) 2017 gathered stakeholders in Asia's finfish aquaculture industry. Reflecting the range of finfish species farmed in Asia, this year's Hard Talk segment invited two farmers from the marine finfish sector; a CEO operating a barramundi (Asian seabass *Lates calcarifer*) farm in Indonesia and a CTO operating a Asian seabass and fourfinger threadfin (*Eleutheronema tetradactylum*) farm in Singapore. Joining them was the MD of a major tilapia hatchery company in Thailand.

I Gusti Arya Ameri Eman Himawan is CEO and Owner of PT Bali Barramundi, a fully integrated aquaculture company, set up in 2012 in Gerokgak, West Bali. The company has a land-based hatchery and nursery with cages offshore. It also runs a seafood restaurant in Denpasar. It is one of the top 4 marine finfish farming businesses in Indonesia.

Tan Kay Heok is Chief Technical Officer at Marine Life Aquaculture Pte Ltd (MLA) in Singapore. MLA has a hatchery, nursery and grow-out business mainly of the seabass and fourfinger threadfin. Tan Kay Heok, with 35 years of experience in farming shrimp and finfish in several countries, including Australia, China, Indonesia, Malaysia, Thailand and Seychelles, manages all technical aspects related to land-based and net cage divisions at MLA.

Amorn Luengnaruemitchai is Managing Director of Manit Farm Co. Ltd, a hatchery business in Thailand. After university, he joined the family business in farming the black tiger shrimp, and then diversified the business by starting a tilapia hatchery. Amorn also established the Manit Farm's Breeding Nucleus Center for Nile and red tilapia.

The farms

PT Bali Barramundi uses a three-phase farming system for the barramundi. The hatchery's capacity is 100,000 fingerlings/month in an indoor land-based hatchery, while the 80-day nursery stage produces up to 30,000 fingerlings/month in tanks and cages. Grow-out in 22 offshore cages can extend to 600 days for 2.5 kg fish. The farm starts harvesting with 500 g with regular partial harvest from 1.0 kg up to 2.5 kg for every cage.

MLA has a three-phase system, from land based hatchery and nursery facilities to grow out in cages. There is a 60-day nursery stage for the fourfinger threadfin. MLA's grow-out cage farm area has a total culture volume of 20,000 m². The farm's total production for 2016 was 100 tonnes. The farm's special features include, vaccinations with Strep-Si and Irido-V, stand-by pure oxygen and canvas bags for red tide.

Manit Farm has three hatcheries and nursery facilities in Phetchaburi, Thailand, covering a total 320 ha producing 0.3-1.0g fry and 20-50g fingerlings. The total output/year is over 200 million fry. Some of the farm's special features are vaccination of broodstock, probiotics for water treatment and feed probiotics. The Nile and red tilapia fry and fingerlings were the major species in 2016.

On challenges and lessons learnt

Amorn began his aquaculture career at his family's shrimp farm managing 30-40 ponds/cycle. "As we began to face rampant disease outbreaks, which affected three shrimp crops in a row and little was known on disease control, we wondered whether to continue with this 20-year shrimp farming business. I then decided to start a tilapia hatchery business where the cycle is much shorter with a faster return on investment.

"We were better because we diversified into tilapia, giving a steady source of income for the company. Later on, we started to distribute the feed and sell other products. If we did not do this, I am quite sure that we will not exist today."

Eman strongly believes in the traditional philosophy of life on the island of Bali: *Tri Hita Karana*, emphasising 'harmony with the people, nature and god'. "If I can implement this, I believe I can achieve success. Fish farming is very challenging and it costs a lot of money. I started this business because I was finding it so difficult to get supplies of barramundi, although I already have a market in Australia. Now my farm can supply 50% of demand. If this year I produce 200 tonnes, next year the target must be 400 tonnes. In terms of production, the most difficult thing in the past 4 years is getting good quality fingerlings derived from high quality and genetically improved broodstock".



“..the most difficult thing in the past 4 years is getting good quality fingerlings derived from high quality and genetically improved broodstock ..”
- I Gusti Arya Ameri Eman Himawan

Tan Kay Heok recounted the story when he left the shrimp industry and was asked to join the marine fish farming industry by the Singapore government. In his absence, the shrimp company he had been with encountered many problems and it asked for his help. On analysing the issues, he found that it was a management problem because many of the protocols were changed after he had left. "The lesson learnt was that in aquaculture, one can have the heart to run a farm but setting and adhering to management protocols is critical."



Brood stock at Manit Farm, Thailand

MLA started investing in sea bass farming but after four years, the production cost for sea bass went up to SGD 6/kg, while the market price was only between SGD 6-8/kg, giving a very small margin.

"MLA then shifted to focus on the fourfinger threadfin, but the survival was only 80-85% which was not acceptable by the management. Only last month, we used Aqua Life Services from Scotland to show us the best practice in vaccination." Tan Kay Heok explained, "We have learnt the professionalism in the salmon industry. There, the vaccination team is different from the anaesthetic team. What we learnt from them is that we can knock out the fish, but not to overdo it or else fish will not recover. But when this team came, they showed us how to do this the correct way. The main thing is to calculate the actual ppm of anaesthetic required to knock out the fish within one minute." Tan Kay Heok advised the audience not to be wary of vaccination. "Once the protocol is set, vaccination is easy."

On mitigating fish mortality

As Manit is a hatchery, Amorn said survival rates are already high at 90%. The room to improve is small, but improvements are still possible. "When people talk about disease and mortality, they think that mortality and disease are 100% related. From my experience, disease has always been associated with mortality but many times not the cause of mortality. Usually we fail to look at the cause."



".. disease has always been associated with mortality but many times not the cause of mortality. Usually we fail to look at the cause."
- Amorn Luengnaruemitchai

"To give you an example, earlier this year, I tried a new concentrated probiotic and the instruction to the staff was to use the probiotics once every week. However, they remembered the SOP with an older probiotic which we have been using for 5 years or more which required daily inputs. Two weeks later, we had only a 50% survival rate.

"If we send the dead fish or morbid fish to the laboratory, the most likely diagnosis would have been mortality from *Aeromonas*, *Streptococcus* or whatever bacteria or virus present. Actually, what had happened was an influx of seaweed growing with nutrients from the probiotic bacteria added and

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Vaccination in process at MLA by the Aqua Life team

preventing natural productivity. Besides, fish were stressed from the strong and direct sunshine because of the clear water. In our nursery production, we depend on the contribution from natural productivity and only use a supplemental feed. This would not have happened if our feed was complete. I think we lost almost 10 million fry within two weeks because of some misunderstanding of the protocol."

"Tilapia is a robust fish. If we have a problem with disease, we find the hapa dirty or the pond is not well treated. *Streptococcus* is always dominant in Thailand when the temperature is above 33-34°C. We have to reduce stock density, and then if we see any problem with *Streptococcus*, we have to treat them with antibiotics. After we treat the water with antibiotics, we have to put probiotics as well. This is how we manage the problem.

"To mitigate mortality, genetic improvement is key and is one where we can clearly see the improvement. Vaccination is very promising as well. Of course, management is important," added Amorn.

At PT Bali Barramundi's hatchery, larvae survival rate up to 2-10 cm fry is very low at 15%. It is 50% for juveniles from 10 cm to 200 g. Survival of larger fish (>200 g) in cages can reach 70%. "When the weather is good, we stock the cages with 3.5 cm fry rather than keep in the nursery. If we stock 200 fish, we will get 100 fish. If the farm vaccinates the fish, the result is 10% higher with the survival rate of 60%", said Eman.

When asked if the vaccination is worth the 10% increase, Eman added, "If it is only 10%, I do not think there is much advantage. When the environment is good, we put 500 fish into the cage, and then the result is around 300, survival is better. The mortality of the barramundi is commonly due to disease and sea lice.

"However, to have a better business, the farm needs to have at least 70% survival rate. We need good broodstock to improve the survival rate."

At MLA, the survival rate of fourfinger threadfin larvae is around 30-40% with early weaning at day 8. After day 15 in the nursery, the survival rate goes up to 80%. At 20 g, fingerlings are vaccinated with intraperitoneal (IP) injections. "Usually, mortality of the fourfinger threadfin is attributed to mishandling as scales are small. To solve this problem, the farm uses a fish pump, an auto grader modified with shower, and an auto counter. The automation will also save a lot of time, manpower and reduce fish stress. In Singapore, manpower costs are high. It would take about 3-4 days to finish grading 100,000 fingerlings manually.

Post vaccination loss is only 10-20% for the threadfin and lower at 1% for the seabass. Transfers over >700 m to cages with a pump only result in a 1% loss. The investment is worthwhile as the machines last more than 10 years," said Tan Kay Heok.



“ You can save a lot of fish, by not waiting until the disease outbreak to apply hsp. This is a good disease prevention tool. ”
- Tan Kay Heok

MLA has their SOP for disease prevention. Firstly, grading will cull out all the undersized fish because smaller fish have under-developed swim bladders and are disease carriers. A second approach is to upregulate stress tolerance with heat shock protein (hsp) treatment prior to vaccination and then cull out weak fish. This is done in the first 7 days when viral nervous necrosis (VNN) infections are high. But prior to this process, Tan Kay Heok advised to monitor hourly the frequency of rotifer feeding as larvae reach the open mouth stages. "You can save a lot of fish, by not waiting until the disease outbreak before applying hsp. This is a good disease prevention tool."



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Legend



Filleting fish from PT Bali Baramundi

On weakest links in supply chain

Each farmer gave his views on where he thought was the weakest link in the supply chain and what help will be required. According to Amorn, in Thailand, one of the challenges faced by the tilapia industry is that farms are small. This is totally different compared to the salmon industry. Each farmer produces at least 20 to 40 tonnes of fish/year. Each of the 20,000 people in the industry are responsible for some part in the supply chain.

Marketing, image and branding

Amorn said, "The marketing of tilapia in Thailand is very weak. Nobody in Thailand takes care of the image aspect. Even the government does not do this. They just normally focus on farming standards or on legislation. We do not have an equivalent as in the salmon industry. Look at how well Norway promoted the salmon all over the world."

He added that feed companies along with the major stakeholders, farmers and the government should come together and work on the image of the fish. Production volumes of tilapia in Thailand have been stagnant for years.

The weak link is image and branding for the barramundi. Eman said, "Even the locals in Indonesia are not familiar with the barramundi. Globally, everybody knows the salmon. For the barramundi, there is also the question of origin; sea cage farmed or pond cultured. We cannot mix the two. That is why we mention barramundi from Bali is farmed in sea cages so that the image is good. Sea-cage barramundi is sold at a higher price. The farm gate price of barramundi in Bali is around USD 4.90/kg. That is why the barramundi farming has investments from the US and Australia."

Genetic selection

Genetic selection is one area where producers will need the support from governments. Eman repeated his request. "On genetics, we hope to have support from the government to improve brood stock quality."

Supporting this Tan Kay Heok, said that MLA's weakest link is on genetic selection. In order to improve production, the farm needs to carry out a genetic selection program. "MLA tried to do its own genetic selection program in a joint venture with Agri-Food and Veterinary Authority of Singapore (AVA). The broodstock fish need biosecure facilities and require a land-based facility to ensure good quality eggs.

"Lastly, if the farm is managed well and has good biosecurity as well as good SOPs, there will be no problems in the production side. The sea temperature may have increased compared to 20 years ago, but it is good for fingerlings, as they will grow faster, but of course, that means diseases will spread easily as well."



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Image courtesy of CDC

TARS 2017: Finfish Aquaculture – Strategies for Growth

Part 1: Industry challenges

The plenary at TARS 2017 had five sessions, covering;

- state of industry and challenges;
- a new realm for the Asian white fish;
- production, health and environment;
- performance feeds and cost efficiency, and
- new frontiers in finfish farming.

During the interactive breakout roundtable session, participants deliberated on strategies for growth via production efficiency and industrialisation; performance and functional feeds and marketing image and sustainability.

TARS 2017 was supported by the Indonesian Ministry of Marine Affairs and Fisheries. Industry sponsors were Inve Aquaculture, BioMar, Biomim, Nutriad, Jefe, DSM, Aquativ, HJ Baker, BASF, Cargill and Skretting. It was organised by Aqua Culture Asia Pacific magazine and Corporate Media Services, Singapore.

Growing Indonesia's finfish industry

Indonesia is the third largest producer of farmed fish, after China and India. It also has the world's largest tilapia farm. Finfish production rose to 3.7 million tonnes in 2015. Most of the farming activity is in the western part of the country producing 2.9 million tonnes.

In his presentation on 'Growing Finfish in Indonesia', **Erwin Suwendi**, Head of Nutrition and QC, PT Suri Tani Pemuka, Aquaculture Division of JAPFA Group in Indonesia, described the structure of the industry. Tilapia is the major species at 1.09 million tonnes of production in 2015, followed by the *Clarias* catfish at 719,000 tonnes, a relatively cheap fish for local consumption. Next is the common carp at 461,500 tonnes and pangasius at 339,100 tonnes in 2015. Public centres conduct brood stock domestication and genetics programmes focusing on traits such as fast growth, improved feed conversion ratio (FCR), disease resistance, high fecundity and better fillet yield. Seed stock are from public and private hatcheries; large scale and backyard hatcheries. Nursery culture is common for groupers, tilapia, milkfish, catfish, common carp, gourami and pangasius. The four-stage tilapia nursery is from larvae to a final size of 8-12 cm after 60 days. Almost all grow-out systems are monoculture, from low to high density.



At the breakout roundtable on Performance and Functional Feeds (PFF), Dr Nguyen Huu-Dung INVE Aquaculture, Vietnam (middle) and Dr Thomas Wilson (standing). Thomas presented on Sustainable aquaculture starts with feed.



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Dr Preecha Ekatumasuit (right) and Nonthawit Sae-Hia, TRF Feed Mill Co, Thailand



“Our industry is seeing a growing momentum to learn from the past, educate farmers and influence market demand..” - Erwin Suwendi

outlets where fried fish is the main product. Exports are fish fillet and value-added products. Demand and price fluctuations are common and are correlated to festival periods,” said Erwin.

“In the feed industry, among the 49 registered aqua feed producers, there is awareness on the need to replace fish meal for sustainable feed production. In fact, Japfa is the first company to produce low phosphorus tilapia feed to address the impact of this nutrient on the environment. It is the only company from Indonesia invited to participate in the Free Fishmeal/Fishoil Feed (F3) challenge in the US,” said Erwin.

Meeting targets

“Despite the government’s plan to increase production in 2015, the actual achievement at 3.7 million tonnes was only 66% of its target of 5.6 million tonnes. This is still an increase of 2.5% over production in 2014. This implies that the country’s finfish farming industry is currently facing many challenges.

In his SWOT analysis on the industry, Erwin identified several strengths, from high species diversity with ten commercial finfish species, strong government support, affordable and willing manpower to work in remote places, availability of local feeds and locally manufactured equipment such as cages. The government has initiated several development programmes. The Indonesia National Standard has codes of practices along the supply chain (genetics, brood stock, hatcheries, nursery, grow-out and feed) for several species. Currently all of these are present for grouper, tilapia, common carp, pangasius and *Clarias* catfish.

Two major weaknesses are in seed quality and availability and farmer capability. “Local farmers still do not have proper standard operation procedures (SOP) and are not familiar with scientific approaches to solve problems. I believe that public R&D budget is low and research projects are fragmented and too focused on short term problems.”



From left, Mary Ann Solis, Biosolutions, Roselyn De la Cruz Usero, Negros Prawn Producers Cooperative and Maria Abigail Apostol-Albaladejo, Bureau of Fisheries and Aquatic Resources, Philippines

In terms of opportunities, there is large potential for investment in freshwater and marine aquaculture in the eastern and central regions of the country. “The future of Indonesian aquaculture is also in sustainable and responsible off-shore mariculture,” said Erwin. “Our economy is growing at 5% annually and with a population of 240 million and rising incomes, the domestic market is large. But, in marketing, the multiple supply chains also mean that prices are high for the end consumer.

“We will need to focus on the threats, mainly disease outbreaks from *Aeromonas hydrophila*, *Streptococcus agalactiae* and *S. inae* occurring during the rainy season. Others include environmental pollution, land and water conflicts such as use of lakes for tourism.”

Fish production, mainly freshwater fish, is also for national security. “We have several potential fish species for the export market such as barramundi, grouper, pompano, tilapia and eel. Our challenge is the intense competition with most Asean countries producing the same species. To survive, we just need to be unique and different.”

Erwin concluded, “Overall, our industry is seeing a growing momentum to learn from the past, educate farmers and influence market demand; it is calling for more responsible and sustainable methods to grow future finfish production via technology and a nutritional holistic approach. Cooperative work and collaborative research are absolutely needed among aquaculture stakeholders: farmers, private sector as well as government in order to minimise or resolve the problems.”



Laura Khor with Dr Olivier Decamp, INVE Aquaculture. Olivier presented on the Tilapia-increasing value through technology



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Dr Ketut Sugama, Research Center for Aquaculture, MMAF (left) with Agus Somamihardja (middle) and I Gusti Arya Ameri Eman Himawan, PT Bali Barramundi, Indonesia

Challenges in China's finfish farming

While working at the JV company, Tongwei-Biomar, based in Chengdu, China, **Niels Alsted** (BioMar Group A/S, Denmark, Business Relations and Technical Director) spent a year in China and frequently visiting China during the last 10 years. His presentation on the industry in China reflects his experiences in China's fish feed world. He compared this with his 40 years in Denmark as a farmer and in the feed industry.

Aquaculture in China is varied, with more than 100 species in production. Farmers have considerable experience in handling water and farming conditions. In terms of volume, farming is dominated by the cyprinids, but farming of other species such as bass, pomfret and croaker is growing, as a result of the demand from a growing well-to-do population. "As such, it should be a good starting point to move aquaculture from a rural to a more industrialised activity," said Niels.

The fish feed industry comprises numerous small and medium size companies and a few big feed producers supplying mainly small family farming units, with the majority using low cost feeds. "Only the larger companies have the scale to carry out R&D to support the development of feed and farming. The feed price is the main contention, especially among the small producers. In Scandinavia, the introduction of more advanced performance feeds usually comes with a lot of expectations from farmers. For them, the decision to use the feed will be based on the final output."

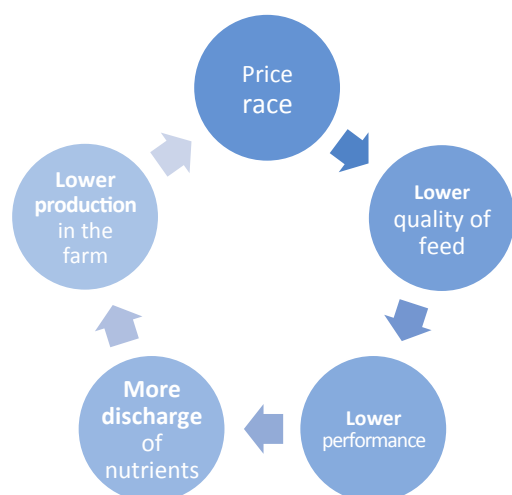


Figure 1. Negative spiral in feed supply and demand

Huge demand for finfish

There is a lot of strengths in the industry. Among them, farmers are flexible and work fast to swap species. There is a huge demand for farmed fish and fish is highly valued as a food item. Weaknesses include access to water (in terms of quantity and quality) and poor control of farming conditions sometimes giving rise to algal blooms and extreme low oxygen content, 1-2 mg/L is not unusual. "Warm water fish farming in the south lacks good water quality. Retailers rank food safety top on their list of demands. Sustainability has a low ranking. Consumers are not aware of traceability," added Niels.

Niels said that opportunities revolve around access to water and its quality. "New technologies such as simple to complex recirculation aquaculture systems (RAS) were recently introduced. This development requires the use of efficient feed and technical knowledge more professionalism in the sector. The focus on exports will require certifications such as Aquaculture Stewardship Council (ASC), Best Aquaculture Practices (BAP) and GlobalGAP."

Climate change giving rise to more extreme weather conditions, temperature fluctuations and flooding is a perpetual threat in the south. These in combination with poor water management lead to disease situations which could explode. Consumer focus on food safety and farming conditions could mean imposition of environmental regulations to control discharge of nutrients (nitrogen, phosphorus etc).

Production performance

The demand for safe and sustainably produced fish requires new types of feeds where performance is more important than feed price per kg and where the formulated feed is less polluting to the environment. There is a huge need in China to switch from the use of trash fish to pelleted feeds. This will require stricter enforcement of food safety regulations, the environmental footprint and a more transparent chain from raw materials all the way to the consumers.

An important issue is building trust between the farmer and the feed miller. This is explained by the negative spiral shown in Figure 1. "Raw material price variability leads to necessary changes in formulation which could change feed colour or smell without affecting performance. Many farmers see these as attempts by the feed miller to increase profits at their expense. In China, we see the initial change in focus from protein to digestible protein. Over at Biomar in Denmark, we have made the necessary shift via huge investment in R&D to be less dependent on fish meal without compromising fish performance and this is yet to come to China," added Niels.

"In this negative spiral, it is difficult to sell higher performance and thus higher cost feeds. If there are no environmental regulations to restrict environmental pollution, feeds with lower discharge of nutrients will not be readily accepted and could add to cost of production. Similarly, when feed conversion ratio (FCR) and growth is not the limiting factor (very often it is water quality or dissolved oxygen), high performing feeds have no added advantage and will only add to production cost. With limited documentation at the farm level, no farmer will pay extra for feed. The reality is that because of the lack of control in water and pond management, water quality will affect the performance more than feed would." The need for improving both farming conditions goes hand in hand with more effective and competitive feed.



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“ China is on its way to make these changes as there are no other alternatives. ”
- Niels Alsted



“ ..Our greatest fear is NNV affecting the groupers with 90% mortality, when temperature rises. ” - Laura Khor Li Imm

Production technology

With limitations on water use, there are already ongoing shifts from simple to advanced RAS involving high-end technology, high investments and intensive control. Today many farms in south China have 1-1.5 ha ponds producing 50-80 tonnes/year. The potential to produce more with less is obvious.

“It is all about water management and adapted feed. There is a lot of interest in RAS systems but it does not mean that the conventional system has to be abandoned. Rather, some of the advanced technologies can be applied to existing systems and it is important to be able to evaluate the weaknesses of an existing system.

His message was that the more exigent segment of the population will demand for safe and sustainable food and this requires a new approach to feed as well as farming. China is on its way to make these changes as there are no other alternatives.

A challenging marine finfish farming business

In Malaysia, the IKS group, started in 1997 as KS Aquaculture, a company formed by three farmers with 20 net cages in Pulau Ketam, Selangor in Peninsula Malaysia. Through acquisitions and organic growth since 1998, it is now the largest marine finfish farming business in Malaysia with 8 cage grow-out farms around Pulau Ketam, Selangor, as well as a land based hatchery and 3 other cage grow-out farms in Johor in the south. Today, it has a total of 7,482 cages covering 154,000 m².

In 2016, production comprised 50% of red snappers *Lutjanus malabaricus*, 20% groupers (tiger *Epinephelus fuscoguttatus*, giant *E. lanceolatus* and tiger x giant grouper hybrid) and 10% of pompano *Trachinotus sp.* Other farmed species include the golden snapper *L. johnii* and Asian seabass *Lates calcarifer*. The yearly fish production is 1,250 tonnes of marketable fish and 5 million of 2-inch (<5cm) fry.

Laura Khor Li Imm, Quality Control Manager at KS Aquaculture highlighted the challenges faced by fish farmers in the group in keeping up with environmental and market changes. Her task at the group level is to bring the company to a sustainable level and according to Laura, a considerable amount of the time is spent on monitoring disease outbreaks and environmental conditions.

Survival and growth rates

Both survival and growth at grow-out have declined significantly. “Average survival rates of one-year old red snapper went down from 75% in the 1990s to only 25% in 2016. In the case of the one-year old grouper, it was 15% in 2016, versus 65% in 2005. This is common across almost all of our grouper species. Growth has also suffered - we used to get a 22 kg giant grouper after 4 years of grow-out. But today, we get a 12 kg fish after 4 years and 18 kg fish after 5 years.

“With more than 40 years in marine fish farming, some of the farmers are experiencing less than pristine farming conditions such as nets touching the sea bottom with sedimentation. Loss of bivalves around cages signifies poorer water quality.”

Natural phenomena indicative of climate change have been a bane for the farmers. “These include phytoplankton blooms which destroyed market-size stock in cages in Johor. Our sampling of the phytoplankton showed the presence of red tide algae species, dinoflagellates and diatoms causing clogging of gills. There were also instances of mass fish mortality where we could not identify the cause,” added Laura.

Production planning and challenges

Farms avoid extremes in water pH and dissolved oxygen (DO), fluctuations when stocking. “Traditional farmers will also avoid the lunar full and new moon when the current velocity is highest. They also try their best to avoid periods with the higher possibility of parasite infestations especially of *Benedenia sp.*



Wully Wahyuni, PT Novus International Indonesia



Gede S Sumiarsa, Institute for Mariculture Research and Fisheries Extension (IMRAFE), Bali



Thomas Levallois, Maqpro, Indonesia



Ketut Bendesa, CV Surung, Indonesia

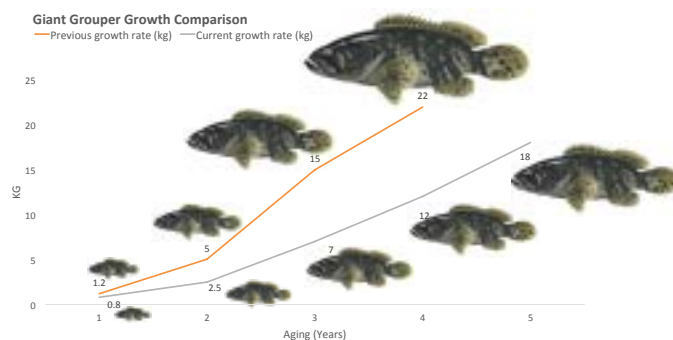


Dr Rutchanee Chotikachinda, DSM, Thailand (left) with Candra Yanuartin, PT Sinta Prima Feedmill, Indonesia

“The other challenge is planning harvesting to meet customer demands, highest during the lunar new year week (usually in late January to early February). For example, it takes a year to grow the red snapper to 600g fish and so stocking should start a year earlier. During the arrival of the harvester ships or festival periods, all workers have to be mobilised across all farms to assist with the harvesting. A lack of manpower also poses limitations in managing the health of fish stock in a large farm.”

Farmers are not able to raise current fish prices in tandem with the rising costs of feed and fry, due to more competitive prices of wild catch. Laura said that the price for wild caught grouper and crimson snapper was USD 4-5/kg (Indonesia wild caught fish in March 2016) as compared to their ex-farm prices of USD 7-10/kg. Farmers use both extruded feeds and trash fish, depending on species. “In 2016, we saw a 31% increase in feed cost and 188% increase in trash fish prices. Farmers still depend on trash fish for the grouper which give faster growth.”

Slower growth rate for giant grouper



“We have a supply shortage of affordable grouper fry that are free from pathogens and able to tolerate the conditions of the cage farm after being reared in the protected hatchery environment. Farmers currently depend on imports of grouper and pompano fry from Indonesia, China and Taiwan. We also suspect that fry may carry vertically transmitted viruses. But in order to provide health certifications, suppliers may then increase fry costs to offset the extra cost of certification.”

Two recent government rulings affect fish marketing and daily operations. “KS sells its groupers live to Hong Kong harvester ships plying the region regularly. The government is limiting entry of these boats into our waters by imposing strict requirements for documentation. KS has a total workforce of 170 in all farms, both local and foreign workers. However, the government has now limited foreign labour to 2 workers/ha and there is 10-year stay limit for each foreign worker.”

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Angga Aditya Putra Nugraha, PT Matahari Sakti (left) and Andri Budi Santosa, Phibro Animal Health, Indonesia with A K M Ruhul Amin Sarker, DSM, Bangladesh (right)



Presenters in the session on New Frontiers in Finfish Farming; from left, Dr Anant S Bharadwaj, iAqua (A future with fishmeal-free feeds), Alain Michel, France (Critical success factors of marine fish farming) and Bent Pedersen, DSM, Denmark (Benchmarking: The Salmon Model). See pages 45-48 for an article by Alain Michel on 'Farming the barramundi alongside pathogens'

Disease challenges

"Over the years, farmers have also observed 70% more disease outbreaks compared to 15 years ago, associated with poor nutritional health, parasites, secondary bacterial infections and viruses carried by infected fry," said Laura.

"We have seen infections and reinfections of the parasite *Benedenia* sp in red and golden snapper causing scale loss and white head syndrome. *Dactylogyrus* infections are mostly seen in morbid red snapper and grouper. Farmers are afraid of *Polyopisthocotylea* (*Microcotyle*) which are difficult to get rid of in red snapper. Isopods in tiger and hybrid groupers are also difficult to eliminate and need to be removed manually. Both bacteria, *Vibrio alginolyticus* and *V. parahaemolyticus* cause

ulcers in orange-spotted grouper, tiger grouper and hybrid grouper while *Streptococcus* sp infections have been found across all fish species. *Tenacibaculum maritimum* outbreaks have been observed in Asian seabass causing ulcers and scale drop mainly after the rainy season. *Nocardia* sp was also found in red snapper with chronic disease.

"We have some cases of viral infections. Lymphocystis causes low gradual mortality and slow growth in the grouper. In some instances, the overgrowth of lymphocysts on fins slow the swimming for the red drum, making them susceptible to parasite and secondary bacterial infection. Iridovirus outbreaks are responsible for high mortality of up to 60-80% in grouper, red snapper and red drum. In these cases, supplementing feed with

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Breakout at a roundtable on production efficiency and industrialisation (PEI)



“ The industry had to rationalise the fixed costs. The first impact was on the small farms with 5-10 cages. ”
- Hervé Lucien-Brun

yeast products and vitamin C helps to overcome stressful periods and offers some level of protection for the fish. Our greatest fear is nervous necrosis virus (NNV) which could result up to 90% mortality in groupers when temperature rises.”

Moving forward

The group is on its way to obtain farm certifications which will require constant testing of water, feed and fish. It is adjusting SOPs to match limitations in staff and its traditional farming structure. Adapting to changing market conditions, KS now offers online sales of vacuum packed whole and processed products (gutted whole and portions) to local customers. Laura sees a need for change, “We really need to transform traditional culture practices towards more sustainable methods in the face of changing demands and environment.”

Strategies with competition in the Mediterranean

In the 1980s, France, Spain and Italy were the main producers of the European sea bass *Dicentrarchus labrax* and gilthead sea bream *Sparus aurata* in the Mediterranean. By the 1990s, the breakthrough in hatchery production pushed up production. Competition increased with spectacular developments in Greece and Turkey, helped by numerous suitable sites and European Union financial support.

During this TARS, **Hervé Lucien-Brun**, Jefe Aquaculture Consultant had the role of explaining these developments and how producers rationalise their fixed cost in this very competitive market. These developments in the Mediterranean are lessons to learn for the industry in Asia.

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Apirum Wanaputh, Biomin Thailand (right), Apirux Kimawanit TRF Feed Mill (left) with Nuttapon Muangsuwan Charoen Pokphand Foods (Public) Co., Ltd, Thailand



Dr Wee Kok Leong, Gold Coin (left) with Paul Chen, Wenger, Taiwan and Ramesh G., Wenger, India.

"In the 1990s, we opened the bottleneck in fry and fingerlings which previously came from hatcheries in France or were wild caught. Initially most of the farmed fish, fresh and whole 300g-500g fish were sold to the Italian market with very high prices. Then farmed production of seabass and seabream increased at a rate of 30 % per year between 1992 and 2002 and induced a dramatic fall in prices. The ex-farm prices of both species decreased by approximately 60% between 1990 and 2000. In January 1999, the price of seabass was €7/kg and this dropped to €3.2/kg in 2002. Currently, prices fluctuate between €4.6 and €3.8/kg.

"The industry had to rationalise the fixed costs. The first impact was on the small farms with 5-10 cages. We saw business bankruptcies, even among the larger companies. Some groups of producers, with the support of banks caused involuntary dumping to remove competition. It was a real war."

Reduction of fixed costs

This came with acquisitions and consolidation of farms. The number of companies producing marine fish fell from 430 to less than 40 in 2016. There was integration along the supply chain. In Turkey, Kilic Deniz increased production by 26% between 2004 to 2014 and exported to 40 countries. They produce 30% of the Turkish seabream and 12% of the seabass. They have a production capacity of 394 million fingerlings in 46 hatcheries, have feed mills, processing plant, transformation units and commercialisation units. In France, the much smaller but totally integrated Gloria Maris, produces almost 80% of the French farmed marine fish. Expansion was possible in Greece and Turkey where there is a balance between tourism with aquaculture but

not in France, where the number of suitable sites is less and the priority is tourism.

Reduction in cost of production

"With low prices, farms needed to improve on costs of operation to remain competitive. They had to adopt strategies to improve feed conversion ratios. FCR was reduced from 1.8-2.2:1 to 1.4-1.6:1 for portion size fish (500 g fish). In larger fish (>1 kg), the FCR came down to 2.2:1 from 3:1. Feed producers made a strong effort to reduce part of fish meal and fish oil in the feed. Only extruded feeds were used. In feed management, automation was introduced. Fingerlings were produced in specialised hatcheries (almost 1 billion per year) to optimise production cost," said Herve.

Branding and image

While in the 1990s, fish was sold as whole fish in open markets, the change was to focus on branding. Companies shifted to produce large 3-4 kg fish, filleting and developing product forms for a new generation of consumers. Renown chefs assisted in promotional campaigns to expand markets. The focus was also on country of origin to encourage national pride in local products. Emphasis is now on product quality by shortening the time between slaughter and conditioning and logistics between farm and market. Certification is a strong asset in some markets. New markets such as the UAE, Russia and US were developed.

His message was, "Any drop in prices is always a no-win situation and possible ways to regain markets are branded products with differentiation based on origin, quality and certification."



At the breakout roundtable on PEI, from left, Chi Man, BASF East Asia, Hong Kong, Hermanto, Fish Hatchery at PT Matahari Sakti Indonesia



Dr Philippe Sourd, Diana Aqua - Aquativ, France (right) and Dr Luís Conceição, SPAROS Lda, Portugal.



“ Who would imagine that our humble pangasius as premium product! ”
– Jonathan Forrest Wilson

Moving up the whitefish ladder

In this presentation, **Jonathan Forrest Wilson**, Executive Director Godaco Seafood JSC, Vietnam, discussed the need to grow the value of the pangasius through value added production. Godaco is a fully integrated company in pangasius; from fry, feedmill, grow-out to cooked products. “Vietnam produces an overwhelming majority of the globally traded pangasius products. Therefore, it makes sense to talk about the evolution of value added pangasius in the context of the Vietnamese experience, economy and industry.”

Today, Vietnam's output of pangasius is 1.2 million tonnes, 80% of global production. It has come a long way, to be an international product farmed and processed under certified standards and modern processing techniques. “The Big Bang was from 2000-2007 with an exponential growth in production, from a mere 59 tonnes in 1996 to 1.3 million by 2013. Exports targeted high prices in US markets. Prices were more than USD2.7/kg in 2007. The industry attracted investments and capital. In 2015, exports totaled 865,000 tonnes and main markets were the EU, US and Middle East.”

Since 2010, there has been an industry consolidation. According to VASEP, in 2016, there were only 105 exporters and 58 producers from 380 and 120, respectively in 2010. Partial integrated companies support farmers with technical help to ensure compliance to certifications.

“The industry is dependent on the Mekong, the greatest gift to pangasius farming but also its greatest challenge as a natural resource. Going forward, shared resources will continue to be an issue. Periodically, there is sensational media coverage purporting pangasius from Vietnam to be one of the most environmentally damaging fish. Today, the pangasius is a well-monitored fish. There are many programs implemented by industry, government and global NGOs. In 2017, top pangasius producers agreed to establish and contribute to a fund to counter negative publicity on the pangasius.”

Wild ride for producers

“However, for the producer, it was a wild ride since 2007; lower prices with over supply typical of any commodity. Prices in Europe have declined since 2013 linked with various issues. Oversupply is one reason but many instances it is due to bad press. Our challenge has been coping with one crisis after another. One way forward is to increase productivity and the other to go downstream with cooked products,” said Jonathan.

“The US market, although a target, has become restrictive with tariffs and 100% inspection holding up consignments. Producers are looking for Asian and Middle East markets to expand. In Q1 2017, China was the leading importer. It is easy to enter China which focuses on food safety but there is little demand for sustainability which we have been investing and working hard to be certified by ASC etc .”



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At the Q&A, presenters in the sessions on production, health & environment and performance feeds & cost efficiency. From left; Dr Philippe Sourd, Diana Aqua – Aquativ, France, Dr Thomas Wilson, Thailand; Michele Muccio, BIOMIN; Francisco E Montero, University of Valencia, Spain; Dr Dominique Bureau, University of Guelph, Canada and Dr Luis Conceição, SPAROS Lda, Portugal. Reports on their presentations will be in the next issue

Up the value chain

“The pangasius is a fantastic fish and can play a strong role in the world of the whitefish. However, as a commodity, it competes in the low-cost whitefish arena. Vietnam exports most of its pangasius as white fillet. Several integrated producers are trying to advance and drive value through further integration by moving up the value chain, by coating and in some cases even cooking. According to VASEP, the amount of value added is a mere USD13 million which means that 0.74% is value added out of the USD 1.6-1.7 billion of exports.”

As an example, Jonathan showed a case study of value added pangasius in the UK retail market. “In 2016 the UK imported USD 44 million of pangasius fillet from Vietnam. Some 65-70% of the volume imported is then value added, coated marinated or blended in the UK for retail and food service distribution. In UK supermarkets, value added pangasius or basa sits alongside premium white fish such as the cod. Who would imagine that our humble pangasius as premium product!

“Currently the UK, EU, USA, ASEAN, and the Middle East are all importing frozen pangasius and then further processing into products such as coated pan fried, marinated and coated frozen. Vietnam’s pangasius can move up the value ladder designing food for the developed world rather than selling just raw material.”

In terms of pricing along the value chain, Jonathan added, “We can see returns on investments into value adding. From the farm gate price of USD 1/kg we can see retail prices of USD15/kg. Therefore, convenient foods and ‘ready to eat’ represent further opportunities for the industry in Vietnam. Bringing the value

added processing back to point of processing rather than doing it in the importing country will generate benefits for industry’s productivity and growth but also more sustainable and better yields for the people of Vietnam,” added Jonathan.

However, this is still a long journey ahead. Can the pangasius challenge other whitefish traditionally used for value adding such as hoki, pollack and tilapia?

“We have learnt that food technical knowledge is a critical success factor and that we can be in competition with some customers. We also must be able to “design” a food product and not just freeze a fillet. Finally, certifications throughout the value chain are just “entry fee” which we should not expect to add much value.”

The message was, “We are no longer in the frozen fish business, we are in the frozen food business and that is a bigger pond of profits.”

TARS 2018 will focus on Shrimp Aquaculture and will be held on 15-16 August 2018.

Next issue: Part 2 will cover presentations on Tilapia-increasing value through technology and on production health and environment; performance feeds and cost efficiency and new frontiers in finfish farming.

Measuring performance in formulation

By David Serene

A tool to measure feed performance can evaluate formulation process improvement during a period of time.

The job of a nutritionist has changed a lot in the past years. The nutritionist in a feed mill does not only prepare feed formulas; he or she is also responsible for defining the constraints that will affect software optimisation in the selection of the cheapest formula option. The formulation perimeter is the space allowed to the software between four distinct sets of constraints: nutritional requirement, non-nutritional requirement, raw material composition and raw material prices. The mission of a nutritionist is to adjust the formulation perimeter (or constraints) to optimise the feed performance (feed conversion ratio, feed cost, growth, mortality, feed intake, etc).

With monitoring formulation performance, we are touching a very critical topic that dictates the competitive game among feed millers. It is about which company will formulate the best feed at the cheapest cost. It requires a lot of thinking, time and energy to build sets of feed formulas. We need to be sure not only that we are performing better than our competitors but that we are also actually getting better every month.

The difficulty for feed millers is that raw material prices are constantly changing, requiring the software to modify the formulas. Therefore, we cannot compare the performance of formulas made with today's prices with the ones made with yesterday's prices. The economics vary and make internal benchmarks over time difficult.

Without a clear benchmark, it is difficult to measure formulation performance. These are the questions we need to ask:

- Are we formulating more efficiently today than last year?
- Are we getting better than our competitors in terms of formulation know-how?
- Are we innovating enough to increase our feed performance?
- Are we recognising the contribution and effort of our nutritionist in improving our feed performance?

It is critical that we define the proper tool to answer these questions in order to ensure that our formulation skills are improving and that the nutritionist and all support functions are thriving to increase our feed performance.

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Table 1. Test of two formulas

	Field trials results			Strategic weights	Formulation Performance Index (FPI)
	January formula*	December formula*	Variation		
ADG	0.95	0.97	102.1%	30%	102.1%
FCR	1.55	1.48	95.5%	30%	104.5%
Cost	0.54	0.56	103.70%	30%	96.3%
Survival	80%	85%	106.3%	10%	106.3%
*both formulas have been optimised with the same raw material prices					101.5%

Formulation performance

The tool that we propose is called the formulation performance index or FPI. It is used to evaluate the formulation process improvement during a period of time. The formulation process involves the definition of what we call the 'formulation perimeter'. During the year, the formulation will change illustrating the modifications in the formulation constraints. The wider the constraints, the higher are the chances to reduce feed cost.

As we are trying to evaluate if the change in the constraints derived by the software formulator is having a positive impact on the feed, we need to eliminate the ingredient price variation from our evaluation. At the end of the period, for example at the end of the year, we simulate a formulation by entering into the software the same ingredient prices that was used at the beginning of the year.

If the formulation constraints have not been changed by the formulator, the formula will be the same as at the beginning of the period and it will underline an absence of improvement during the period.

If the formula coming out from the software is different than the formula at the beginning of the year, it means the nutritionist has modified the constraints and it is time to evaluate the impact of those changes on the feed performance.

In table 1 we show how we test the two formulas in a farm to calculate a performance index based on key parameters.

The weightage is very important as it illustrates the company strategies regarding the importance of each parameter. Some companies will favour the importance of feed conversion ratio (FCR), others the average daily growth (ADG) and others will emphasise cost reduction. Other dimensions like feed intake and diarrhoea score can be added. The table will have to be adjusted for each individual company depending on their strategy.

A FPI higher than 100% shows that the formulation perimeters improve over time. This underlines good performance of the nutritionist team and should be celebrated as an important achievement.

The benefit of such a tool is that it gives a strong message to the nutritionist, technical and research team that any improvement of the perimeter will be recognised and celebrated. It is a strong incentive to innovate through the adjustment of nutritional and non-nutritional requirement. Every trial to be made by the R&D team should aim at confirming a new constraint to be later incorporated into the formulation perimeter. If the trial conclusions do not end up into the formulation software, the finding will not be converted into economical benefits.

Constructive changes

The second strong message supported by the FPI is that our job is not just to derive new formulas. Animal nutrition excellence

“ We do not improve on what we cannot measure. ”

is not related to the number of formulas we have prepared but rather to the number of constructive changes we bring to the formulation perimeter, such as defining more accurately animal requirement, understanding better the non-nutritional constraints and monitoring more precisely the raw material composition. The relevancy of these changes will be ultimately assessed through the FPI.

Finally, the FPI is a tool for nutritionist to make decisions. We all know how to improve feed performance (reduce FCR and increase growth rate) but it always has a cost. The right decision is when the decrease in FCR compensates the increase of feed cost to minimise the animal production cost. By calculating a weighted average between FCR decreases and cost increases; the FPI helps to find the optimal balance between these two opposite drivers, feed performance and material cost. It will help nutritionist to screen more objectively new nutritional strategies, namely new feed additives.

The FPI requires field trials and cannot be done for every formula. We need to select only a few formulas to be monitored. That would be sufficient to drive positive team behaviour that will, in return, have positive consequences on other formulas as well.

It is important to understand that these formulas designed for evaluating formulation performance are not optimised for selling purpose. They should only be used for field trials and not sold to customers.



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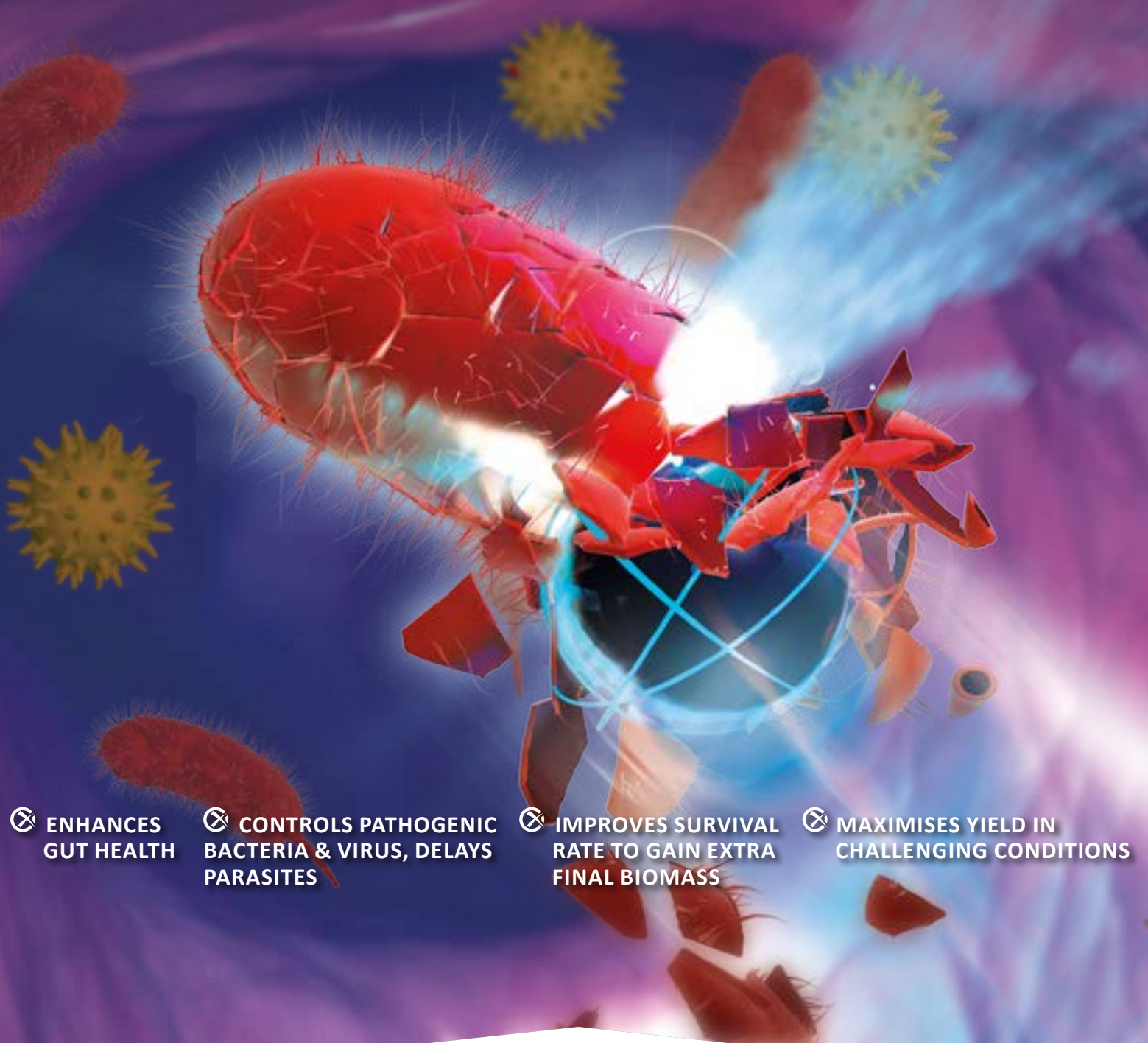


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Proactive feeding for shrimp broodstock and larvae

By Aedrian Ortiz Johnson and Eamonn O'Brien

Broodstock and larval diets with appropriate combinations of functional ingredients to enhance shrimp immunity showed better survival rates.

Global warming is affecting the oceans' ecosystems as well as disrupting their physical and chemical parameters. One of the parameters most affected is water temperature, which has risen by 2-3 °C above the historical average (GAA, 2016). As ocean temperatures rise, so too does the risk of *Vibrio* spp. outbreaks.

Another recognised effect is the increased acidification of seawater, where the pH has decreased from 8.0 to 7.7 in some cases (Ceballos-Osuna et al., 2013). This represents a significant stress for those marine species that depend on the bioavailability of calcium carbonate in seawater.

To counter the negative effects of these environmental changes on shrimp, Skretting has incorporated an immune pack into its broodstock feed Vitalis 2.5 and PL Diet for larval stages, comprising precise combinations of functional ingredients such as organic acids, plant extracts, vitamins, minerals and antioxidants which are proven to work in synergy with the immune system of shrimp (figure 1). This helps the shrimp to better cope with external

stressors and modulate specific genes of the immune system. Group immunity results from the feeds' physical characteristics such as decreasing acidity and faeces binding, which in synergy maintain better water quality in the culture tanks.

Feed and the shrimp immune system

In the case of shrimp, its immunity is affected by external factors such as water quality and bacterial communities in the water which are influenced by the feed. Internally in the shrimp, feed quality influences the gut microbial community. Externally the feed affects the microbial community and chemical parameters of the water in which the shrimp are grown.

Shrimp live in aquatic environments that directly affect their immune systems (Figure 2). Other important factors influencing the immune system include what the shrimp eat and anything that penetrates their exoskeletons. This is why feed plays such an important role in the immune system, as the feed is not only ingested by the shrimp but also influences the microbial communities in the water through the feed particles that remain in the water. Figure 2 illustrates that the feed not only influences the nutrition of the shrimp, but it also has a synergistic effect on the water parameters and microbial ecosystem of the culture tanks.



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External factors that affect the shrimp immune system:

1. Water Quality; Chemical and Physical parameters.
2. Bacterial communities in the water. Influenced by the feed.

Internal Factors that affect the shrimps immune system:

1. Feed Quality.
2. Gut Micro-fauna produced by the feed.



Figure 1. The shrimp immune system is affected by external, water, temperature, oxygen, etc and internal factors such as feed, bacteria in the digestive system, etc. Feed not only plays a nutritional roll but has an influence on the microbial community in the culture water as well as the shrimp itself.

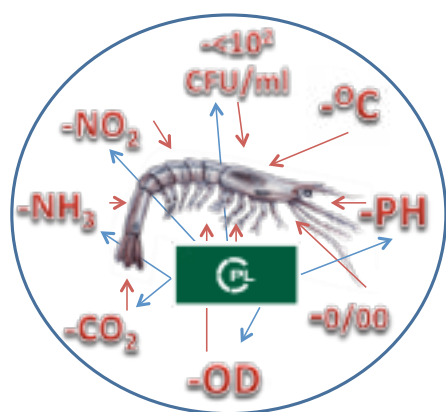


Figure 2. The effect of feeds in the culture tank and on the shrimp

The aim of the immune package that is added to the feed is to do the following: protect the exoskeleton, gills and gut; reinforce the immune system by acting as an antioxidant and cellular regeneration whilst balancing bacteria, virus and fungus in the shrimp gut and environment.

Results in commercial hatcheries show that survival is higher with shrimp that are fed these diets. Diet Vitalis 2.5 has been designed to replace a portion of the fresh feeds in the shrimp maturation phase. It can replace up to 80% of the fresh diets. Replacing fresh diets that are disease vectors reduces the risk of the broodstock becoming infected and passing the disease on to its progeny. This ensures that the first stage of the shrimp production is healthy. It is important to maintain a good bill of health in the broodstock entering the maturation systems. Feeding fresh diets is not the best way of guaranteeing health as they are vectors of bacteria and viruses. Feeding and artificial diet showed a better survival than the group fed a fresh diet, indicating a greater likelihood of optimizing success in the hatcheries.

Using the diet in quarantine

An example of the use of Vitalis 2.5 in the broodstock quarantine section as compared with a fresh diet is described here. The fresh diet was pelleted feed and fresh or frozen squid. This first case used broodstock that were raised in a low salinity environment of less than 5 ppt. Once the broodstock were taken to the quarantine area they were acclimated to full strength seawater, which had a salinity of 35 ppt. This presented a stressful situation for the broodstock and in some cases, mortality occurred. Case details are presented in Table 1.

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Broodstock fed with Vitalis 2.5 showed better survival at 85% compared to the group fed with the fresh diet which showed 45% survival (table 2). Development was also greater in the shrimp fed Vitalis 2.5. This confirmed that the immune package in this diet provided support for the osmotic balance of the animals, enabling them to better handle the osmotic stress resulting from the change in salinity. Further trials are taking place to demonstrate whether animals fed with the broodstock diet will handle transportation stress better than those fed with traditional diets. The results will be presented shortly.

Feeding larval stages

At present, most of the larval rearing departments in hatcheries worldwide are being challenged by more pathogenic bacteria present in the ocean water. Larvae face increasing bacterial resistance to prophylactic treatments. It has become a common practice to use a "mix" or "cocktail" of different brand diets. We have seen that feeding our diet called PL Diet improves the survival rate of shrimp larvae. This is due to the immune pack and the good assimilation of the nutrients present in the diet. The diet has been designed to provide larval nutrition for both Pacific white shrimp (*Litopenaeus vannamei*) and black tiger shrimp (*Penaeus monodon*), from zoea I (Z1), the first feeding stage of larval shrimp all the way to the nursery phase, harvesting post-larvae 25 (PL25).

In two case studies, we compared the use of commercial brands of larval diets, versus PL Diet during the larval rearing phases and then in a nursery raceway with post larvae (PL12) stocked at 25 PL/L and cultured for a period of 25 days (Table 4). In table 3, we observed different inclusion rates of larval feeds in the mix fed to larvae. With a greater percentage of our PL Diet, the survival rate increased, as did the overall health of the larvae produced.

Table 1. Details of experimental trials on broodstock fed Vitalis 2.5 versus fresh diets during quarantine

Specifications	Units
Number of tanks	5 tanks
Water Exchange	100%
Number broodstock/tank	400 broodstock
Time in quarantine	10 days
Feeding rate	
Vitalis 2.5 diet	4% total biomass
Fresh diet	11% total biomass of pellet feed + 3% squid

Table 2. Survival of broodstock after 10 days of feeding with different diets.

Production Parameters	Vitalis 2.5	Fresh Diet
% Survival	85%	45%

Table 3. Survival rates (%) produced by using different feeding protocols. Results from case studies with the use of a mix of larval diets versus PL Diet during the larval rearing phases

Case 1: Larvae culture Nii nauplii to post larvae PL12					
Feeding protocol	AverageRoom I with 10 tanks	Average Room II with 10 tanks	Average Room III with 10 tanks	Average Room IV With 10 tanks	Total average Survival
Composition of the feed	%SR	%SR	%SR	%SR	%SR
60% Feed1 + 20% Feed 2 + 20% Flake	63.9%	84.4%	81.2%	78.8%	77%
60% PL Diet + 20% Feed 1 + 20% Flake	76.7%	72.5%	81.2%	82.4%	78%
100% PL Diet			80%	84.1%	82%
Case 2: Larvae culture Nii nauplii to post larvae PL12					
Feeding protocol					Total survival
60% Feed 1, 20% Feed 2, 20% Flake	1 tank				79%
60% PL Diet + 20% Feed 1+ 20% Flake	1 tank				82%
100% PL Diet	1 tank				84%
Feed 1, Feed 2 are two different brand larval feeds. Flake is a shrimp feed in a flake form PL Diet is from Skretting.					

Table 4. Total survival rates (%) of post larvae in nursery raceways and stocked at 25 PL/L.

Feeding protocol	Number of PL12 stocked	Number of 250 mg juveniles harvested	% survival after 25 days of culture
25% PL Diet	4,000,000	3,432,000	85.80%
50% PL Diet	4,000,000	3,560,000	89.00%
25% Feed 1 + 25% Feed 2 + 50% Feed 3	4,000,000	2,874,000	71.85%
Feed 1, Feed 2 and Feed 3 are three different brands of larval feeds. PL Diet is from Skretting.			

Table 5. Cost analysis of larvae fed with PL Diets

Feeding protocol	Number stocked	Number harvested	Total post larvae sale at USD 2.2/1000
25 % Feed 1 + 25% Feed 2 + 50% Feed 3	4,000,000	2,874,000	USD 6,322.80
50% PL Diet	4,000,000	3,560,000	USD 7,832.00
Difference*			USD 1,509.20
*Positive difference in favour of larvae fed the PL Diet (Skretting). Feed 1, Feed 2 and Feed 3 are three different brands of larval feeds.			

Cost analysis

It is important to highlight that in most cases the tanks fed with the PL Diet had their feeding protocols adjusted, since a reduced amount of this feed obtained better results. This is due to the high nutritional value of the PL Diet, which makes it more bio-available to shrimp as well as making the feeding regime more cost-effective. The cost analysis for the larvae reared in raceways shown in Table 5 demonstrated that feeding larvae with the PL Diet gave 20% more profit than feeding larvae with the traditional diet.

References are available on request



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Mycotoxin detoxification: Science vs Marketing

By Maarten Jay van Schoonhoven and Marie Gallissot

The challenge for a mycotoxin detoxifying agent is to reduce the intestinal absorption of mycotoxins, and increasing the interlayer space of clay structures can increase adsorption capacity of mycotoxins.

Awareness of mycotoxin risks in aqua feeds is growing due to the increasing need for plant ingredients to replace fish meal as a source of protein and the need to use increasing quantities of plant ingredients in the anticipated growth in aquaculture production. Presently, the term “mycotoxin” is becoming more common in articles related to aqua feeds and aquaculture production.

Mycotoxins are secondary metabolites from specific mould strains. They are potentially toxic substances that can affect health when ingested. The toxic effects of mycotoxins can vary depending on their chemical structure, concentration, exposure, animal species, animal health status and whether one or more than one mycotoxin is present (polycontamination).

International trade, climate change and a better control and knowledge of these substances have created a greater awareness of the risks they pose to health and growth performance of fish

and shrimp. Figure 1 shows the frequency of polycontamination in 1,553 samples of various feed ingredients collected in the past 3 years: 82% of the samples tested positive for two or more mycotoxins. Figure 2 shows how often the different mycotoxins were found in the different samples. There is a clear indication that the complex tricothecene and fumonisin mycotoxins are the more commonly found mycotoxins in the various samples.

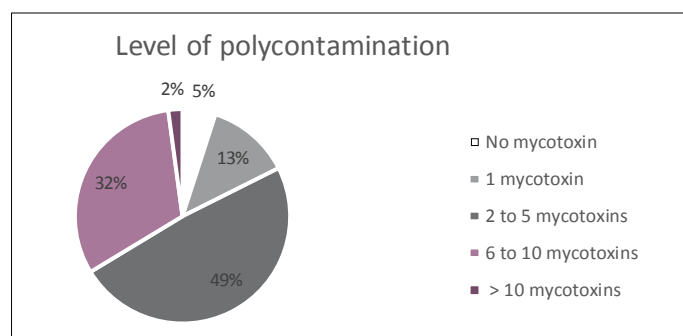


Figure 1. The level of polycontamination found in 1,553 samples of feed ingredients analysed by LC-MS/MS over the past 3 years. Ingredients included corn and corn by-products, wheat and wheat by-products, soya and soybean meal, rapeseed, cotton meal and rice bran.

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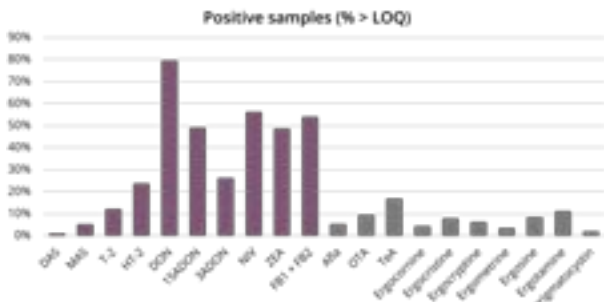


Figure 2. Frequency of positive testing for the different mycotoxins found in different samples of feed ingredients.

The high probability of having polycontamination of mycotoxins in one raw material is due to the favourable conditions where the development of one mould often permit the development of other moulds. In addition, one mould can produce different types of mycotoxins. Research suggests that toxic effects can occur at much lower mycotoxin contamination levels in the presence of polycontamination and its resulting synergistic effects. A recent review (Pierron et al., 2016) highlights the synergistic effects of deoxynivalenol (DON) and fumonisins (FUM) on intestinal health, via their respective effect on gut barrier, nutrient absorption and intestinal immunity among others.

Various authors have published findings describing the negative effects of DON and FUM on fish. Commonly described negative effects of DON are reduced growth rates, feed refusal and a poorer feed conversion ratio (FCR) in rainbow trout (Matejova et al., 2014 and Ryerse, 2014), in tilapia (Braggio, 2015 and Tola et al., 2015) and immune suppressive effects in carp (Pietsch et al., 2015). Likewise, commonly described negative effects caused by FUM are reduced growth rates in tilapia (Tuan et al., 2003), channel catfish (Gbore et al., 2010 and Lumlertdacha, 1995) and in carp (Pepljnjak et al., 2000).

Efficacy of mycotoxin detoxifying agents

Demonstration of the effectiveness of a potential mycotoxin detoxifying agent in contaminated feed is often conducted under *in vitro* conditions. Classic *in vitro* systems used for that purpose are simple but very far from the natural *in vivo* conditions. Important dynamic processes related to digestion and the fates of feed compounds during their passage through the gastrointestinal tract include: the composition and pH of gastric and intestinal contents, the gastrointestinal transit conditions, the activity of bio-chemicals (enzymes) and the intestinal microflora. These processes cannot be simulated in static *in vitro* models. To demonstrate under the most repeatable and reliable conditions the *in vitro* efficacy of a mycotoxin detoxifying material, the TNO Intestinal Model (TIM) can be used (www.tno.nl).

The TNO *in vitro* gastrointestinal model simulates the successive dynamic processes in the stomach and small intestine (TIM-1) and in the large intestine (TIM-2). These models are unique tools to study the fate of compounds during their passage through the gastrointestinal tract. As the proximal part of the small intestine is the main absorption site for mycotoxins, the TIM-1 is most effective to test these mycotoxin detoxifying products. This computer controlled model simulates the successive dynamic conditions in the gastric compartment and in the three successive compartments of the small intestine. In this system, the gastrointestinal conditions simulate digestive conditions of the pig after the intake of feed.

In 2004, Döll et al. (Table 1) showed it was very difficult to bind complex fusarium mycotoxins like trichothecenes, while zearalenone (ZEA) was efficiently bound. Thus, the challenge for a mycotoxin detoxifying agent is to reduce the intestinal absorption of mycotoxins like trichothecenes and fumonisins.



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Table 1. Reduction of the concentrations of zearalenone (ZEA) and deoxynivalenol (DON) (%) compared to the blank) in the supernatant buffer solution by various detoxifying agents in the *in vitro* detoxification test (mean and SD of four independent replications). Extracted from Döll et al., 2004.

Product	ZEA		DON	
	Mean	SD	Mean	SD
Activated carbon	100 ^a	0	67 ^a	6
Cholestyramine	94 ^b	1	10 ^b	15
Modified aluminosilicate (trial product)	81 ^c	6	17 ^b	16
Modified aluminosilicate (commercial product)	55 ^d	1	1 ^b	2
Esterified betaglucan from yeast cell wall	24 ^e	1	24 ^b	18
Yeast extracts and activated zeolite	20 ^{ef}	4	0 ^b	5
Combination of clays, detoxifying enzymes and plant and alga extracts	17 ^f	2	1 ^b	4
Bentonite	13 ^f	12	1 ^b	1
Colloidal silica acid with added clay minerals	5 ^g	1	21 ^b	31
Combination of enzymes and adsorbent minerals	5 ^f	2	2 ^b	3
Values in one column with different superscripts are significantly different (P<0.05)				

Table 2. *In vitro* ability of various detoxifying materials to adsorb deoxynivalenol (DON) and nivalenol (NIV) at different pH and concentrations. Percent of adsorbed mycotoxin (mean ±S.D., n=3). Extracted from Avantaggiato et al., 2004.

	pH	DON (2 µg/mL)	DON (10 µg/mL)	NIV (2µg/mL)	NIV (10 µg/mL)
Combination of HSCAS, ilite and chlorite	3	11±1	3±2	10±0	1±1
	8	1±0	10±2	4±1	11±1
Esterified beta glucan from yeast cell walls	3	18±5	0±0	6±4	1±0
	8	3±3	9±5	10±3	7±5
Glucmann	3	1±3	0±1	2±2	1±0
	8	1±6	12±1	3±1	14±5
Combination of mineral substances	3	0±1	16±2	0±1	11±1
	8	4±1	10±1	4±0	10±0
Synthetic aluminosilicate	3	3±8	10±1	4±7	11±0
	8	0±1	11±1	4±1	11±1
Aluminosilicate	3	9±0	16±2	11±1	13±4
	8	1±2	10±0	3±0	10±1
Combination of clays, detoxifying microorganisms and plant and algae extracts	3	9±0	9±1	9±1	10±1
	8	1±2	13±1	7±1	13±1
HSCAS	3	9±1	11±0	11±1	12±0
	8	0±0	12±1	0±0	11±1
Cholestyramine	3	4±3	7±5	5±3	7±4
	8	10±1	4±7	12±2	5±7
Florasil	3	5±6	9±6	7±6	9±6
	8	9±2	11±0	10±2	10±0
Celite	3	4±3	5±7	3±1	5±7
	8	1±2	10±1	2±1	10±1
Zeolite	3	5±4	2±1	3±1	1±0
	8	2±1	3±1	2±1	0±0
Bentonite	3	2±2	9±5	4±1	9±6
	8	3±2	1332	332	10±1
Activated carbon	3	84±2	5935	62±3	33±7
	8	95±9	57±5	63±1	30±6

Avantaggiato, from ISPA in Italy, ran several trials using this TIM-1 system to evaluate the efficacy of several commercial binding agents and substances as potentially useful chelating agents (Avantaggiato et al., 2003; 2004 and 2007).

One of the trials, carried out in 2004, described an *in vitro* screening, where only activated carbon, out of 14 different commercially used detoxifying materials, proved to be an effective binder of DON and nivalenol (NIV), with binding capacities of 35.1 µmol and 8.8 µmol DON and NIV/g of adsorbent, respectively, calculated from the adsorption isotherms (Table 2). The study then used the dynamic laboratory model (TIM-1) to evaluate the absorption of DON and NIV in the small intestine and the efficacy of activated carbon in reducing this absorption. The *in vitro* intestinal absorptions of DON and NIV were 51% and 21% respectively. With the inclusion of 2% of activated carbon in the feed, the absorption with respect to the intake was lowered from 51% to 28% for DON and from 21% to 12% for NIV.

Using information from previous studies activated carbon appears to be one of the most effective mycotoxin adsorbents. All other detoxifying agents showed poor efficacy in their capacity to control fusarium mycotoxins. However, ingestion of high concentrations of activated carbon (> 0.5% w/w) should be avoided to minimise the risk of nutrient adsorption and the impairment of the nutritional value of the feed (NOSB, 2002; Ramos et al., 1996).

Innovative technologies, modified materials

Specific technologies can modify clay structure at a nanometric scale, and increase the interlayer space, thus modifying the adsorption capacity of mycotoxins. With the use of this modification, 100% of the clay developed surface is accessible and new types of adsorption sites are available, therefore increasing its adsorption capacity. This process is patented and 100% environmentally friendly.

The interspaced clay was tested in TNO, using the previously mentioned TIM-1 system. Results showed the interspaced clay had a higher adsorption capacity than activated carbon. The interspaced clay, at an inclusion rate of 0.1%, inhibited DON bioavailability up to 40% compared with the control, where 2% of activated carbon were needed to reduce DON bioavailability by 45%. The efficiency of this unique interspaced clay was simultaneously demonstrated for FUM in the TIM-1 (co-contamination design): the bioavailability of this mycotoxin was reduced by 60%. In addition to this, the use of this product did not inhibit the digestibility of proteins and carbohydrates, or impair the bioaccessibility of vitamins (Demais and Havennar, 2006).

Conclusion

The limited availability of fish meal has led to the increased use of plant ingredients to fill the gap left by the growing need for other source of proteins in aqua feeds. With the use of plant ingredients there also comes the risk of mycotoxin contamination. The best way to avoid the potentially harmful effects of mycotoxins is to ensure that the contamination risk of ingredients is minimal. Since there is no guarantee of mycotoxin free ingredients a good mycotoxin binder is essential. Different components used in a mycotoxin detoxifying product normally target specific mycotoxins. It is therefore important that the components used are targeting the mycotoxins that pose the higher risks.



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Optimising productivity of copepod cultures as live feed

By Aurore Trottet, Rémi Maguet, Mathilde Richer de Forges and Guillaume Drillet

Dry macroalgae flakes are low cost feed alternatives but live phytoplankton, enhanced with probiotics, substantially increased density per biomass.

Copepods have nutritional and behavioural characteristics which make them exceptional live feed candidates for fish larvae with a large size range. This is especially relevant for tropical aquaculture where many species of fish are produced. In most cases, species such as the groupers and ornamental fish have small gape sizes and require very small prey, making many species of copepods more appropriate than the larger rotifers or *Artemia*.

To date, copepods are not widely used in an industrial scale in fish hatcheries because of the difficulties of raising adequate groups of copepods at high densities. However, recently their economic value has been assessed and recognised (Drillet et al. 2011; Abate et al. 2015).

We have isolated *Tisbintra* sp (Copepoda) (Figure 1) in Singapore waters (Schmoker et al. 2014) and developed cultures of this harpacticoid copepod in a low cost setup. We evaluated the estimated costs to produce microalgae using algae flakes, and tested dry macroalgae as a food alternative to live phytoplankton. Additionally, we evaluated the potential use of commercial probiotics from Biomin as a feed additive to enhance the culture productivity.

Table 1. Biochemical composition of the different feeds tested (reported by Aleor). *The composition of the phytoplankton is extracted from (Seixas, Coutinho et al. 2009) and is considered to represent the closest available reported composition to the *Rhodomonas* sp used in our experiments.

% of dry weight	<i>Fucus serratus</i>	<i>Palmaria palmata</i>	<i>Ulva lactuca</i>	<i>Rhodomonas lens</i> *
Protein	13	22	17	55
Carbohydrates	56	57	53	11
Lipids	3	2	2	10



Figure 1. *Tisbintra* sp. isolated in Singapore waters

Culture of copepods

The harpacticoid copepod *Tisbintra* sp. was cultured in the DHI laboratory in Singapore since June 2011. The stock culture was maintained in rectangular polyethylene tanks filled with 10 L of artificial sea water (salinity 30 ppt, temperature 25 °C, and photoperiod 12 h light/12 h darkness). Copepods were fed three times a week with the microalgae *Rhodomonas salina* and *Tetraselmis suecica*.

Experiments were carried out to;

- evaluate the feasibility of live phytoplankton replacement with dry algae flakes and
- evaluate whether the use of commercial probiotics as feed additives could be used to optimise production and culture densities of the copepod cultures.

Experiments on different types of food with and without probiotics

These were conducted in 2 L plastic containers filled with 1 L of 25 °C water (salinity 30 ppt, photoperiod 12 h light /12 darkness), in triplicates with gentle bubbling to suspend the food particles. Three types of dry macroalgae flakes (*Ulva lactuca*, *Fucus serratus*, *Palmaria palmata*) were tested as copepod feed and compared to a control fed live *Rhodomonas* sp. The additional treatment was where probiotics were added to a control (*Rhodomonas* sp.+ probiotics).

The biochemical composition of the feed is described in Table 1. The phytoplankton cell density was maintained above 40,000 cells/mL of *Rhodomonas* sp which is equivalent to 1,900 µg C/L (Berggreen et al. 1988). The macro algae flakes used were obtained from Aleor (Brittany-France) (Table 1) and comprised of a green alga: *Ulva lactuca*, a brown alga: *Fucus serratus* and a red alga: *Palmaria palmata*. More than 10 mg/L of these algae were offered as feed every week (Table 2).

The probiotics used for the experiments were AquaStar® Pond and Aquastar® Hatchery (Biomin, Austria) and were added to the experimental containers at 10 mg/L (Table 3) as recommended. The first inoculation occurred on day 1 with AquaStar® Pond and was repeated every 7 days, while the inoculation of Aquastar® Hatchery was initiated on day 4 and repeated every 7 days thereafter. This ensured that the copepods were offered either one or the other probiotic as an additive every 3 days. Once a week, 50% of the water in each experimental container was siphoned off using a fine PE hard tube and a filter to remove dead material (such as exoskeletons) and dead copepods from the bottom of the culture tanks. Then, new filtered seawater was added to replace the water siphoned off.

The measurement of the copepods and the calculations of the bio-volume were done by assessing more than 30 nauplii, copepodites and adult males and adult females under a binocular dissection microscope. The bio-volume of nauplii was determined to be 0.40 mm³, copepodites and males as 0.68 mm³, and the much larger females as 3.06 mm³.

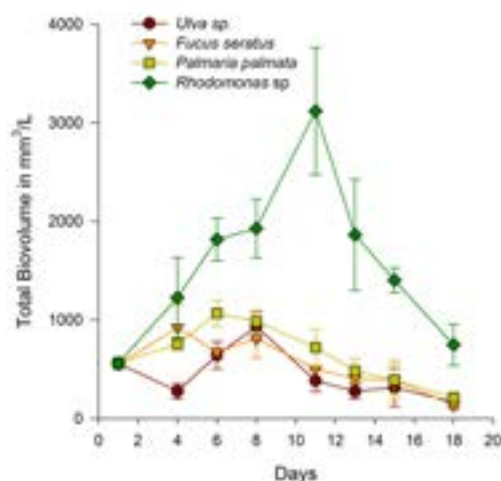


Figure 2. Average biovolume (mm^3/L) of *Tisbintra* sp. cohorts fed different feed sources. The graph shows a comparison of alternative dry flakes from 3 macroalgae and a control fed with a live phytoplankton (*Rhodomonas* sp.).

Growth patterns

The growth pattern of the copepods *Tisbintra* sp. in culture followed a bell shape curve with a peak after 8-13 days and a steady decrease thereafter in all experimental conditions. In general, the dried macroalgae flakes used in this experiment seemed sub-optimal for *Tisbintra* sp. culture but still supported growth and reproduction of the copepods at a very low cost (Figure 2).

The largest difference between treatments was observed after 11 days when the bio-volume of copepods in the most optimal macroalgae treatment (*Palmaria palmata*) was 4 times lower than in the treatment fed with live phytoplankton (*Rhodomonas* sp.) alone. From day 6 onward, this difference between the live phytoplankton and the dried macroalgae feed was significant (Kruskal-Wallis, $P < 0.05$).

Compared to the treatment without probiotics, the addition of probiotics in live *Rhodomonas* sp. feed improved the growth of the copepods (Figure 3). On day 8, the bio-volume of copepods fed with live *Rhodomonas* sp. + probiotics was double that of the copepods fed just *Rhodomonas* sp. This difference was 40% on day 11. However, only day 13 presented statistically significant bio-volume differences (ANOVA Holm-Sidak, $P < 0.05$).

The proportion of the females in the tanks was relatively constant, with females representing $<15\%$ of the organisms in the experiments. Also, there were no differences in the proportion of gravid females amongst treatments (Kruskal-Wallis; $P = 0.473$).

All treatments tested in the present experiment revealed a production pattern with successive peaks of production and sudden decreases in population densities, which we hypothesise as reflecting possible cannibalism to compensate for limitations in essential nutrients.

Quality of the food

The feeds used in the present experiment were of different qualities but similar quantities were fed to the copepods (Table 1). The low quantity of fatty acids present in the dried algae (2-3% of dry weight (DW)) compared to that in live phytoplankton (~10%) could explain the nutritional limitations in the different treatments, which eventually triggered cannibalistic behaviour. This is also supported by the observation that the number of

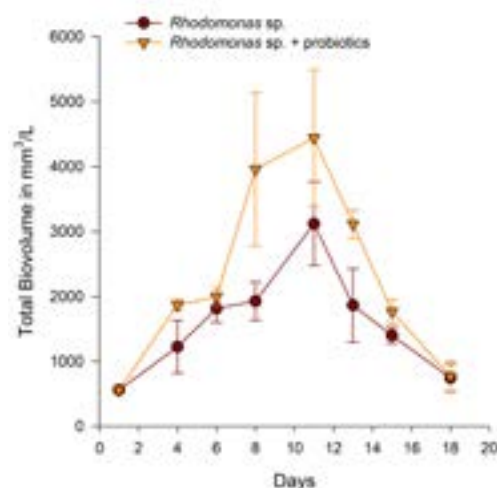


Figure 3. Total biovolume (mm^3/L) of the *Tisbintra* sp. cohort when fed the live microalgae *Rhodomonas* sp. with or without addition of probiotics.

nauplii was higher in the treatment fed live phytoplankton than those fed dry microalgae.

Since the number of gravid females was similar in all treatments, the nauplii must have suffered higher mortality rates due to either poor nutrition, a higher cannibalistic pressure, or both. Nevertheless, in the present experiment, all the feed tested resulted in an increase in copepod biomass in the culture tanks, showing that the replacement of live phytoplankton by dried algae flakes is possible for this species but may decrease the production yield.

Production costs for live phytoplankton during the experiment included capital costs (durable) and operating and maintenance (O&M) costs following the method developed by Waning (2002). We estimated that the culturing of live phytoplankton was 10 times more expensive than using algae flakes in 3 m³ cultures, with man hours representing the most important cost.

The present cultures fed dry algae flakes successfully developed to ~25% of the biovolume/biomass achieved using live phytoplankton but at a 10-fold lower cost. Therefore, we can consider dry flakes from macroalgae as a suitable alternative feed to harpacticoid cultures, but the farm setup must be taken into account as the size of the production would need to be appropriately modified.

Effects of probiotics

AquaStar® Pond and AquaStar® hatchery are probiotics containing diverse bacteria, including *Bacillus* spp., *Enterococcus* spp., *Thiobacillus* spp., and *Paracoccus* spp. and have been successfully used on crustaceans. The results achieved using these commercial probiotics are somewhat similar to those reported earlier for other crustaceans, confirming that the use of bacteria may be an excellent way to improve productivity of cultured copepods.

Our rough economic estimation shows that the lowest quantities of probiotics required to achieve high performances was less than 1% of the production costs and therefore the gain from their use was substantial and recommended. Other than the total biomass estimated in the present experiment, the use of probiotics might also have positive effects on the final product quality. Therefore, further studies to evaluate the use of probiotics

in combination with dry algae flakes should be performed. The aim will be to solve production yield issues that are often seen as barriers to the commercial use of copepods in aquaculture.

Conclusion

The locally isolated harpacticoid copepod *Tisbintra* sp. was successfully fed macro algae in the form of dry flakes to replace live microalgae commonly used for copepod cultures. Although copepod productivity was lower when fed dry flakes than when fed live microalgae, the rough cost estimation shows that this could well be a good alternative to feed copepod cultures. The addition of probiotic products to live feed is beneficial for copepod cultures; it improves the density/biomass attained in cultures and therefore decrease the cost of production per unit.

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Farming the barramundi alongside pathogens

By Alain Michel

Learning the hard way at an integrated farm for barramundi and other species in Indonesia.

In 1998, Fega Marikultura, an Indonesian company, investigated the potential of offshore fish farming in the Pulau Seribu Archipelago in the Java Sea. The company was then operating a large shrimp hatchery in a small coral island, Pulau Jukung, 64.3 km north of Jakarta. Fega's target was a mass production of high quality marine fish for the international market of fresh frozen fillet and portion cut, based on the salmon model in Norway for grow-out and seabass and seabeam model in the Mediterranean for hatchery and nursery stages. In the 1990s, marine fish production in Southeast Asia focused on high value species such as groupers for the live fish market and no one industrial marine fish farm was in existence.

Fega had a team of skilled aquaculture technicians, key to this new development. The pathogen impact on juveniles has been the main constraint to the production till a serendipity effect opened the way to better pathogen control. This was the 'Jukung way'. This is my view of the 17 years in its development.

The environment

Pulau Jukung (Jukung Island), an 11 ha private island located south of the Equator has optimal environmental conditions for aquaculture. The surrounding waters have a typical coral ecosystem, comprising of a huge diversity of soft and stony corals up to a depth of 15 m. The Java coast is sufficiently far away to avoid the impact of pollution during the rainy season. Physical and chemical parameters of the pristine waters are very stable with a constant temperature of 28-29 °C and a salinity of 33 ppt. There have been no eutrophic events observed and dissolved oxygen (DO) is always at saturation point. No contamination with pesticides or heavy metals have been detected.

It is far from the typhoon path and the strongest winds during the north-west monsoon season range from 30-40 knots. Waves do not exceed 2-3 m and also do not last long. The large open sea areas around the islands are deep, ranging from 25-35 m with a sandy muddy bottom very suitable for mooring floating cages. These are optimal conditions for a reliable and sustainable production of tropical fish from culture conditions. There are sufficient areas to sustain a large annual production, of several thousand tonnes without endangering the carrying capacity.

Planning an industrial farm

The goal was to set up a fully integrated farm with complete traceability of the final product and to use modern techniques of fish culture adapted to local conditions. The priority species was the Asian sea bass *Lates calcarifer* or barramundi which was already well known biologically and has a strong demand in the Australian market. Fega also targeted other species, such as the grouper, snappers (mangrove and red emperor), pomfret and cobia.



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From left to right, mass juveniles production from 1 g to 10 g and nursery from 10 g to 30 g

From the early days, Fega had a strategy of 10,000 tonnes/year for a single unit of grow-out cages with subsequent development of similar units in different locations for biosecurity reasons. This was also the scale required for mass production of frozen fillets and the minimum size to be fully integrated with a future feed mill.

The farm targeted full domestication with broodstocks, electronically tagged and genotyped for continuous selective breeding. Initially, the goal was to double growth within five generations and subsequently towards the selection of disease resistant strains. The farm targeted reliable mass production of juveniles, vaccinated against the main diseases, to avoid the use of any antibiotics. The grow-out units were circular 90 m circumference cages maintained by reliable moorings and polyethylene nets. Initially, fish were fed by hand but in the plans were automatic computerized feeding. Harvests of 100 tonnes in 60 m cages were obtained (30kg/m³).

Pathogens and water quality

Pathogens are the big unknowns when we started as they are species and site dependent. This is the most difficult part of any aquaculture project as there is always the possibility to see a new disease emerging. In 1998, the only advice we had was to try not to introduce any pathogens by using good husbandry practices and implementing biosecurity measures but no treatment were known. The pathogens are existing in the environment hosted by the wild species but another source could be through the first batch of broodstock brought into the hatchery from South Sumatra in 1998.

Water quality

Water quality covers physical parameters but also more subtle dissolved organics and mainly bacterial and viral fauna linked with organisms or adsorbed on the particulate organic matter. Few farms have the means to run a detailed study covering a whole year and the data of pesticides and heavy metals are often one time analyses. An extensive search for pathogens at the early hatchery phase was not done but we were aware of the potential presence of at least viral nervous necrosis (VNN) and *Streptococcus iniae*.

Pathogen control

To achieve full control of the water entering the production system, farms are generally equipped with large filtration units, sand and cartridge filters, UV sterilization and even ozone treatment. Some have reservoirs for chlorinated water to season water for batch by batch use. To be fully efficient it should be also applied to the production of live food (algae, rotifers and *Artemia*).

This strategy is to produce, in the best case scenario, "pathogen free juveniles", protected from the potential pathogens during their most sensitive stages. However, when released in the sea

they are fully "naïve" and susceptible to be infected immediately to all or some of the pathogens present in the surroundings. At the beginning by adopting this approach, we faced difficulties just with the maintenance of such systems with breaks in the biosecurity chain. Regular dry outs were improving the survival in the nursery but mortality was delayed in the pre-growing cages.

Fega then took another approach; it looked in-depth at the intrinsic values of the raw water which was anyway sustaining the coral environment and the large diversity of invertebrates. The water appeared turbid with suspended clay particles only during rough weather. Using directly this raw water at least for the first month of culture, we found that there was no difference in growth and survival of the same batch of larvae compared to filtered and UV treated water. Finally, Fega was using just cotton socks attached to the tank valves to retain the gelatinous organisms sucked by the pump and the shells developing in the pipes.

“ We learnt to live with our pathogens by keeping them at the lowest possible level to avoid any significant mortality.. ”

From then on, we pumped raw water without any filtration or treatment for 14 years with the same result: good hatching rate and no weak or dead larvae seen during the first weeks. But we were aware that this protocol may lead to the introduction of pathogens and the necessity to control them. Their recurrent occurrence in all the batches demonstrated that they are part of our culture system from early larvae to adults. We learnt to live with our pathogens by keeping them at the lowest possible level to avoid any significant mortality.

Learning the hard way with barramundi

The barramundi has a schooling behaviour where fish crowd and move together in a black ball occupying only a small volume of the tanks or cages. Even when feeding, the whole school moves under the feeding device, the best condition for a pathogen to spread from one individual to the group. Reducing the density has few beneficial effects. Below is the story on main encounters with pathogens.

The big belly problem

The first barramundi spawning was in 1998 and with the first batch of juveniles, we faced an unusual mortality. Among 5,000 very healthy 2-3 g juveniles, swimming in a dense school, some fish took on a darkened hue, left the school and were not feeding. They died quickly within less than an hour. Other juveniles showed normal behaviour and continued to feed extremely well but gradually, more juveniles left the group and finally, we lost 95% of the fish over 10 days.



Grow-out in 90 m circumference and 10 m deep open sea cages

This disease was given the name 'big belly syndrome' because the fish were losing their internal water with their posterior body shaped like a razor blade and the belly inflated. In fact, the whole mass of internal organs was emulsified. Histological studies conducted at the Intervet laboratory (now MSD) in Singapore found an intracellular *Vibrio*-like bacteria. Later the 'Jukung way' was used to treat efficiently this syndrome instead of using high doses of antibiotics.

Streptococcus iniae

This was first encountered in 2000, in three circular grow-out cages where we lost more than 10 tonnes of 1 kg fish over 10 days. *S. iniae* was diagnosed immediately. A vaccine strategy counteracted the bacteria. A water-based vaccine, StrepSi, was developed and licensed in Indonesia in 2005 by Intervet after 4 years of laboratory experiments conducted in Singapore and field trials conducted in Fega, avoiding the use of antibiotics.

Parasites in cage.

In the first cage trials, we immediately faced a bloody tail problem, 2 weeks after stocking. Freshwater baths revealed the presence of a huge quantity of a *Benedenia* sp flat worm localised mainly on the tail peduncle and destroying blood capillaries, causing fish mortality. After an unsuccessful trial with a functional feed, we found that a bath of peroxide using a tarpaulin around the cage was very efficient. This had to be repeated weekly, in the first month and later every month until the fish reached 500 g and were no longer sensitive.

Tenacibaculum maritimum

In the grow-out cages, there was large outbreaks of saddle back disease occurring 2-3 days after stocking juveniles of less than 5 g. This problem was due to the bacterium, *T. maritimum* which was also encountered regularly in nursery tanks but was routinely controlled by peroxide baths after each grading or handling.



Brood stocks were tagged electronically in maturation room

VNN outbreaks

During the first years of farming, we did not see VNN occurring with the barramundi but only with the groupers. Infections were sporadic and mainly when water temperatures in the larval rearing tanks were lower than 28 °C. Polymerase chain reaction (PCR) assays on broodstock (ovaries or eggs) were negative but strangely the larvae showed typical signs of the disease around day 7-10. The infection became more frequent, and we modified husbandry practices using an ozone bath for eggs followed by the Jukung treatment. This was preventive and curative and generally stopped the outbreak at day 20. When the first signs were seen after one week it was better to start again a new tank.

Iridovirus

Identified in 2004, through PCR analysis in nursery samples, iridovirus was our main killer. However, some previous records also described the same clinical signs such as haemorrhages in the eyes which we called the red eye syndrome. Infected fish were swimming weakly often at the bottom of the tanks and cages dark black, away from the school with white gills, a result of blood loss into the water. This explained the quick spread of the disease by virions. Infection started early with 3 g juveniles and continued until the fish reached 30-50 g. Despite removing the weak fish from the batch, cleaning, siphoning and maintaining the best culture conditions, survival was only 2-5% over a 2-week period. Strangely, the main characteristic of the big belly and the red eye diseases is that they always start on the head of the biggest and fastest growing juvenile in every batch. When trying to vaccinate with the oil-based irido vaccine, the outbreak became worst. Our "Jukung" treatment was the only way.

Mass mortality syndrome

At Fega, the culture of juveniles from 10 g to 30 g was done in a nursery system of 20 tanks of 40 m³ each, and with water level at 2 m depth. Occasionally, early in the morning we observed high or even total mortality of juveniles which were perfectly healthy the day before and feeding extremely well. Initially, low DO was suspected but our measurements every 2 hours during the night always showed values of more than 4 ppm. Juveniles did not recover even with high water renewal and only experimental antibiotic bath treatment plus peroxide baths were effective. We concluded that this was due to an external bacterial problem.

Further observations showed that the day before the onset of mortality, tank water assumed a yellowish colouration which increased after the afternoon feeding. In dead or dying fish, the gills secreted a heavy mucus colonised by bacteria embedded in a lot of organic matter. It appeared to be a bloom of *Flexibacter* and *Cytophaga* (gram negative bacteria) fuelled by the high feeding rate and starting as biofilms on the bottom and the wall of the tanks. In fact, juveniles were dying from a lack of oxygen due to clogging of gills with organic matter.



From eggs to 2.5 kg fish in 18 months

What was achieved?

The farm suffered with the big belly syndrome for almost 4 years before it was able to achieve its control. For the iridovirus, it took 7 years. However, it was a constant combined control of the different pathogens during juvenile production. There was often a blurring of the clinical signs complicating the choice of the right treatments which can be contradictory in their effects, putting the pressure on one pathogen but enhancing another at the same time. Full control of each viruses was the most difficult task. It has come from a best understanding of their presence and propagation in our culture system.

The vertical transmission through the ovarian fluid and the eggs for VNN is well known; but strangely, PCR tests were always negative in our broodstocks. At Fega, mortality was never observed with large fish, but with outbreaks at day 7-9 in larvae, there was evidence of its permanent presence in the broodstocks.

In the case of our iridovirus outbreaks, our search has been on its horizontal transmission. We did not know whether the pathogen came from our broodstock, was integrated in the genome, or had entered our culture system at a specific point. The latter could explain the outbreaks occurring often at the same period. The presence of iridovirus is well known in insects, but the transmission of iridovirus from insects to fish has not been documented. In the outdoor rotifer ponds, mosquitoes and chironomids larvae were always present and preyed upon by late larvae. This could be the mode of entry of the iridovirus.

The histopathological studies carried out by Dr Susan Kueh, Perth University, Australia showed its systemic presence at the early juvenile stages with typically enlarged cells. The early presence was evident in our system but outbreaks only occurred with 4 g fish. This was unexplained as we were able to induce the disease in small juveniles of less than 1 g through direct contact.

We observed that in every batch, both the VNN and the iridovirus were appearing always on the biggest fish in the batch indicating that cannibalism was the route of transmission. Barramundi juveniles are swallowing the entire body of its prey, head first after a clear chasing behaviour and the use of their protractile jaw. They do not touch dead fish.

Thus by accumulating the virus present at a low level in each prey, the level of infection gradually increased and suddenly the typical clinical signs of dark black fish with pale gills were appearing. The spread is fast with the release of virions in the water with an infection period estimated at 1 week. This is why there is a necessity, for numerous grading during the juvenile stages starting at a frequency of every three days for a batch. If not, 30 % losses can be expected just from cannibalism.

The "Jukung Way" -a serendipity effect

Despite all our efforts, with lots of focus on grading, cleaning and running regular external treatment with peroxide plus some dry outs we were still unable to sustain our target of 400,000 of 30 g juveniles/month, mainly with the strong impact of the iridovirus when transferring 30 g juveniles to the pre-growing cages.

The "Jukung Way", described in the earlier article was our serendipity effect. We understood this as a host pathogen effect driven by the temperature shock. This was the beginning of the solution to control the VNN and in addition, it appeared rapidly. It was also the right way to control the big belly disease without the need for antibiotics. Fortunately, it was also the solution for the iridovirus. By 2014, we had reasonable control of the whole juvenile production by boosting permanently their innate immune system at the level of a production hatchery and we achieved the transfer in cages without further subsequent losses. It was a different paradigm to live with the pathogens and to benefit of their presence to vaccinate in real time our juveniles by boosting their innate immune system which will relay a memory one. It was done by non-lethal thermal shock for a certain period of time and at a certain frequency.

The Jukung way is a pragmatic approach developed mainly by trial and error through the observations of the skilled Fega technicians. It is explained by the effect of heat shock proteins which are chaperone proteins upregulated by temperature shocks.

Some 3 years ago, we knew that we were not at the end of the road, and that the fight was not finished. We understood better, the viruses, bacteria and parasites and how they increase their presence and pressure. The result were achieved by "being able to seed hardened juveniles in the cages already adapted to pathogens of the environment by a first encounter". They were vaccinated.

Unfortunately, despite these achievements which were opening the door to a full development, Fega farm ceased operations in 2014.

I would like to attribute this new approach of pathogen control to the whole Fega team, among them, Bambang Wahjudi, Andrizal Almizar, Saari Muhyi, Daryona Onoi, Indra Gunawan, Dani Jatnika, Bowo Sapratono, Yulissa Fitriani, Akbar Rahmadan and many others who have been the main actors of this development. Without their presence and skills nothing would have been achieved.

Related article: "Pathogen control in aquaculture" in issue May/June 2017, pp 26-30



Alain Michel is currently a permanent consultant for a new barramundi farm in Sri Lanka. From 1998 until 2014, Alain was scientific adviser to Fega Maricultura, a barramundi farm in Indonesia. His present main interest at the field level is the boosting of the innate immune system to a better control of aquaculture pathogens. Email: alainhenri@aol.com

First case of sea lice, *Caligus* spp outbreak in snappers in floating cages

By Leong Tak Seng

A description on disease symptoms on several species of snappers in 2016.

Outbreaks of diseases in marine fish culture in floating cages are common occurrences in many fish farms in Peninsular Malaysia, especially towards the end of each calendar year. Initially, the outbreak of disease at the end of 2016 in Penang appeared no different from other years. All fish farmers assumed that the outbreak was similar to previous cases of 'white' worms affecting their fish. All they did was to carry out freshwater treatment on the fish. However, the 2016 disease outbreak appeared to be more severe compared to other years. Mortality was high in some fish species, particularly the crimson snapper *Lutjanus erythropterus* and the emperor snapper *Lutjanus sebae*.

During a survey, the author, found it very unusual to see a 1.2 kg marketable size crimson snapper swimming sluggishly in a Pulau Jerejak, Penang fish cage. The snapper was removed from the cage and treated with freshwater in a plastic bag for 5 minutes. The caudal fin appeared red with haemorrhagic symptoms, and there were dry patches among the scales of fish. The content of the water in the plastic bag was examined for ectoparasites (Table 1).

“ The problem was more than just ‘white’ worms ”

An examination of the affected fish at the fish farms surveyed showed that the problem was more than just 'white' worms (capsalid monogeneans) infection. Many parasitic copepods belonging to the *Caligus* spp were recovered. *Caligus* spp found in low numbers have been reported in a large variety of cultured marine fish (Leong 2014; Arthur and Mohamed Shariff 2015).

During the 'white' worms outbreak in Penang, some fish *L. erythropterus* (5 fish, average length, 33.2 cm and average weight, 566 g) and *L. sebae* (5 fish, average length, 29.5cm and average weight, 426 g) were examined from a fish farm at Bukit Tambun.

The results are shown in Table 1. An outbreak of 'white' worms disease on *L. erythropterus* during the previous year at a fish farm at Pulau Pangkor were also examined and is included in this table for comparison. At both locations, both species of

snappers were heavily infected with capsalid monogeneans, with the emperor snapper, *L. sebae* having 938.2 monogeneans/infected fish and crimson snapper with 304.4/infected fish. At the Pulau Pangkor site, the crimson snapper, *L. erythropterus* was not infected with caligid parasitic copepod, whereas at the Penang farm, the emperor snapper was infected with 315.8 and crimson snapper with 70.4 caligid copepods/infected fish. To the author's knowledge, the presence of the large number of parasitic copepods/infected fish has not been previously reported.

Diseased crimson snapper at the Bukit Tambun fish farm were devoid of scales around the head and eye regions of the fish, patches of scale loss with haemorrhagic underneath and loose scales on touching (Figure 2). The external symptoms of diseased fish were similar to symptoms that were observed in many disease outbreaks in the fish farms in recent years. Freshwater treatment (Figure 3) of diseased crimson snapper revealed large numbers of capsalid monogeneans and caligid copepods. The capsalid monogeneans belonged to a mixture of *Benedenia lutjani*, *B. epidemicus*, *Benedenia* spp. and *Neobenedenia melleni* (Figure 4). Beside the monogeneans, there were large numbers of parasitic copepods *Caligus rotundigenitalis*, with a small number of *C. epidemicus*.

Diseased emperor snapper, *L. sebae* from the same farm also showed similar external symptoms of missing scales around the head region, loose scales, but without haemorrhages on the body (Figure 5). Parasites recovered after freshwater treatment also revealed large numbers of *C. rotundigenitalis*, *C. epidemicus* and capsalid monogeneans, *B. lutjani*, *B. epidemicus*, *Benedenia* spp. and *N. melleni* (Figure 6).

Table 1. Parasites observed during a disease outbreak in Pulau Pangkor and Penang.

Fish species	Farm location	Capsalid monogeneans	<i>Caligus</i> spp	<i>Zeylanicobdella arugamensis</i>	Mean total/infected fish
<i>Lutjanus sebae</i>	Bukit Tambun	938.2	315.8	5.6	1259.5
<i>Lutjanus erythropterus</i>	Bukit Tambun	304.4	70.4	5.2	380
<i>Lutjanus erythropterus</i>	Pulau Pangkor	385.8	0	0.25	386.1
<i>Lutjanus erythropterus</i>	Pulau Jerejak	127	37	0	164



Figure 1. Diseased market size crimson snapper. Note the reddish colouration and haemorrhages on the caudal fin and dry patches on the scales of the fish.



Figure 2. External symptoms of diseased crimson snapper. Fish were devoid of scales around the head and eyes regions of the fish, patches of loss scales with haemorrhage underneath and loose scales on touching.



Figure 3. Freshwater treatment of crimson snapper during the disease outbreak. Fish were placed in freshwater in a plastic container for 5 minutes



Figure 4. A mixture of capsalid monogeneans and caligid copepods from diseased crimson snapper



Figure 5. External symptoms of diseased emperor snapper observed at Bukit Tambun fish farm

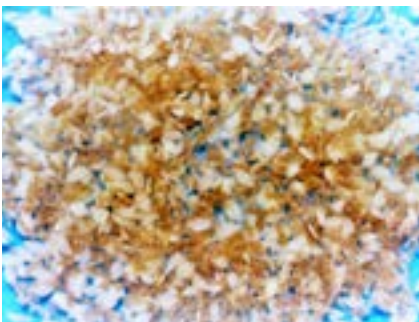


Figure 6. A mixture of capsalid monogeneans and caligid copepod from diseased emperor snapper

At the Pulau Pangkor fish farm, the symptoms of diseased crimson snapper were different from that seen at the Penang farms (Figure 7). The diseased fish had rotting caudal, dorsal and anal fins, large area of haemorrhages on the body surface, which were devoid of scales, as well as loose scales which dropped off on handling. These symptoms indicated that the diseased fish also had secondary bacterial infection.

At this farm, all cages with 300 g fish were affected and repeated freshwater treatments did not help to reduce mortality.

This resulted in a prolonged outbreak of the disease. In this farm, the diseased fish not only harboured a large number of capsalid monogeneans, but were also infected with bacteria pathogens.

The consequences of this prolonged outbreak seemed to have an effect on the marketable size crimson snapper in cages nearby. The affected crimson snapper showed large patches of dryness on the scales with large lesions at the caudal region and haemorrhagic tissues at the caudal fin. These symptoms clearly indicated secondary bacterial infection in the marketable sized fish (Figure 8). This is a consequence of delayed treatment of affected crimson snapper in other nearby cages.

Control and prevention

The current interest is to study the number and species composition of ectoparasites (excluding monogeneans on gills) of fish in a cage after freshwater treatment. This is then followed by repeated freshwater treatment of the fish in the same cage within certain time intervals. The overall objective is to determine how frequent one has to treat the fish with freshwater to reduce the population of ectoparasites to a reasonable level to minimise mortality and without causing a disease outbreak. These recent observations indicate that regular freshwater treatments have helped to reduce disease outbreaks provided that the farmers do regular interval treatment within a 2-3 weeks period between treatments. This is particularly important for fish of less than 300 g. Some fish would succumb to secondary bacteria infection if treatment is prolonged.



Figure 7. External symptoms of crimson snapper observed at Pulau Pangkor fish farm



Figure 8. External symptoms of marketable sized crimson snapper at Pulau Pangkor fish farm

References available on request.



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China's agenda in aquaculture

Chinese stakeholders show the way forward with green technology, sustainability, aquaculture transformation and efficiency.

The Global Aquaculture Summit 2017 organised by the China Aquatic Products Processing and Marketing Alliance (CAPPMA) in Fuzhou China, from June 29-July 1, was attended by more than 200 participants comprising mainly local academicians and industry stakeholders. The US Soybean Export Council (USSEC) was co-organiser. The summit focused on ways to attain an efficient, green and sustainable aquaculture industry. Future opportunities for its aquaculture industry improve with an increasing global population. China's 'one belt, one road' initiative announced recently by President Xi Jinping, is expected to create new markets for aquaculture products.

Sustainable with low FI:FO ratio

Professor **Kangsen Mai** of Ocean University of China presented on the challenges and opportunities facing China's aquaculture industry. "We have a long history in aquaculture and large-scale production started as early as the 1960s. By 2009, aquaculture accounted for more than 70% of national fish production."



“ China is net producer of fish since it has a low fish in/fish out ratio (FI:FO) of 1: 4.1.. ” - Kangsen Mai

However, Mai said that in recent years, China's aquaculture industry has received adverse reports; that it is depleting the world's natural fisheries by using up global fish meal supplies and that aquaculture in China is not sustainable. He countered these reports with figures. "Out of the 50 million tonnes of fish produced annually, only 8% are carnivores, 42% omnivores and the other 50% are either herbivores or filter feeders. According to the 2012 data from the Food and Agriculture Organization (FAO), China imported one million tonnes of fish meal and contributed to 61.7% global aquaculture production. In comparison, Japan imported 0.7 million tonnes of fish meal but contributed only 1.0% global aquaculture production. Vietnam imported 0.1 million tonnes of fish meal and contributed only 4.6% global aquaculture production. Mai further reiterated that China is a net producer of fish since it has a low fish in/fish out ratio (FI:FO) of 1:4.1 (total fish and crustacean production).

Industry transformation

There is a need for aquaculture reforms in China to make it more ecologically and environmentally friendly, said **Xiaoming Ding**, Bureau of Fisheries and Fisheries Law Enforcement, Ministry of Agriculture. He advocated for tidal flats to be zoned into areas



Dr Cui He, President of CAPPMA gave the welcome speech

where aquaculture activities can be carried out. "Coastal and off-shore cage farming should be regulated and strict enforcement should be carried out. A top priority is R&D on sustainable aquaculture models such as recirculation aquaculture systems, integrated paddy-fish farming, and off-shore cage culture."

The call was also for a speedy establishment of a fish health and quarantine system to control the spread of fish and shrimp diseases. "Fish vaccine development should also be a priority to ensure a sustainable industry and food safety in fish products."



“ Making aquaculture activities green and sustainable is also a social responsibility. ”
- Honglang Ho

In the discussion on ecological patterns in aquaculture, **Honglang Ho**, National Fisheries Technology Extension Station, said, "We still face some major problems in our aquaculture industry and we need to address them to ensure that all our activities are green and sustainable, our culture systems efficient and our products certified safe for consumption." Ho also listed scarcity of suitable land and water (both quantity and quality) and small-scale inefficient farms with low productivity. "Making aquaculture activities green and sustainable is also a social responsibility. Future directions for aquaculture development will involve the use of different aquaculture models (which are site and species dependent) to address specific problems faced. Aquaculture will need to become more intensive to improve efficiency and productivity. Culture technology will also need to address high energy consumption and to reduce our carbon foot print."

Environmentally friendly aquaculture systems

Jian Zhang, Aquaculture Program Manager, USSEC, discussed the advantages of the intensive pond aquaculture (IPA) system. This is an environmentally friendly system that does not discharge pond effluents outside the pond. It maximises the use of water resources as there is zero water exchange except to compensate for evaporation. Yields of more than 300% in comparison with yields from conventional pond systems are possible. IPA promotes production of safer products since no or little chemicals are used. In 2016, there was a total of 1,500 IPA raceways in China, mainly in Jiangsu, Anhui, Zhejiang and Shanghai Provinces. (Related article: Zhou Enhua, 2016. In-Pond Raceway aquaculture (IPA) technology expands in China. Aqua Culture Asia Pacific, July/August 2016. pp24-26).



Future opportunities in aquaculture is expected with China's 'one belt one road' policy

China has a long history of rice-fish culture. However, this method of fish production remained inefficient until the 1980s when there was support from the government and other agencies. Rice is vital to food security in China. The culture technology must ensure an optimal balance between rice and fish production with priority given to rice. **Zhongyang He**, Zhejiang Fisheries Technology Extension Station discussed its application. "Rice-fish culture has developed dramatically. Fish output increased tremendously from 36,000 tonnes in 1983 to 1.63 million tonnes in 2016, from semi-intensive and intensive fish culture systems in paddy fields. Research was focused on ditch and dyke designs, and contraptions were built to prevent fish escapees. Fish fry were stocked at optimal densities and feeding with commercial feeds has greatly improved productivity. Fish yield improved from 0.75 million tonnes in 2000 to 1.24 million tonnes in 2010."

Genxi Guo, South China Sea Fisheries Research Institute, Chinese Academy of Fishery Sciences looked at developments in deep-water cage technology and a new production model. Damage to off-shore cages exposed to strong waves and currents is due mainly to the frame and the anchoring system of the cage giving way. He proposed using an elastic anchoring system with a single point mooring polygonal cage which could withstand typhoon strength up to grade 14. The cage model proposed could easily be installed, utilising cutting edge technology in its design.



At the expo, summit co-organiser, USSEC promoted the US Soybean Sustainability Assurance Protocol (SSAP) to meet sustainability demands in the use of soybeans as an animal feed ingredient

Asia-Pacific Aquaculture Expo 2017

The Asia-Pacific Aquaculture (APA) Expo 2017 was held in the Fuzhou Strait International Conference and Exhibition Centre, Fuzhou City, Fujian Province, China from June 30 to July 2. CAPPMA organised this expo with the Fujian Aquatic Products Processing and Marketing Association (FAPPMA) and China Great Wall International Exhibition Co. Ltd. (GIE). Co-organisers were the Food and Agriculture Organisation of the United Nations (FAO), USSEC, Innovation Norway, Global Aquaculture Alliance (GAA) and World Wildlife Fund (WWF China).

This annual expo is a platform to showcase new products, new technologies, equipment and ideas for a green and sustainable aquaculture. The expo attracted huge crowds comprising not only entrepreneurs, scientists and aquaculturists but also the general public visiting booths displaying a variety of seafood at bargain prices. There were 380 booths and a total of 145 exhibitors. International exhibitors were from Canada, Ecuador, Indonesia, Malaysia, Scotland, Sri Lanka, Thailand and USA. Displays ranged from fish and shrimp seed stock, feeds, chemicals, farming technology and equipment to fresh and frozen aquaculture products, processed products, logistics and trade.

Marketing farmed products

Dalian Fugu Group Co. Ltd. farms mainly the fugu fish *Takifugu rubripes* and the prickly sea cucumber *Apostichopus japonicas*. The company has a hatchery to produce fugu fingerlings for culture to market size in cages. Fugu fish were mainly exported to Japan and South Korea, but with the 16-year old ban on live and processed fugu lifted (in September 2016), the company will target the domestic market. The new regulation allows only two species of fugu fish to be cultured and the fish are allowed to be sold only as processed products from certified companies. Processed fugu products marketed by Dalian Fugu include fugu dumplings and fish balls, hot pot ingredients, Jellide fugu skin, sliced fugu skin, fugu lips, crispy fugu fish bones, canned fugu and fugu wine. Processed sea cucumber products include dried sea cucumber, salted sea cucumber and ready-to eat sea cucumber (www.dlfugu.com).

Three Plus Three Shareholding Limited developed the Xiao6 Aquatic Network, an aquatic product e-commerce platform. This network uses big data, cloud computing, artificial intelligence, the Internet of things (IOT) and other technologies. It links buyers and sellers, matching up areas of common interests. The vision of the company is to attain a CNY trillion level aquatic production e-commerce platform.



Dalian Fugu Aquatic Product Co.

Showcasing fish cages

Dongguan Souther Plastic Pipe Co. Ltd. is one of China's technology companies dealing with aquatic environment management, raw-water pretreatment and the use of high polymer materials for various types of construction including off-shore cages for aquaculture. The off-shore cages can withstand strong winds, up to grade 12 typhoons, waves up to 7 m high and current speed up to 1.2 m/sec. These cages have a long life-span up to 15 years. These cages are widely used in China and several other countries (www.nfwcage.com).

Copper alloy net cages are becoming increasingly popular due to the properties of copper. The **International Copper Association China** is promoting copper alloy netting. The benefits ranged from anti-corrosive and anti-fouling properties, a long life-span, high mechanical strength, recyclable to better fish health and higher productivity. Net cages made from copper alloy are able to resist predator attacks and reduce the escape of farmed fish from the cages. Copper alloy mesh retain their shapes better than most other net materials, preventing fish crowding. The antifouling and anti-bacterial properties of copper alloy cages reduce maintenance needs and costs. From the operations point of view, copper alloy cages require less labour and lower the accident risks of divers and overall costs associated with divers (www.copperalliance.org).

RAS technology

Qingdao Hishing Smart Equipment Co. Ltd. specialises in R&D and manufacturing of industrial recirculation aquaculture systems (RAS), equipment for off-shore cage farms and intensive pond aquaculture, intelligent fishery management systems and IOT. Hishing has technical cooperation with top research institutes in China to transform scientific research achievements into commercial applications. For industrial RAS, Hishing is able to provide smart recirculating water treatment system, smart

fish feeding and control systems, such as real-time monitoring and management of the RAS. The intelligent system monitors all critical parameters of the RAS, and alerts the RAS operators of system failures or when the RAS system is not functioning at optimal conditions (www.hishing.com).

Swedish environmental engineering company, **Wallenius Water AB** provides water purification systems for use in various applications including aquaculture. It has developed an advanced oxidation technology that enables free decomposition of hazardous micro-organisms and other undesirable substances to provide chemical free water. This technology has been used to further develop RAS consisting of mechanical filters, thermostats, oxidation technology and biofilter reactors. Three RAS models are available: mini-RAS (for small-scale farming, where there is no access to natural water intake and is a compact system for low water volumes); single-layer RAS (developed especially for conditions in China to fit all species and water volume) and multi-layer RAS for high productivity farming in multi-layer raceways, with exceptionally small carbon footprint and low water consumption (www.walleniuswater.com).

Shrimp disease diagnostics

Malaysian biotechnology company, **Speedy Assay Biotechnology Co. Ltd** was at the expo to market ISO compliant shrimp diseases detection kits. Widely used in Malaysia, Thailand, Vietnam and India, these include rapid test kits to detect white spot syndrome virus (WSSV), monodon baculovirus (MBV), infectious myonecrosis virus (IMNV) and yellow head virus (YHV). The polymerase chain reaction (PCR) kits and real-time PCR kits have high sensitivity to detect all these pathogens as well as acute hepatopancreatic necrosis disease/early mortality syndrome (AHPND/EMS), *Enterocytozoan hepatopenaei* (EHP), hepatopancreatic parvovirus (HPV), infectious hypodermal and haematopoietic necrosis virus (IHHNV) and taura syndrome virus (TSV). The low cost/test rapid test kits are easy to use and can provide results within 20 minutes (www.speedyassay.com).

Commitment to sustainability

On World Oceans Day, the Marine Stewardship Council (MSC), together with leading Chinese partners including China's largest online marketplace Tmall.com, announced their commitment to sustainable seafood procurement. MSC and Tmall signed an MOU that Tmall will prioritise purchasing seafood from sustainable sources. Tmall also committed to a target of 20% of seafood products sold with the MSC ecolabel by 2020. Tmall, owned by Alibaba Group, has more than 375 million active buyers and can handle 25 million payments per second.

"Alibaba Group's Tmall will be the only primary platform to release new labelled certified products, and jointly organise a promotion program," said Ray Ho, General Manager of Tmall Fresh, Alibaba Group. Ole (part of Vanguard Group, owned by China Resources (CR) Group), Shenzhen Rainbow Grocery and the Shangri-La Hotel Chain also announced their commitment to sustainable seafood procurement and marketing. "CCFA initiated the China Sustainable Retail Roundtable to develop market links with reliable certifiers to meet emerging market demand," said Pei Liang, General Secretary of China Chain Store and Franchise Association (CCFA).

"The Chinese seafood industry has a vital role in the global market, from traditional international trade for processing imported raw seafood and re-export, to transforming the domestic market and enhancing brand building. Sustainability is a crucial condition, that will be in line with a new central government initiative for green industry development and green life style. More and more Chinese seafood enterprises, such as Zonoco group, Ocean Gala, BeiYangJiaMei, Oceaniese and Spring Seafoods, have joined the MSC program and try their best to provide MSC ecolabel products to the Chinese seafood market," concluded Cui He, President of China Aquatic Products Processing and Marketing Alliance (CAPPMA). www.msc.org



Spotlight on Africa

By Eric Roderick

Sustainable Aquaculture - New Frontiers for Economic Growth at WA 2017



Siphokazi Ndudane, Deputy Director General, Department of Agriculture Forestry and Fisheries, South Africa, gave the welcome address.

This year, World Aquaculture went to Africa. Nowhere is this theme more appropriate than in Africa, where the huge aquaculture potential has been talked about for 25 years. After many false dawns, there seems to be growing momentum to finally make this happen. Africa – the world's second fastest growing regional economy, offers significant investment opportunities in aquaculture development. The conference organised by the World Aquaculture Society (WAS) had the following co-organisers; Aquaculture Association of Southern Africa (AASA) and South African Department of Agriculture, Forestry and Fisheries (DAFF).

Sponsors include several African development institutions including DAFF, the African Union, NEPAD and World Fish Centre. It was held from June 26-30 in Cape Town, South Africa.

This was the first time the WAS had held their annual conference and trade show on the African continent. With 1,981 participants from 87 countries of which 1,297 were from 33 African countries, it was deemed a successful conference. With almost 500 oral presentations and 215 academic posters there was also a broad range of research topics covered. Africa is expanding its aquaculture industry to feed the steadily increasing population. Aquaculture is the fastest growing sector within agriculture and the increasing demand for healthy high protein food is vital for food security throughout the African continent.

One of the highlights of the conference was the setting up of a WAS Africa Chapter that will work closely with the Aquaculture Association of Southern Africa. WAS president, Dr Juan Pablo Lazo from Mexico and the other WAS Directors formally announced the Chapter at a special conference meeting. The importance of conferences such as WAS being held in Africa was emphasised.

There were two plenary addresses, one by Dr Rohanna Subasinghe, the former chief of Aquaculture at FAO who spoke



Farmer, Jackson Thubisile Chiwaye from Botswana (left) with Alexandre Bédier (Nutrimea, Reunion Island), an aqua feed producer. To expand his tilapia farming business, Jackson is looking east for technical information and training.

on “Feeding the nine billion: The role of aquaculture”. The second plenary address was given by Dr Sloans Chimatiro, acting country director of World Fish Zambia, on “African Perspectives on Aquaculture” which highlighted the success of aquaculture in Zambia and the surrounding countries. As usual, the conference covered all aspects of aquaculture and included two special 2-day post conference workshops on aquaponics organised by Stellenbosch University, and aquaculture biosecurity organised by the International Aquatic Veterinary Biosecurity Consortium. Both were very timely with aquaponics gaining momentum globally and new diseases appearing regularly across all aquaculture species to challenge our industry.

In recognition of the early developmental stage of African aquaculture, special sessions on developing African aquaculture value chains, financing and an African aquaculture policy day were organised by the African Union, NEPAD, World Bank and WorldFish. The aim was to review the status, growth potential and risk profiles of African aquaculture investments, with a focus on the amount and types of capital needed to help the sector produce revenues, jobs and fish for a growing continent. There were insights into some challenging aspects of commercial aquaculture such as the presentation by Andre Bok, on the rise and fall of the marine fish farming industry.

Focus on tilapia

Tilapia is the most important fish in Africa. Two full day sessions were devoted entirely to tilapia chaired by Kevin Fitsimmons, University of Arizona and Hussein Elboghashy, Egypt. There was also a special session on tilapia aquafeed sponsored by Aller Aqua. Egypt, with a production of 1.17 million tonnes in 2015 is by



WAS premier sponsor Ziegler introduced specialty feeds including an Artemia replacement diet. At their booth, Ziegler's Dr Craig Browdy (middle) and Chris Stock, with Lukas Manomaitis (USSEC)



Dr Madhumita Mukherjee (left) and colleague from the Department of Fisheries, West Bengal. The state is a leading producer of tilapia in India.



Participants from India. From left, K Venkata Raju (Avanti Feeds), Dhanunjaya Goud (Lallemand), S. Mohanty (Avanti Feeds), PVS Rao (Devee Biologicals), Prasad Kumar, Murali Krishna and Anuj Tyagi (Avanti Feeds), Harikumar Sampath (Kemin, India), Dr Rayaprolu Srinivas (Devee Biologicals) and Dr Chandran Bakthavachalam (Kemin).



Dr M A Kabir Chowdhury, Global Product Manager - Aquaculture (right) and Kurt Servin, Representative Aquaculture, Mexico, Jefo Nutrition Inc.

far the main aquaculture producer in Africa. Historically there has been very limited production from all the other African countries, but aquaculture investments, both local and foreign, is driving a major expansion in the industry with new farms planned in Egypt, Namibia, Zimbabwe and South Africa. Yalelo is proposing significant expansion of its Zambian cage farm operations in Lake Kariba to produce 30,000 tonnes/year. Lake Harvest is also based on the Zimbabwean side of Lake Kariba. In South Africa, the Tilapia Aquaculture Association of Southern Africa (TAASA) is helping to drive this expansion. Lack of good quality feed and high quality fry have been major limiting factors in Africa's expansion.

Active expansion in feed production is expected with Aller-Aqua building a new tilapia feed mill in Zambia and expanding its factories in Egypt. There is also a new feed factory in Nairobi, Kenya developed in partnership with Nutreco and Dutch funding, which is producing 5000 tonnes/year to supply local tilapia farmers in the region. Alltech recently purchased Coppens, the Dutch feed supplier with a strong customer base in Africa.

Special attention was given to tilapia health in light of the recent OIE reports on tilapia lake virus (TiLV). MSD conducted a special session with presentations on prevention, biosecurity protocols, diagnostics and sampling by the global and Singapore teams. Dr Win Surachetpong, Kasetsart University, Thailand discussed the impact of TiLV in Thailand while Leonardo Cericato and Dr Huchzermeyer presented on experiences with vaccines in Latin American and Africa, respectively.

The trade show was a very important event for the industry to showcase its products, and the nutrition sector was extremely well represented with a total of 32 companies selling feed or involved in feed or feed ingredients, showing the importance and the competitive nature of nutrition in aquaculture. Aller-Aqua, the Gold Sponsor reported a lot of business visitors (see pages 56). It also conducted a session on catfish feeds.

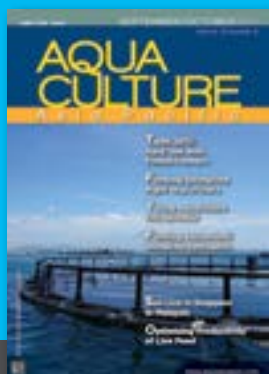
Skretting Africa, sponsored a special Tilapia Nutrition Symposium chaired by Dr Arjen Roem, Technical Director at Skretting Africa (see page 59) and Dr Lourens De Wet, Director of Nutrition Hub (formerly University of Stellenbosch). Skretting also, through its 3-year association with Cape Town's world famous Two Oceans Aquarium offered all delegates a free pass to visit the aquarium, throughout the conference week.

New innovative feeds, as replacements for fish meal in farmed fish diets, were represented by Entomo Farm, based in France, which produces a 70% protein insect meal with a well-balanced amino acid profile. With insect meal recently approved by the EU for inclusion in fish feeds, this sector is expected to expand significantly. There are already several global companies producing insect meal including Protix- Buhler, an EU based joint venture, Enterra, a Canadian company and Agriprotein based in the UK. All the companies are focused on generating high value insect protein to replace fishmeal and land based protein in fish feeds, at the same time reducing landfill waste by utilising the high grade organic waste as food for the insect larvae. Black Soldier Fly is one of the main candidate species.

World Aquaculture 2018 will be held together with Aquaculture Europe 2018 in Montpellier, France from 25-29 August, 2018. (www.was.org/www.aquaeas.eu)



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NEXT ISSUE

November/December 2017

Issue focus: E-commerce

Industry review: Genetics

Feed/Production Technology: Functional Feeds for Health/Aeration Technology

Deadlines: Articles - September 18, Adverts - September 25

Email: zuridah@aquaaasiapac.com; enquiries@aquaaasiapac.com for details

Growing with customers in Africa



Niels Lundgaard

As a company focused on its customers and expanding in Africa, it was natural for Danish aqua feed producer **Aller Aqua** to be active at World Aquaculture 2017 (WA 2017) as the Gold Sponsor. Aller Aqua has already established local production and several additional sales companies in the large continent.

Its African journey started in 2009 when the first meetings took place in Egypt, and picked up pace in 2011, when it acquired a feed factory through a joint venture with a local family. The factory was built in 2014 and production tripled. The recent addition of the third line in March 2017 increased capacity to 100,000 tonnes per year (tpy) of mainly fish feeds.

Today, the group's structure with subsidiaries in Nigeria, Kenya and Ghana, forms a strong base for customer services in the region. It has a network of distributors and agents in Rwanda, Benin, Cameroon, Senegal and Tanzania. Its German factory, Emsland-Aller Aqua exports to Uganda and Madagascar. The group's Danish and German factories exports mainly marine fish feeds to Tunisia, Morocco and Algeria in the north. Family-owned Aller Aqua is rooted in the feed business and the family values of being together and helping each other is brought to the Africa continent.

"Although we have been active in Africa with direct contact with clients for several years, in the past 3 years, we have been increasing our focus on the African aqua feed market. Since May 2015, we opened a subsidiary, Aller Aqua Nigeria and we also incorporated one in Kenya. In 2016, Aller Aqua Ghana was added. In most countries, we have direct sales to large farms but still work with agents and distributors. In Zambia the factory is under construction and we will commence production in August/September," said Niels Lundgaard, Commercial Director for Africa at the Aller Aqua booth.

Move into Africa

In general, the major farmed fish are the African catfish and tilapia. Egypt is very strong in tilapia production with almost 1 million tonnes of annual fish production. Tilapia is also the major species in Kenya and Zambia. In Nigeria, the major species is the catfish.

"What we started in Egypt and are now doing in Nigeria, Ghana, etc. are not just to deliver feed. Instead we look at how can we add value to the entire supply chain. This is the best way to ensure that the farmer is profitable. From our point of view, we want to see farmers achieving faster growth and producing healthier fish. Our market share may not be large, but we prefer a small share in a large market. My colleagues and I know that we must be part of this industry in Africa," said Niels. "Our history is with us every day and the philosophy is if the farmer has a good harvest, the miller has a good business."

"With the Aller Aqua Zambia factory, Aller Aqua will be the leader of modern and environmentally friendly extruded fish feeds for aquaculture in Africa. Transport maybe expensive in Zambia but our factory will open up for the aqua feed market in surrounding regions, in Malawi and Botswana, parts of Mozambique as well as cage farming of tilapia in Lake Kariba bordering Zambia and Zimbabwe. We want to deliver high quality feed at reasonable prices."

Formulating feeds for Africa

Aller Aqua's R&D department, formulates the feeds sold in Africa specifically for the region, considering the species and the nutritional and physical quality for the environment the fish are farmed in. Both tilapia and catfish grow fast, and a high-performance feed enables faster and more economically efficient growth, resulting in improved income to the farmer at harvest. The company has formulations for 30-35 freshwater and marine fish species. It can deliver feeds covering the entire lifecycle of the fish, as well as both organic and functional feeds. Temperature adapted feeds are adjusted to the four seasons and are especially useful for summer conditions in Egypt to limit stress.

"In Africa, we have talented local teams in place in the different countries. They deliver training as well as work together with farmers. We also conduct farm trials to demonstrate valid results to farmers. We want to cooperate with farmers to ensure that they have a profitable business. Our feed prices may be higher than other available feeds, but our focus is on feed performance.

"We cannot see Africa as one market. Challenges will vary with each country but in general, we need to be flexible, understand the need for talented local people and adapt to the different farming systems and culture of farmers," said Niels. "To be successful, we need a long term approach."

What's next in Africa?

"Since 2009, we made this move into Africa and this is a long-term plan as Africa and Asia are where the potential growth is. We are here because we want to be here. Coming from the EU, we have been exposed to some sustainability criteria such as use of fish meal replacements and impact of aquaculture on the environment. There may be little interest on such criterion in African aquaculture but we have the responsibility in that what we deliver in Africa is the same as in Europe. In the large lakes of Kariba, Volta etc., it is critical to take care of the environment."

At World Aquaculture 2017 Aller Aqua has set out to achieve both visibility of their activities in Africa as well as meeting as many customers as possible. Talks at their booth focused on how the company could help maximise output and achieve better farming economy for the customers, based on the company's vision: let's grow together. The Aller Aqua team was happy with their participation in WA 2017.

Large presence for aqua feed market leader in Africa

The **Skretting Group** is now well established with three fish feed mills in three African countries. In 2013, it entered Africa with a strategic acquisition in Egypt and increased its presence with a feed mill in Nigeria in 2014. Skretting Zambia started production recently and was set up in 2016 as a joint venture with ACF, Africa's largest fish producer.

During World Aquaculture 2017, Dr Arjen Roem, Technical Director Africa, said, "Five years ago, we started building up the Skretting Africa organisation. Our Egyptian feed mill producing feeds for the tilapia, mullet and seabass has been growing very fast. It is possibly one of the largest tilapia feed mills in the world. In Nigeria, which is the second largest aqua feed market in Africa, mainly for the catfish *Clarias gariepinus*, we are the leading fish feed producer. We see that tilapia production is also fast growing in Nigeria particularly as there are many large lakes and reservoirs suitable for cage culture. We will supply this feed demand from the Egypt feed mill. At the same time, throughout Africa, we are looking for partnerships or distributors."

"Why is aquaculture in Africa still in its early stages? It is because there are a lack of good quality fry and fish feed. We want to be the catalyst for development on the feed side, at good prices. In Egypt and Nigeria, there are many feed companies and the feed market is well established. In other countries, there are livestock and ruminant feed producers but they do not have the expertise and technology to produce fish feeds."

Although there are other species farmed in Africa, such as trout in South Africa, marine fish in Mauritius and shrimp in Madagascar, 90% of the feed market is for the tilapia and catfish. "These are fish that can be produced at low cost and there is a large growing domestic demand for such fish. Tilapia and catfish farming is top priority in most countries. A lot of aquaculture companies are looking at the African aqua feed market here at the WAS meeting in Cape Town. We have been through this process 5-6 years ago and so we feel we have a head start."

R&D from China to Africa

The uniqueness of Skretting is its nutritional knowledge base in more than 60 fish and shrimp species which is being used to plan the strategies in feed production in Africa, added Marit Husa, Communication Manager, Skretting Group. "We now produce tilapia feeds in Brazil, Ecuador, Vietnam, Honduras, China and in Africa. We have a global tilapia team now from these countries, involved in developing new products. For example, they have developed the Nutra starter diets. Part of the tilapia research is carried out in China in our Skretting Aquaculture Research Centre. Validation is carried out in the respective countries. We also have a small research station in Egypt for these validation trials. We will be building another one in Zambia, too."

Support in value chain

The Skretting team in Africa does not involve itself in fish production nor with buying back harvest. However, they do support farmers with services centred around the feeds and with management such as training and informing on technology updates to create a more professional value chain. The aim is to bring technology to aquaculture in Africa."

Understanding the market

On challenges with entering the new market in Africa in 2011, Arjen said, "It was a bit like when we started in Asia. The process was similar. We needed to learn and understand the market and



“ We want to be the catalyst for development on the feed side, at good prices.... ” - Arjen Roem

get local knowledge and find out where were our type of fish farmers. There are more than 50 countries in Africa and so we needed to determine where to start and which countries were potential markets for us. Egypt and Nigeria were obvious starting points, but in Africa, it is also about managing risks and the strategy was to start at a smaller scale."

Today, Skretting has a strong base in Egypt with a production capacity of 100,000 tonnes (tpy). Nigeria is the second largest aquaculture market with 300,000 tonnes of catfish annually. Feeds from Skretting Egypt are sent to East African and West African (Mali, Senegal, Benin and Ghana) farms. Skretting Nigeria will expand its feed mill to match the capacity in Egypt by 2019. The feed mill in Zambia located close to Lake Kariba, has a 35,000 tpy capacity and supplies feed to neighbouring countries as well: Skretting Zambia will supply Zimbabwe, Botswana and Malawi.

These feed mills will produce mostly the larger grow-out feeds for tilapia and catfish. However, Skretting will continue to produce the smaller starter feeds such as the Nutra range which requires sourcing for the highest quality raw material and micro pelleting technology, in France.

In many countries, the farmers do not face major disease outbreaks yet, but it can be expected wherever fish densities increase. "Health and hygiene management will become more critical. In many parts of Africa, the temperature is perfect for tilapia but it is also perfect for bacteria and viral diseases for tilapia. In Egypt, in the summer, when temperature rise to more than 30°C, disease outbreaks and high mortality losses are common. We are developing health concepts to help farmers handle these challenges. We have our health diet, PROTEC, documented for tilapia. In Egypt, this diet is an important tool in health support but farmers need to combine its use with good pond and water quality management.

"The days of extensive farming are over as more farmers are increasing stocking density. Our philosophy is that the small farmers also deserve to use high quality feeds just like the larger farmers. So, we really need to help the small farmers with micro financing," added Arjen.



Supporting Vietnam's aquaculture growth



Ribbon-cutting ceremony of the new shrimp feed factory

A new, dedicated aquaculture feed plant was recently opened in the Mekong Delta by Skretting Vietnam to help the country's fast-growing shrimp farming sector reach its full potential. The new 23,000 m² facility is located within the Thuan Dao Industrial Zone, Long An, for the convenience of local customers as well as to make best use of the transport links to other important farming provinces in the Mekong Delta.

More than 600 guests, including distinguished representatives from Nutreco and Skretting, partners and investors, and many local farmers, attended the plant's official opening ceremony in June 2017. At this event, they were given guided tours of the facility and heard senior executives from Skretting and parent company Nutreco underline the company's commitment on aquaculture development in Vietnam and across the Southeast Asian region through the provision of high-quality feeds and technical support, which is made possible through its world-class R&D.

Welcoming guests at the opening ceremony, Marc Le Poul, General Manager of Skretting South Asia, said, "Building on several years of experience operating in Vietnam, we feel that 2017 is the year to reach new heights: new heights in terms of delivering innovation and best product performance to our customers; and new heights in term of providing best standard of working environments for our employees'.

"In recent years, Skretting has been actively promoting our feed-to-food safety commitment to the market. This is because we are dedicated and proud to provide additional value to our customers. Aligned with the trust that our traceability systems have achieved, we have shown that working with Skretting adds both value and trust in even the most demanding markets."

Skretting Vietnam's new plant will adhere to the same robust standards, support and ways of working that are in place at all other locations operated by Skretting and parent company Nutreco. As well as incorporating state-of-the-art technology that has been specifically designed in line with the company's strict health and safety standards, the facility also houses a special system to produce Skretting's unique functional health feed for shrimp, Lorica.

Alex Obach, Managing Director at Skretting Aquaculture Research Centre (ARC), the global research organisation for Skretting, informed guests that Lorica's complex profile of innovative functional ingredients is designed to shield shrimp during challenging phases in their lifecycle, including transfer and handling. Furthermore, its unique formulation delivers invaluable support to the defence mechanisms of these animals, enabling them to better cope with stress factors.

"In Skretting, we believe in Vietnam. And because we believe in Vietnam, we also want to increase our innovation efforts in the region with the construction of a new station in the coming months. Together with you, the local producers, we want to ensure a brilliant future for aquaculture in Vietnam and in Asia," said Obach.

On behalf of the Nutreco Executive Committee, Samson Li, Managing Manager of Nutreco Asia, shared details of the company-wide mission of 'Feeding the Future' as well as its dedication to supporting the sustainable growth of the global fish, shrimp and animal farming sectors with high-quality products and services.

"Building this new state-of-the-art plant in Vietnam underlines the strong commitment that we have long shown to our customers in this very important country. This investment will be a vital contributor to the progress of Vietnam's aquaculture industry and meeting the dietary needs of its fast growing population. We shall continue to provide you with all the knowledge and support that you will need to take this industry forward into a new golden age," said Li.

As well as being an important contributor to the country's aquaculture industry, Skretting Vietnam also takes a lead role with regards to improving the lives and social well-being of local communities. It has implemented many non-commercial initiatives, such as donations to underprivileged school children, including funding a scholarship programme for children of low-income families. It has also funded the construction of much-needed local infrastructure, including building four bridges in remote farming areas. These and other important interactions demonstrate that Skretting Vietnam and the broader Skretting group is much more than a feed supplier and an employer, it is a major supporter of farmers and the communities in which it belongs.



Customers visit new shrimp feed factory

Adding value to African aquaculture production



Africa is a continent with huge demands for more food, produced in a responsible and sustainable way. “We believe that aquaculture is one of the answers to this demand”, said Ole Christensen, Vice President for **BioMar**’s EMEA division. “BioMar Group has ambitious targets and initiatives for shaping an efficient and sustainable global aquaculture in collaboration with the entire aquaculture value chain.”

As farms become increasingly intensive, the need for a diet targeted for broodstock has grown. To meet this demand, BioMar France now expands its product range to cover all nutritional needs of these species at all stages of their life cycle by introducing broodstock feed type EFICO Genio 838F, available for all tilapia and African catfish farmers in Africa and other markets served by BioMar’s EMEA division.

“The goal of broodstock feed EFICO Genio 838F is to increase reproduction capacity”, said Michel Autin, Technical Director of BioMar EMEA. “The vitamin mix and levels are fine-tuned to promote an increase in the number of females actively spawning. Our newly developed broodstock feed has a formulation that includes the necessary protein and vitamin balances, which contributes to increased spawning frequency, hatchability, and survival of fry.”

African aquaculture production is expanding in various ways and into various species. BioMar’s presence in Africa steadily grows. The markets served by BioMar are not limited to tilapia and catfish. “We have for many years also supplied feed to a growing number of sea bass and sea bream farms based in Northern African countries. We aim to add value to African aquaculture production”. www.biomar.com

Intelligent technology for optimum dryer performance

Bühler Aeroglide, a global leader in thermal process engineering and technology for food, feed, and industrial materials, has introduced a complete moisture control system that helps customers maintain a dryer temperature profile and minimize over drying. Controlled drying parameters ensure that a food or feed product is shelf-stable, removing the precise amount of moisture. However, one processing deviation can dramatically affect batch specifications, requiring an operator to over dry, just to compensate, and this can mean reduced yield as well as compromised product.

Bühler Aeroglide is leading the industry with a collaborative new approach to moisture control. AeroPro Moisture Control gives operators access to full time, real-time monitoring with hardware, software, and ongoing process expertise, combined with technical support, to ensure the most efficient dryer operations ever. “Too little information and too much time between adjustments makes optimising a dryer’s temperature profile a constant challenge,” said Doug Beloskur, Manager of Bühler’s dedicated automation team. “AeroPro Moisture Control reduces time-based moisture deviation with a control algorithm that improves dryer yield. It also reduces dryer energy consumption.”

Microwave sensor technology, coupled with algorithms that are built on decades of drying experience deliver a comprehensive closed loop system for automated dryer control. Discharged product passes through an analysis chute where approximately 20% is diverted to a sensing chamber that slows the product flow for analysis. Then, a high performance microwave sensor gathers moisture data and sends it directly to the AeroPro control panel. Automation then makes necessary dryer adjustments that can instantly produce product consistent to the target moisture



content. “Efficient intelligent control can do a lot for a customer’s ROI and it can ensure sustainability,” said Beloskur. “AeroPro Moisture Control can increase production and profitability while decreasing energy and material costs. Furthermore, a dynamic web-based reporting provides information in a quick read way, customized for the process, and this helps a customer have correlations that are meaningful. It gives the processor the ability to make decisions with confidence.”

AeroPro Moisture Control also makes it possible to view production data in real time via computer, phone, tablet or other web-connected device. Custom dashboards can be built to provide the most critical data in a quick and meaningful way. Data storage is cloud-based making viewing and reporting fast and easy. In today’s competitive marketplace, the smallest percentage gain can increase yields and profitability. Therefore, real-time management that can achieve a net increase of just 1% in finished moisture can result in a return-on-investment increase of USD 300,000. This translates into an energy savings valued at USD20,000 per year. (www.buhlergroup.com/drying)

Sponsored talk on fish parasites at TARS 2017

Once more, multinational feed additives producer **Nutriad** sponsored The Aquaculture Roundtable Series (TARS), which was held August 16-17 in Bali, Indonesia. This year's theme was Finfish Aquaculture: Strategies for Growth. A pioneer in additives that support health and nutrition in fish and shrimp, Nutriad continuously strives to interact with industry professionals and scientist from all over the world.



"Parasite control is one of the key issues in health management of all commercial species of fish, including salmon, tilapia and marine fish. However, there is a general lack of basic knowledge on fish parasites in the aquaculture industry, particularly in Asia," said Dr Maria Mercè Isern Subich DVM, Nutriad's Business Development Manager Aquaculture Health.

Professor Francisco E Montero, University of Valencia, Spain involved in research on fish parasitology since 2001, shared his views on the life cycle and mode of action of different species of fish parasites relevant for aquaculture. His presentation was on Parasite Prevention in Fish farming and Montero illustrated graphically the mode of infections and damage to fish. He discussed current practices and challenges to prevent and/or treat parasites in fish farms in Europe.

TARS 2017 is a successful platform for the industry to exchange insights and experiences. The objective is to expand and to share knowledge enabling producers to better manage and control the variables in fish farming; build on industrialization; and improve



Professor Francisco E Montero (second right) with the Nutriad team at TARS 2017. From left, Dr Peter Coutteau, Business Unit Director - Aquaculture, Allen (Ming-Hsun) Wu, APAC Regional Manager - Aqua and Ho Gim Chong, SEA Manager - Aqua

production efficiency on a technical and operational level. This meeting in 2017, attracted more than 180 professionals from international corporates and regional aqua feedmills farm owners and major suppliers in the region who all actively engaged in sharing updates and experiences, exploring workable solutions and developing a clear strategy to prevent and control future disease outbreaks in fish aquaculture in Asia. www.nutriad.com

Editor's note: A report on the presentation by Professor Montero will be published in the November/December issue.

Australian-focused website launched

A brand new website directed at Australian aquaculture professionals, PentairAES.com.au, is now live. **Pentair Aquatic Eco-Systems'** regionally-focused website is well-timed, as the Australian aquaculture industry continues to grow. In order to meet demand, the industry needs a reliable supplier. With an office in Melbourne, and a local stock of products, Pentair Aquatic Eco-Systems (PAES) offers convenient and comprehensive service to customers, with a wide array of technologies and solutions.

With farming of species such as the barramundi on the rise, expertise is at a premium. Pentair Aquatic Eco-Systems has the equipment and expertise to offer solutions for a variety of species; Atlantic salmon, rainbow trout, barramundi and more. Their offering addresses the entire life cycle of these species. Pentair's Melbourne office features a full range of aquaculture technology and equipment that is ready to ship. Their dedicated sales staff is prepared to answer any questions and provide solutions to new and existing farms.

Pentair Aquatic Eco-Systems' Sales Manager for Australia and New Zealand is Brendan Lee. With a great passion for the industry, prior to Pentair, Brendan has held positions at a leading rainbow trout producer in Victoria, after which, he moved on to a research and development role, working with fresh and salt water algae species and live feed production – all of which has built valuable experience in all aspects of aquaculture, which benefits his customers greatly. When asked for comment on Pentair's focus on the Australian market, Lee said, "I look forward to assisting current and future customers with any of their project, design, service and equipment needs, as we continue to build the Australian and New Zealand aquaculture sector together!" PentairAES.com.au.

Launch of CJ Selecta

Korea's CJ CheilJedang Corp. has completed the takeover of Brazilian animal feed raw material supplier Selecta and launched "CJ Selecta." CJ hosted the launching event of **CJ Selecta** brand on 25 August in Goiania, Brazil, attended by CEO of CJ CheilJedang Kim Chul-Ha and executives. CJ announced the vision of CJ Selecta and congratulations for being part of the CJ family.

At the launch, Kim Chul-Ha said that the company will not be satisfied with the title of Korea's No. 1 food company and will continue to strengthen its global business.

Selecta produces soy protein concentrate, a key material for livestock feed. Its sales reached some USD 355 million and operating income stood at USD 49 million in 2016. Selecta has global sales networks in 40 countries and is considered to have cost competitiveness as it is based in Brazil, one of the world's biggest soybean producing countries.

With the launch of CJ Selecta, CJ CheilJedang has completed its business portfolio as a company that produces both fermented soybean meal and soy protein concentrate. These two products are used as materials for high protein vegetable livestock feed. The company said that it plans to produce and supply various types of animal feed for poultry and pigs, and farmed fish. CJ Select also plans to produce food grade soy based products.



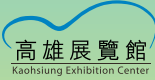
CEO of CJ CheilJedang Kim Chul-Ha at the launch

The scale of the high protein vegetable livestock feed market is about USD 1.4 billion. The market increased by 7% on average for the past five years. The goal of CJ is to reach over USD 700 million in sales from Korea, Brazil, Vietnam and China by 2020. Based on this, it expects to increase its share of the global soy concentrate market up to 40%. www.cjselecta.com.br

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Connecting aquaculture in Asia

The Asian Pacific Aquaculture 2017 (APA17) conference and exhibition was held from July 24-27 in Kuala Lumpur, Malaysia. According to organisers, the Asian Pacific Chapter of the World Aquaculture Society (WAS-APC), it was attended by approximately 3,000 participants from 46 countries, with 87% from Asia. The conference had 325 oral presentations and 119 posters within 37 sessions. At the trade show, there were more than 170 booths with exhibitors from 20 countries led by Malaysia, Singapore, USA, Thailand and Taiwan.

The two plenary presentations were by Herve Lucien-Brun, Aquaculture & Qualite, France on marketing of farmed seafood from Asia to global markets and by Dr Mazuki Bin Hashim, Senior Director of Fisheries Biosecurity Division for the Department of Fisheries Malaysia on transforming the aquaculture industry in Malaysia. Lucien-Brun's message to the audience was, "The real key of success for the producer is being able to adapt harvests according to buyer specifications. The target should be to obtain the best price of the moment for the harvest. Specifications for each market will evolve differently in each country and it is important to have sufficient knowledge of its evolutions to adapt and remain competitive."

APA17 was the annual meeting of WAS-APC. It was jointly organised by the Malaysian Fisheries Society (MFS), and Universiti Putra Malaysia. The host was the Department of Fisheries (DOF), Ministry of Agriculture and Agro Based Industry, Malaysia. At the President's reception, participants were served hybrid grouper farmed in Malaysia and contributed by Fishance, the President Reception sponsor. Several companies, active in Asia, took the opportunity to organize special sessions.

Malaysian farmers day

The leading activity at APA17, was the DOF/MFS organised Malaysian farmers day, attended by more than 400 fish farmers and aquaculture stakeholders. In marine fish farming, Alexey Dorin, Fishance presented the company's plans to transform Langkawi into a grouper industry hub in Malaysia while Dr Leong Tak Seng discussed managing pathogens in floating cage culture of marine fish. Professor Patrick Sorgeloos, University of Ghent, Belgium, discussed aquaculture as the new blue biotechnology. Khaw Hooi Ling, WorldFish, Malaysia presented on the breeding program for Nile tilapia and DOF's Gerald N Misol Jr gave an introduction on antimicrobial resistance to the fish farmers. The future of marketing fish and shrimp was presented by Shirlene Antonysamy, Infofish.

Special shrimp industry session

Gold sponsor Sheng Long Bio Tech International organized a special shrimp industry session "The Advanced Research Developments on Shrimp Culture" which focused on shrimp disease management. The company invited five regional experts from Asia Pacific to this session. This was an open session attended by industry in Asia, customers and conference participants. Presentations topics ranged from shrimp nutrition, farming management and disease prevention and treatment. Among the presenters were Dr Loc Tran, Vietnam who discussed work on the development of an infection model for the white



At the Malaysian Farmers Day, DOF also had a book launch by Munir Mohd Nawi, DOF's Director General (left). This was on the National Fish Health Strategy of Malaysia. On the right is plenary speaker, Dr Mazuki Hashim.

faeces syndrome (WFS) on *Penaeus vannamei*. Dr Han Ching Wang National Cheng Kung University, Taiwan discussed establishing biosecurity for the shrimp aquaculture industry. Dr Yu Hung Lin, National Pingtung University of Science and Technology discussed the evaluation of bile salt as cholesterol replacer in diet for the white shrimp.

Functional feeds for disease prevention

Nutriad, a world leader in specialty additives for fish and shrimp organised and sponsored, "Functional Feeds for Disease Prevention." The aim was to update on current market developments and new findings on health management. Its health expert Dr Maria Mercè Isern Subich presented on health management for profitable and safe aquaculture production. Dr Prakan Chiarakhongman, Charoen Pokphand Foods PLC,



At the Sheng Long Bio Tech International booth, Jeff Jie-Cheng Chuang, General Manager (fifth from right) and Maple Hung, Vice President-Global Marketing (fourth from right) with customers, distributors and teams from India, Vietnam and Malaysia.



Chi Yuan Liu, General Secretary, Taiwan Fish Breeding Association (second right) with some members from Taiwan.



The team from Tunku Abdul Rahman University College (TARUC) and industry, from left, Tee Hock Koon, THK Sales and Services; Tan Peck-Yen, TARUC; Liaw Boon Lai, Kg Chennah Agro Resort; Choong Yun Loong and Dr Lim Hong Chang, TARUC and Khoo Eng Wah, Sepang Today Aquaculture Centre, Malaysia

Thailand gave an overview on health management and farm practices in Thailand including several innovations developed in Thailand to overcome several diseases; from early mortality syndrome (EMS), white faeces syndrome (WFS) to Streptococcus in tilapia. Working on WFS and Dr Loc Tran, ShrimpVet Laboratory, Vietnam looked at prophylactic approaches in reducing the impact of enteric bacterial disease on *P. vannamei*. His message was that several products can be mixed into the feed and delivered orally as prophylactic agent against EMS or WFS. Dr Yu-Hung Ling, also presented at this session and this time, discussed the effects of different dietary soybean meal levels on tissue cholesterol status and molting relative gene expression in *P. vannamei*.

Session chair, Dr Peter Coutteau, Business Unit Director Aquaculture commented, "Nutriad is committed to working in the field with producers and in labs with scientists to provide practical solutions to challenges producers face. We feel it is important to share our knowledge and join industry professionals from all over the world each day in making aquaculture production more sustainable, more efficient and more profitable."

Amino acid nutrition

Evonik sponsored a session on amino acid nutrition in aquaculture. Dr Dominique Bureau, University of Guelph, Canada gave a critical look at estimates of apparent digestibility of protein and amino acids. The effect of a methionine peptide supplementation in reducing fish meal levels in diets for shrimp reared in green water conditions was discussed by Dr Orapint Jintasatporn, Kasetsart University, Thailand. Evonik's team made several presentations; Dr Alexandros Samartzis gave a brief review of the nutritional value of different methionine sources in fish; Dr Dhanapong Sangsue looked at how protein and amino acid nutrition can

potentially improve quality as well as cost savings of a vannamei shrimp feed; Karthik Masagounder reviewed information on essential amino acids (EAA) in different life stages and production scenarios of Nile tilapia.

In June, Evonik launched new service AMINOTilapia® for aquaculture. The aim was to increase production efficiency in tilapia aquaculture through optimal feed formulation; help to formulate on ideal protein basis and contribute to maintaining water quality. The new software tool calculates the ideal amino acid recommendations for different growth stages of tilapia considering various production features. The software helps nutritionists to formulate diets that optimally meet the animals' needs and improve feed conversion rate. The tool is a step towards modern diets that are formulated to balance amino acids and reduce excess dietary protein, which is usually the costliest component in feed.

Tilapia health

MSD sponsored a tilapia health session. Several presentations gave updates on managing tilapia such as the presentation by Dr Win Suratchetpong, Kasetsart University, Thailand. on tilapia lake virus (TiLV). Frank Tan, Marine Life Aquaculture, Singapore shared his experiences in using vaccines for disease control.

Next issue: A report on selected exhibitors at the APA17 trade show

Next year, APA18 will be held at the Taipei International Convention Center Taipei, Taiwan from April 23-26, 2018.
More information: www.was.org; worldaqua@was.org

Appreciation award for aquaculture in Asia



During APA17, Dr Endhay Kusnendar, WAS-APC President presented an appreciation award to **Allen (Ming-Hsun) Wu**, Regional Manager Aquaculture, APAC, Nutriad for his outstanding services and contribution to WAS-APC during his last board meeting at APA17. A member since 2002, Wu was elected as Board Director of WAS-APC for 2015-2017. He served as a member of the WAS Industry Relations committee since 2012 and as member of the Asia-Pacific Aquaculture 2013 steering committee. He presented at the World Aquaculture editions of 2004, 2005, 2007, 2008 and 2009 and at the Asian-Pacific Aquaculture editions every year since 2007. He judged the student presentations at World Aquaculture Adelaide 2014 and chaired a session at World Aquaculture 2015. Wu furthermore contributed to membership promotion/exhibitions of SE Asia and China. He will be a steering committee member of APA18, which will be held in Taipei in 2018.

Release of enhanced feed probiotic for shrimp farming

INVE Aquaculture's Sanolife range is widely appreciated for offering the industry's highest concentrated probiotics at the lowest application cost. The company now further strengthens this reputation with the release of a significant novelty: a new and enhanced version of the successful feed probiotic for shrimp farming, Sanolife PRO-2. The product was successfully launched at the APA 17 tradeshow and a customer seminar in Kuala Lumpur.

The company's innovation team has identified ways to improve the activity and efficiency of the Sanolife strains of *Bacillus subtilis*, *Bacillus licheniformis* and *Bacillus pumilus*. These strains were selected for their ability to inhibit pathogens, be metabolically active in the shrimp gut and in the pond, and improve feed digestibility. The *Bacillus* strains were deposited in the Belgian LMG Culture Collection, which guarantees the unique composition, quality, performance and consistency of the product.

Olivier Decamp, Product Manager Shrimp Farm said, "The remarkably high *Bacillus* spore count (20 billion viable spores per g) grants Sanolife PRO-2 the highest number of viable active *Bacillus* per USD invested."

Developed together with farmers

Bringing its 'Care for Growth' philosophy into practice, INVE Aquaculture has developed this new probiotic in close collaboration with the industry. Feedback was gathered from farmers worldwide to match the new product to their challenges. Rearing trials and AHPND (EMS) challenge tests were conducted in Asia and Latin America, reliably demonstrating the ability of Sanolife PRO-2 to increase growth rate and survival while reducing FCR. The use of the enhanced Sanolife PRO-2 probiotic promises to lead to better profitability in shrimp farming, thus supporting INVE Aquaculture's mission to support healthy business growth in aquaculture. Decamp added, "Considering the renewed *Vibrio* challenges and white faeces syndrome, this product gives farmers a powerful tool for holistic risk management in their operation."

The release of the enhanced Sanolife PRO-2 probiotic coincides with the rebranding of INVE Aquaculture's packaging labels, which will be introduced in the market as of September 2017. The product will also be integrated into renewed expert rearing protocols for different culture conditions, from semi-intensive to super-intensive shrimp farming. INVE Aquaculture's local technical support teams will assist their customers to effectively benefit from its performance advantages. www.inveaquaculture.com

Aqua Culture Asia Pacific in 2018

Volume 14 2018						
Number	1 - January/ February	2 - March/April	3 - May/June	4 - July/August	5 - September/ October	6 - November/ December
Issue focus <i>Trending issues and challenges for the next step</i>	Nursery Technology	Health Management	Sustainable & Responsible Aquaculture	Disease Management	Genetics & Genomics	Integration and supply chain
Industry Review <i>Trends and outlook, demand & supply</i>	Marine Shrimp	Marine Fish	Aqua Feed Production	Tilapia	Monodon shrimp	Catfish/General Freshwater
Feeds & Processing Technology <i>Technical contributions from feed industry</i>	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 <i>Technical information and ideas</i>	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 <i>Feature articles</i>	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
Deadlines for Advert Booking	November 24, 2017	January 26	March 23	May 25	July 20	September 21
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 Vietfish 2018 August 22-24 Ho Chi Minh City, Vietnam		

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11th National Shrimp Congress

*Sustainable Shrimp Industry: Unified Direction
Towards Productivity and Growth*

November 16-18, 2017, SMX Convention Center
Bacolod City, Negros Occidental, Philippines



November 16-18, 2017,
Bacolod City, Negros Occidental, Philippines

This is the biennial conference and trade show of the shrimp industry in the Philippines. It is organized by the Philippine Shrimp Industry, Inc. (PHILSHRIMP) in partnership with the Bureau of Fisheries and Natural Resource (DA-BFAR) and the Negros Prawn Producers Cooperative (NPPC). This shrimp congress has become the most important gathering for the producers, hatcheries, feedmillers, exporters, suppliers including experts and institutions promoting and supporting the growth of the shrimp industry in the Philippines. The 10th National Shrimp Congress was held in General Santos City in 2015 and gathered more than 700 participants. This 11th National Shrimp Congress will be held at the SMX Convention Center, Bacolod City, Negros Occidental, Philippines

The main aim of this conference is to promote the exchange of ideas, updates, strengthen networks, meet partners and open markets. The meeting is also an opportunity for sponsors and exhibitors to access highly targeted and influential participants.

PHILSHRIMP's primary objectives are to promote and maintain the growth and improvement of the shrimp industry in the Philippines with regards to research, development and production. It is also to create and develop global and local markets for shrimp products. It provides assistance in obtaining capital or credit facilities for members. More information: The Secretariat, PHILSHRIMP 2017 Email: r.usero@yahoo.com (Roselyn Usero)

2017

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@aquaaasiapac.com

September 27-29

Aqua Fisheries Myanmar 2017
Yangon

www.myanmar-aquafisheries.com

September 28-30

Aquaculture Taiwan
Taipei

www.aquaculturetaiwan.com/en-us/

October 3-6

GOAL 2017
Dublin, Ireland

www.aquaculturealliance.org/goal/

October 3-7

AquaSG' 17 Aquaculture Singapore
Singapore

www.aquasg.com

October 17-20

Aquaculture Europe 17
Dubrovnik, Croatia

www.aquaeas.eu/ www.was.org

October 26-29

**The 7th International Conference of
Aquaculture Indonesia 2017 (ICAI 2017)**
Solo, Indonesia

Email: icai.mai.ias@gmail.com

www.ical.aquaculture-mai.org

November 1-2

China Fisheries and Seafood Expo
Qingdao, China

www.chinaseafoodexpo.com

November 7-10

LAQUA 17

Latin American and Caribbean

Aquaculture

Mazatlan, Mexico

Web: www.was.org

November 9-11

**Taiwan International Fisheries and
Seafood Show 2017 (TIFSS)**

Kaohsiung, Taiwan

www.taiwanfishery.com

November 16-18

11th Philippine Shrimp Congress
Bacolod City, Negros Occidental.

Email: robmdg@yahoo.com / r.usero@yahoo.com / mariaabegail11@yahoo.com

2018

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

April 23-26

Asia Pacific Aquaculture 2018

Taipei, Taiwan

www.was.org

April 27-29

Vietshrimp 2018

Bac Lieu, Vietnam

www.vietshrimp.net



VICTAM Asia 2018

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- Feed production technology • Packaging • Energy efficiency
- Auxiliary equipment • Biomass pelleting technology

●●● 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 • GRAPAS & Global Milling Conference Asia 2018 • Biomass and Biomass Pelleting 2018
- Third ASEAN Feed and Rice Symposium

●●● Supported by

- Thai Ministry of Agriculture & Co-Operatives • Thai Department of Livestock Development • Thai Department of Fisheries
- Thai Feed Mill Association • Thai Rice Milling Association
- Thai Chamber of Commerce
- Thailand Convention & Exhibition Bureau



●●● Organized by

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●●● More information

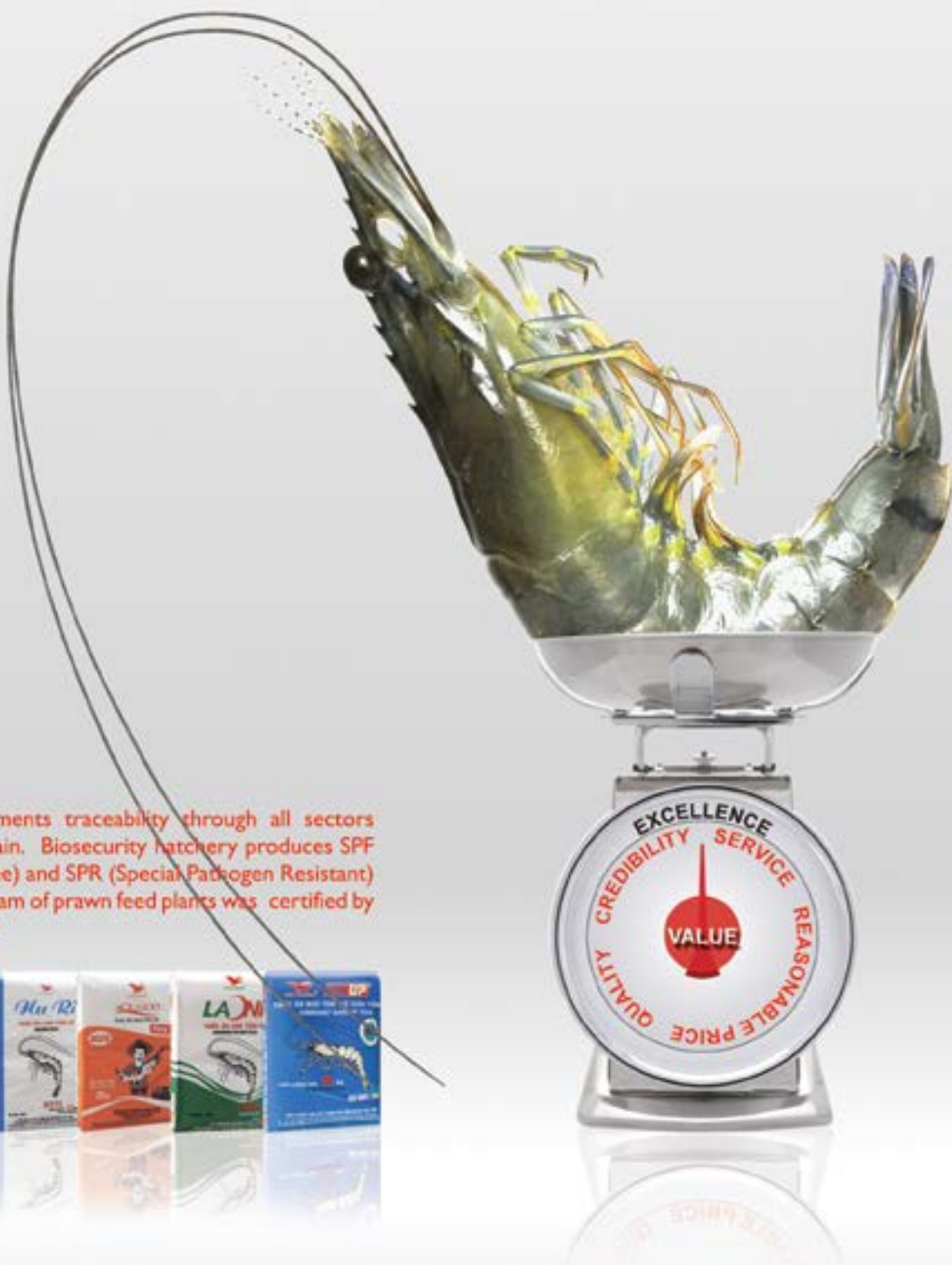
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