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Innovations in Shrimp Farming

Biofloc and Shrimp Disease

Biofloc to increase Tilapia Production

Marine Shrimp in Asia in 2013

Selective Growth of Aquafeeds

Developments in Fish & Shrimp Feed Extrusion

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Contents

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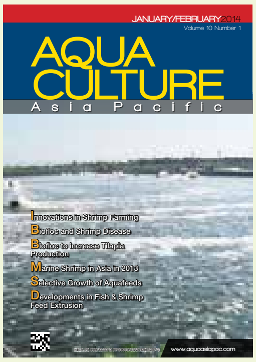

An intensive farm in Central Java, Indonesia. Picture by Poh Yong Tong.

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

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The Aquaculture Roundtable Series
20-21 August 2014

TARS 2014

The fourth of the Aquaculture Roundtable Series (TARS 2014) will be held in Thailand from 20-21 August 2014. It will focus on **Shrimp Aquaculture: Recovery • Revival • Renaissance.** For more information and updates, visit www.tarsaquaculture.com

From the editor

2014: What will the year of the horse bring?

There were a lot of good things happening in 2013 which we would like to continue into 2014, especially good shrimp and fish prices. Most of us have been occupied with the early mortality syndrome in shrimp farming. Here AAP would like to pay tribute to the group of Thai and Taiwanese researchers, led by Professors Tim Flegel and C-F Lo who released free information on AHPND detection. In these times of science for royalties, putting industry ahead is admirable (see page 6).

Disease and survival determine profitability. In 2014, the PCR will facilitate the detection of AHPND in shrimp but the farmer will be still clueless on the next course of action. This scenario is expected to continue into another 18 months, industry sources say. The consequence will be small shrimp flooding markets, well compensated by high prices. Will the large shrimp be passé? As the rest struggle, we expect 2014 to be the year for shrimp producers in India, Indonesia and Philippines to expand production. But it is also important for their stakeholders to self-regulate and be conscious of trans-boundary movement of EMS or any disease for that matter. There are lessons to be learnt from Mexico.

In fish farming, diseases and poor health management show a more chronic role leading to high costs of production from low survivals. In 2014, hopefully producers will give this more attention and not be satisfied with just 50% survival rates. Demand for white fish moved up in 2013 and is continuing into January this year. Asian producers should be ready to supply markets. Using the example of the progress with salmon production in the Faroe Islands, Bjorn Myrseth at TARS 2013, said that disease prevention will pay for itself by reducing production cost! Often producers believe that feed cost can reduce cost of production but we know that the upside is comparatively limited.

In marketing, we continue to see the limits to growth of the chilled and live fish market, particularly in the marine fish sector. A case in point is low prices for the sea bass in Malaysia when production increased with disused shrimp ponds used to farm the fish. The pangasius in India is facing a similar problem as the fish is only popular in certain states. In marketing white fish, we need to look to Vietnam, a country that has shown remarkable expansion in targeting the international frozen fillet market. Constrained by cash flow and quality standards, Vietnam also shows us the way with a good consolidation via integration to not only improve quality but develop economies of scale.

All producers will continue to seek cheaper feeds, in particular in the freshwater fish sector due to the low ex-farm prices. Feed millers in Indonesia try their best but as Philippe Serene says, even for the large volume pangasius, little is known on nutrient requirements. As ingredient prices escalate and fluctuate, such data is contingent for nutritionists to substitute expensive ingredients with lower cost ones but provide the same growth performance of fish. In 2014, we can expect more education for producers on the need to look at economic costs of a feed rather than the feed conversion ratio number per se.

Certainly, we expect expansion of the fish and shrimp hatchery business in Asia but in an industrial manner for cost effectiveness to meet higher demand. The demand for shrimp post larvae will continue to go up as shrimp producers replace stocks after aborted cycles due to EMS. However, the requirement will be for robust seed stock. It is time for the finfish industry to keep up and domesticate and develop new genetic strains to meet commercial requirements. With limited resources, only a few species should be selected. In addition to tilapia, the pangasius species, now cultured in the Vietnam, Philippines and India could be a candidate.

There has been little attention on sustainable seafood in Asia, although awareness is increasing. As Asian producers expand markets, more emphasis on feed is expected. These include the use of ingredients and fish meal from sustainable resources. Ultimately, responsible aquaculture production will come to the fore.

In the Lunar Calendar, the New Year begins on January 31 2014 with the year of the horse. We can choose to gallop towards efficiency or be left behind. There is no middle ground.

Zuridah Merican

2013 update on EMS/AHPND and other disease threats

Dr Tim Flegel, Centex Shrimp, Mahidol University, Thailand gave some recent updates on early mortality syndrome/acute hepatopancreatic necrosis (EMS/AHPND) as well as other diseases affecting *Penaeus vannamei* and *P. monodon*. This was presented at the DSM Asia Pacific conference in Bangkok on 22 November and to a Malaysian audience on 30 November, 2013 in Kuala Lumpur.

In general, the disease threat level depends on cultivated species and country of culture. However, the top viral threat for all countries is white spot syndrome virus, WSSV. The new disease since 2010 is AHPND, which is often inadvisably referred as EMS.

In the case of AHPND, since 2013, the latest development is reported outbreaks in Mexico. Flegel said he guessed that, "Outbreaks probably occurred because of illegal import of Asian broodstock or post larvae for use in aquaculture."

"In 2012, the case definition on EMS showed that the described field diagnosis might also occur with other bacterial diseases, especially at the final stage of the disease. Thus, it is critical to examine the tissue of the shrimp hepatopancreas microscopically to confirm diagnosis of the acute stage of infection. It is characterised by massive sloughing of cells in this organ that functions like a combination of a liver and pancreas. To do the microscopic analysis, I wish to remind everyone that it is extremely important to inject the formalin fixative when the shrimp are still alive, since the tissue of the hepatopancreas starts to disintegrate from autolysis by its own enzymes immediately on death."

The biggest breakthrough was in April 2013, when the team led by Dr Donald Lightner, University of Arizona (UAZ), US published a paper identifying the causative agent as a particular type of *Vibrio* most closely related to *V. parahaemolyticus*, but different from the isolates of the species that pose a human health threat. The UAZ team also showed that transmission is by the oral route. The isolate apparently contained two phages and one or more plasmids, but their significance for virulence is not yet known. A specific detection method by PCR was announced in December 2013 (see p6).

The Loc Tran laboratory infection model involves immersion at 10^8 cfu/ml for 15 minutes followed by dilution to 10^6 for further incubation. Flegel said, "Many will say that the shrimp do not get exposed to 10^8 in the field, but this is a laboratory infection model and not intended to mimic the situation in nature. It may be that other factors make the shrimp more susceptible to AHPND outbreaks under culture conditions, and the lab infection model will help us to examine this and many other questions."

"In our laboratory, we have proven that several isolates of Vibrio from AHPND cases in Thailand cause the characteristic lesions of AHPND and share the genetic characteristics of the Arizona isolate. However, we have also found that the Thai AHPND isolates differ somewhat in virulence, indicating the possibility of genetic variation."

Ongoing studies

Work is ongoing to look at several effects on AHPND, such as of bacterial dose; environmental factors on bacterial virulence and dose; bacterial 'partners' on bacterial virulence and dose; and possible treatments (e.g., biofloc, molasses, pH, and tilapia co-culture). The Thai Fisheries Department has an extensive epidemiological study covering 200 ponds currently underway in the country. Results from 50 ponds so far have shown that only 15-24% have AHPND. The rest have other problems, some, such as microsporidian infections, do not cause death but result in retarded growth. Flegel said that evidence indicates that completely closed raceway systems have not been affected by AHPND. Whether biofloc will prevent EMS is being investigated.

In the search for a unique marker for AHPND bacteria, the Thai and Taiwanese groups are working together to identify proteins that might be unique to AHPND isolates and cause their virulence.

Tim Flegel

With regards to possible AHPND partner bacteria, Flegel said that their earlier metagenomics study showed relatively higher proportions of bacteria from the genera *Delftia, Leifsonia* and *Rhodococcus* associated with shrimp in AHPND ponds when compared to normal ponds.

"However, no isolates have been obtained from AHPND infected shrimp. Bath exposures showed that some of these bacteria cause high mortality without AHPND pathology but changes in histology show that they do affect the shrimp hepatopancreas. Now we are doing combination bath challenges with AHPHD isolates to determine whether pairs of bacteria in doses at environmentally feasible levels may also cause AHPND."

Concurrent with AHPND

In Thailand, since 2009, there is a high prevalence of the microsporidian *Enterocytozoon hepatopenaei* in the hepatopancreas of both broodstock and farmed shrimp. Dr Jirasak Tangtrongpiros at Chulalongkorn University previously found this parasite in shrimp affected by white faeces disease. In addition, there are vermiform, aggregated transformed microvilli (ATM) which were previously mistaken for gregarine-like entities in the shrimp hepatopancreas and there is a high prevalence of distorted hepatopancreatic tubules. The relationship of these problems to AHPND is currently unknown.

Flegel said that it would be advisable that hatcheries make it a practice to screen for this microsporidian in broodstock and post larvae using the PCR and LAMP methods previously developed by Centex Shrimp. "The rapid regional spread of AHPND and the simultaneous increase in prevalence of *E. hepatopenaei* infections, suggests that the current situation in Asia may have resulted from an industry-wide decrease in rigour of biosecurity measures in shrimp hatcheries and ponds.
If it is eventually shown that shrimp from the outbreak ponds in Mexico also carry *E. hepatopenaei*, it would support the hypothesis for illegal import of stocks from Asia, because the parasite has never been previously reported from the Americas."

In summary, Flegel said," The situation for viral pathogens has not changed since 2012. Our knowledge of AHPND, *E. hepatopenaei*, ATM, etc. has improved greatly over the past year. However, more research is urgently needed to provide effective preventative measures. Governments should provide funding for such research."

"I believe that the key issue for successful shrimp culture is still use of SPF stocks in biosecure settings and that the best biosecurity can be provided in completely closed culture systems. Farmers who are doing this do not have problems. The change to closed systems would require capital investments which perhaps may need to be facilitated by government support, but the cost would be quickly recovered by higher, more stable production. In the long term, I believe that the occurrence of AHPND and the control measures to limit its impact will lead to fundamentally change the future of shrimp culture to more closed systems. Given the strategic importance for aquaculture for future food security, this shift should be facilitated by countries with a high potential for aquaculture."

A grave concern in Malaysia

Malaysia, the third country to succumb to early mortality syndrome/ acute hepatopancreatic disease (EMS/AHPND) in 2011 has been seeing its marine shrimp production sliding. At the end of 2013, it will see only 35% of the production in 2010, the best year for the country with 110,000 tonnes. A grave concern in Malaysia is the lack of a concerted effort by industry, government and universities to research and address the problem in the country.

In November, the Malaysian Society of Marine Sciences organised a seminar which focused on EMS, with industry and experts providing updates on EMS and culture practices to overcome outbreaks at the regional and local level. It was attended by more than 200 participants from the various shrimp farming groups in Malaysia as well as from the Philippines and India.

At the regional level, Dr Tim Flegel provided updates on the work he has been leading on AHPND in Centex shrimp, Thailand (see page 4). Dr Loc H Tran, now based in Vietnam, was the researcher at the University of Arizona (UAZ) involved in the identification of a causative agent for EMS. His presentation covered the work carried out by the UAZ team leading to the discovery of the strain of *Vibrio parahaemolyticus* as the causative agent. Phuc Hoang, also from the UAZ team, reported on a study to determine the infection route of the AHPND. Loc also compared the similarities in the outbreaks in Mexico and Asia. On the use of antibiotics he said, "From the point of view of the farmer, as EMS is a bacterial disease, antibiotics could be used. This has been used in Vietnam since 2012 and the consequence is a high level of resistance, particularly to ampicillin and oxytetracycline."

Monitoring of outbreaks is the responsibility of Dr Kua Beng Chu and her team at the National Fish Health Research Centre of the Department of Fisheries, Malaysia. In her presentation, she reported on the survey conducted from January to November 2013 where out of 83 ponds, 27.7% tested positive for AHPND. The general signs have been mortality at less than 40 days. She also reported a second wave of almost 100% mortality occurring after 40 days. Concurrent symptoms are white faeces disease and slow growth. Indicator signs include presence of hepatopancreatic cells in the gut prior to AHPND. With regard to some solutions, she showed that probiotics can save crops by reducing mortality during the second wave by 40-60%.

The point of view of industry was given in the presentation by Akazawa Noriaki from the 500-pond Agrobest Farm in the east coast of Peninsula Malaysia. The first outbreak of EMS was in January 2011 which brought down average productivity from 24 tonnes/ha to only 14 tonnes/ha. The recovery took over a year which, aside from changing sources of post larvae, involved reduction in stocking density to 85 m^2/ha and enhanced biosecurity. A second outbreak occurred in mid-2013. The first outbreak was characterised by rapid mortality at less than 30 days after stocking and the second, slower mortality occurring at less than a week. All in all, the epidemiology of the pathogen was from hatchery and ponds. "For us what is important is the interaction between fry, environment and management and we will continue to find the balance. *Vibrio parahaemoriticus* may be the main cause but I am also concerned on the total population of *Vibrio*." said Akazawa

In his presentation on 'Understanding EMS – A Mechanism Approach', Ung Eng Huan, BioValence, Malaysia believes that the bacteria *Vibrio parahaemolyticus* is only infectious when it incorporates DNA from a phage and releases a toxin, possibly a cationic antimicrobial peptide (CAP) and possibly under quorum sensing. BioValence is looking at developing various remedies to overcome AHPND when more information on the bacteria is available. The different degrees of mortality observed in farms can be explained by types of secondary infection within the shrimp hepatopancreas. In the samples tested from different farms, there is evidence that sometimes a virus, in particular HPV may also be contributing as a co-infection. The EMS infected samples also show an average of 10^5 cfu/mL for 30 days of culture (DOC30) samples and 10^3 cfu/mL for DOC14.

"In Malaysia, we need to have a clearer picture by sampling more farms to answer these questions: is EMS compounded by viral co-infections, and can we isolate a common lysogenic-phage or is there the possibility of a second causative agent?"

The meeting also discussed some preventive measures. Mixed culture of saline tilapia and shrimp worked well against EMS but only for 2-3 cycles before a recurrence of EMS. In Malaysia successful crops have been obtained using specific pathogen free monodon post larvae. In the hatchery, there is also a higher incidence of broodstock mortality after eye stalk ablation. All these are empirical and need scientific explanations. Seminar chairman, Abu Bakar Ibrahim, CEO, Blue Archipelago, a leading shrimp producer summarised the output of the meeting.

"It is clear that EMS is a game changer for our industry. We need to know more about the outbreaks in Malaysia, understand the complexity of interactions and learn how to reduce the risks. Industry cannot do this on their own and need the collaboration among biochemists, microbiologists and others from universities and private companies. Funding is required to prepare us for the time when we can develop solutions."

Abu Bakar Ibrahim (centre) with presenters, from left, Akazawa Noriaki, Loc H Tran, Phuc Hoang, Ung Eng Huan, Tim Flegel and Kua Beng Chu.

Free information on primers and protocols for AHPND detection

A group of Thai and Taiwanese researchers, led by Professor T.W. Flegel of Thailand, Mahidol University and Professor C-F. Lo, National Cheng Kung University, Tainan, Taiwan, have developed a PCR method for detecting the bacteria that causes acute hepatopancreatic necrosis disease (AHPND) in shrimp. In shrimpnews.com, they said that they are releasing free information on the primers and protocols for implementing the detection method.

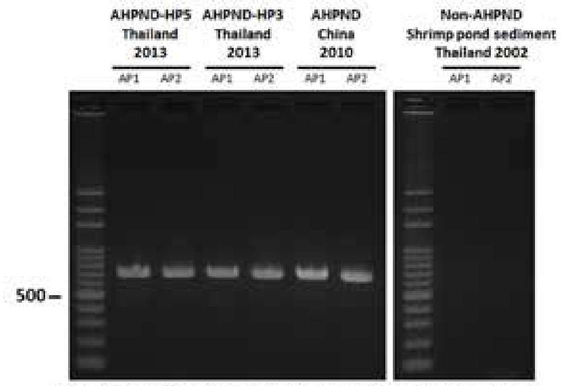
On December 5, 2013, the researchers obtained the sequence comparison information that allowed them to prepare several test PCR detection methods, and they have spent the last 20 days validating them. The researchers say, "We believe that every single day of reduction in the risk of AHPND outbreaks will benefit Thailand far in excess of any possible return on research expenditures that might be envisioned by collection of royalties for our discoveries. Delays amounting to several weeks or months would be needed to prepare documents for a patent application, to negotiate licenses and to prepare and market commercial detection kits in a sufficient volume to satisfy the market demand. To these considerations must be added the complex nature of the funding for our research and the further delays that would thus arise in negotiating a mutually agreeable license fee and appropriate percentage of royalties among the funders and participants. We cannot justify the cumulative potential economic losses that might occur from delays of days, weeks or months."

"For these reasons, we have decided to release, free for public access, detailed information on the sequences and protocols from our research for a PCR detection method for AHPND bacteria. This will allow for their wide and rapid dissemination and allow interested stakeholders to assess the efficacy in developing possible measures to reduce the risk of AHPND outbreaks.

In Thailand, this research was done at Centex Shrimp and the Department of Public Health, both at Mahidol University and the Aquaculture Business Research Center, Faculty of Fisheries, Kasetsart University. Since 2011, the work was supported by contributory funds from many sources including the Agriculture Research Development Agency, the National Research Council of Thailand, the Thai Commission on Higher Education, Mahidol University, the National Science and Technology Development Agency, the Patani Shrimp Farmers Club, the Surathani Shrimp Farmers Club, the Thai Frozen Foods Association, Charoen Pokphand Group, SyAqua Siam Co. Ltd. and Thai Union Group. In Taiwan, the research was supported by several sources including the Taiwan National Science Council, National Cheng Kung University (NCKU), National Taiwan University (NTU) and Uni President Enterprises Corporation.

They added that although they have tested the specificity of these methods for AHPND bacteria, the number of samples used was relatively small. Briefly, it was found that:

- The two primer sets gave the same positive and negative results on 67 out of 68 samples tested. The 1 exceptional sample gave a positive result with set AP1 and negative with AP2.
- Out of 14 samples of pooled hepatopancreatic tissue (10 shrimp from each pond) from an FAO study in Vietnam used for metagenomics analysis, 8 samples deemed positive by histopathology gave 5 positive and 3 negative results with both primer sets while 5 samples deemed negative by histopathology all gave negative results with both primer sets.
- The 68 tests included 5 bacterial isolates that were identified as *Vibrio parahaemolyticus* and were proven to cause AHPND histopathology in bioassays. All gave positive results with both primer sets while 3 isolates obtained from shrimp pond sediment in 2002 and proven not to cause AHPND or shrimp mortality in bioassays gave negative results with both primer sets. So did two other isolates from shrimp pond water and shrimp meat from 2002, although they have not yet been tested in bioassays.



Examples of PCR results with the new primer sets AP1 & AP2 using DNA extracts from the 3 AHPND isolates and the 1 non-AHPND isolate used to do our comparative sequencing work

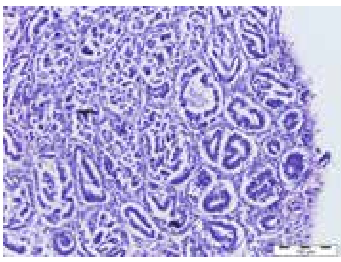
- One isolate that did not give AHPND histopathology in bioassays, but did give severe mortality with abnormal histology of the hepatopancreas gave positive results with both primer sets.
- Isolates of *Shewanella, Rhodococcus, Leifsonia, Delftia, Ralstonia, V. vulnificus, V. harveyi, V. alginolyticus* and *B. subtilis* gave negative results with both primer sets.

"Thus, we cannot guarantee that the methods described will give no cross reactions with every possible non-AHPND bacterium or with any other possible organism. Nor can we guarantee that the methods will successfully detect every bacterial isolate capable of causing AHPND. We invite all stakeholders to help us in further validating these new detection methods.

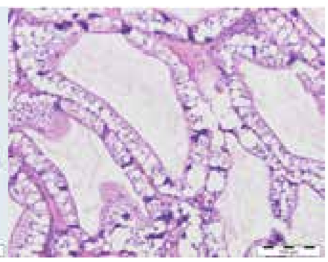
In an update, Flegel said, "We have already received feedback about use of our primers. One respondent just sent us a set of results for 80 PCR tests with our AP1 and AP2 primer sets using 37 *V. parahaemolyticus* AHPND isolates (confirmed by bioassay), 27 *V. parahaemolyticus* non-AHPND isolates and 16 isolates of various other bacterial species common to shrimp ponds (i.e, not *V. parahaemolyticus*). There were no false negative results. There were 3 false positive for *V. parahaemolyticus* isolates using primer set AP1 and 1 false positive for one of the same 3 isolates using primer set AP2, giving overall specificity of 96% for AP1 and 99% for AP2. These results suggest that the AP2 set is better than AP1."

More and full details on PCR protocol and primer is available at these two websites:
http://www.biotec.or.th/en/images/stories/Workshops/2013/Announcement_AHPND%20Detection%20Method.pdf
http://www.shrimpnews.com/FreeReportsFolder/NewsReportsFolder/ThailandTaiwanFreeEMStests.html

More information: Udomrat Vatanakul, Manager, Public Relations Section National Center for Genetic Engineering and Biotechnology email udomrat.vat@biotec.or.th



HP of AHPND shrimp



HP of normal shrimp

Biofloc and shrimp diseases

Can bioflocs in shrimp ponds help farmers avoid or reduce occurrences of early mortality diseases?

Commercial shrimp farming in full or semi biofloc is common in Asia. **Dr Nyan Taw**, consultant in Malaysia said that bioflocs together with biosecurity practices, have helped to reduce or prevent occurrences of white spot syndrome virus (WSSV) in Indonesia and Malaysia and infectious myonecrosis virus (IMNV) in a farm in Bali, Indonesia. Today, as shrimp farmers face the early mortality syndrome (EMS) or acute hepatopancreatic necrosis disease (AHPND), they are interested in biofloc technology which could help them circumvent infections caused by *Vibrio parahaemolyticus*, the causative pathogen of AHPND.

Biofloc technology involves the development of a heterotrophic microbial community in ponds with zero or minimal water exchange to maximise biosecurity. It minimises external environmental effects but the success is contingent on adequate artificial aeration to meet oxygen demand and suspend organic particles. Although biofloc technology has been in use since the early 2000s, many questions remain unanswered. It is still not clear how full or semi-biofloc systems work and how effective these systems are against bacterial pathogens.

Farming shrimp in biofloc in Bali

Dr Yoram Avnimelech, an expert in biofloc systems for tilapia and author of two books on biofloc technology reviewed information from research and the professional aquaculture community. "This (disease preventive effect) may be related to more stable and broad-based microbial communities in biofloc systems. But although intriguing, the reliability, scope and confidence of available data showing the positive effects of bioflocs is limited. Contradictory data have also been reported. I believe that we should work at setting up a system to collect information from the field," said Avnimelech, in his welcome speech at the Biofloc Technology and Shrimp Disease Workshop, held prior to Asia Pacific Aquaculture 2013 on 9-10 December 2013 in Ho Chi Minh City, Vietnam.

Yoram Avnimelech (second right) with from left, Gilbert Pang, Asia Aquatixs, Singapore, B. Suryakumar, Hitide Seafarms and Anil Ghanekar, Ecosecure Systems, India and Jimmy Lim, Venture Farms Pte Ltd, Singapore.

The workshop was jointly organised by Dr Yoram Avnimelech, **Dr Craig Browdy**, Novus Aquaculture and **Dr Tung Hoang**, International University- Ho Chi Minh. It was sponsored by Skretting, Inve Aquaculture, Blue Archipelago, Intron, Blue Aqua and Novus. There were altogether 21 invited and contributed presentations, with topics ranging from the use of biofloc technology in commercial and experimental practices in tilapia and shrimp farming, immune mechanisms in crustaceans, infectious nature of AHPND, observations on EMS in Asia and Mexico and selective breeding in disease mitigation to complement the link on disease control.

Bioflocs in shrimp farming

Nyan Taw showed examples of commercial production of 25 tonnes/ha in Bali and 22 tonnes/ha in a trial in Malaysia. The basic concepts were outlined but he emphasised on a crucial requirement: 22- 24 hours of aeration and correct positioning of aerators. **Dr Robins McIntosh**, Chareon Pokphand Foods Public Limited, Thailand, gave an example of yields from 21-25 tonnes/ha without exchange of water. Prerequisites are clean pond bottoms and a correct C:N ratio. His philosophy on bioflocs includes the roles of probiotic bacteria to oxidise pond bottoms and break down wastes and to encourage nitrifiers over heterotropic bacteria. He stressed the importance of using thinner flocs, the use of quality feeds, the maintenance of clean pond bottoms and the use of carbon to initiate the biofloc system. McIntosh quoted a feed conversion ratio (FCR) as low as 1:1 which showed that flocs not only provide nutrients but also trigger a mechanism to sustain shrimp growth. Both Nyan and McIntosh said that biofloc provides a stable culture environment (oxygen and pH) for shrimp allowing them to go through the development phase in the ponds with less stress.

Browdy said that by eliminating water exchange and inoculating ponds with a healthy and diverse microbial community in a biosecure farming system, control of pathogens can be achieved. Through proper management of inputs, the farmer can achieve maximum benefits and meet production targets. In zero exchange biofloc systems it is critically important to maximise feed efficiencies so that the amount of nitrogen in the feed, not incorporated into shrimp flesh, will not create water quality problems. At the same time, feed should be a vehicle for shrimp health with improvement in the gut environment and overall immuno-competence and fitness.

EMS in Mexico and Asia

In his update on EMS in Mexico, **Dr Donald Lightner**, University of Arizona (UAZ), USA said *V. parahaemolyticus* isolates caused the disease in specific pathogen free-SPF shrimp in Mexico. The stocking pattern implied a broodstock etiology but regardless of the origin of isolates, Southeast Asia or Mexico, pond site patterns, biochemical composition and histology of shrimp were similar.

Hoang Tung (second left) with from left, Leo Cababasay, Blue Archipelago, Malaysia, Olivier Decamp, Rudi Bijnens and Bui Thuy Tien, Inve Aquaculture, Thailand

Dr Victoria Alday-Sanz, Pescanova, Spain observed that despite differences in culture systems between farms in Asia (intensive) and Mexico (extensive), the characteristics of EMS infections were similar. In both regions, mortality was associated with ponds, whether lined or earthen and no mortality was recorded of shrimp in cages suspended in EMS affected ponds. Mortality occurred when shrimp was released into the ponds. Other similar observations were that there were no shrimp mortalities in reservoir ponds and well water. When feeding stopped, mortality decreased, and severity was temperature linked and shrimp were susceptible up to 15 g size. In Mexico infections were related to time of stocking.

In Vietnam, **Dr Dang Thi Hoang Oanh**, Cantho University, Vietnam noted that incidences were more severe in farms with high salinity water and during the hot season (April to July), but water quality was not the main cause. Her experiments on the route of transmission included placing shrimp in hapas in EMS affected ponds. She concluded that transmission occurred via water and co-habitation. Hoang said that in 2012, EMS was also reported in hatcheries. Improvement in production in Vietnam will be through the use of specific pathogen free (SPF) post larvae (PL), produced from a two-phase hatchery (30days) and nursery (45 days) system, with grow-out in square ponds of 2,000 to 3,000 m^2 equipped with 28 hp aerators and bottom diffusers.

Alday-Sanz said that bacteria need nutrients and indicated a difference in virulence. A high dose of bacteria may be required as demonstrated in an experiment which showed that mortality occurred at populations of 10^8 CFU/ml in comparison to 10^4 CFU/ml. What is known is that *V. parahaemolyticus* replicates slowly at salinity of <10 ppt and that granular bacteria are not culturable when frozen, and ozone could be used to disinfect water. Both in Thailand and Mexico, isolates of different degrees of virulence show differences in time to cause mortality and dose. Apparently drying out of ponds even as long as 5 months, ploughing and liming did not help in Thailand. She added that perhaps there is a need to relook at current biosecurity protocols which have been designed for viral and not bacterial exclusions.

Inbreeding and selective breeding

In Mexico, wild shrimp in affected farms show mortality and suggestions that EMS is related to inbreeding is unlikely as the three species; *P. vannamei, P. monodon* and *P. chinensis* come from different genetic programs and different countries, according to Alday-Sanz. **Dr Shaun Moss**, Oceanic Institute (OI), USA discussed potential detrimental effects of inbreeding further. Reports show that inbreeding has small impacts on growth and grow out survival but is more evident at the hatchery level (hatching rates and survival). Work at OI on exposure to viral pathogens (WSSV isolates) showed that for every 10% inbreeding, shrimp survival will decline by 38.7% when exposed to WSSV. "Many shrimp breeding programs have been initiated from small founder stocks and thus make them more susceptible to inbreeding. This is aggravated when hatcheries buy these breeding stock and attempt to use them as breeder for multiple generations. However, despite this common practice, the relationship between the use of multi-generation broodstock and EMS is unclear."

"In selective breeding, the focus has been on resistance to viral pathogens. Today, there is interest among shrimp breeders to develop lines of shrimp that exhibit high survival after exposure to *Vibrio parahaemolyticus* but little is known on the quantitative genetics of the bacterial toxin." added Moss.

Bioflocs and disease mitigation

Anecdotal observations from farmers and results from research trials, suggest that bioflocs help to reduce incidence and severity of disease outbreaks. The innate immune mechanisms in shrimp were discussed by **Dr Kenneth Söderhäll**, Uppsala University, Sweden. An important innate immune response in arthropods is activation of prophenoloxidase (ProPo) which leads to melanisation and elimination of pathogens. In the assessment of response to bacterial attacks, Söderhäll said that antimicrobial peptides, astakines are melatonin induced and immune responses vary between night and day. **Dr In-Kwon Jang**, West Sea Fisheries Research Institute, Korea showed that the mRNA expression of most selected genes was significantly different between clean seawater and biofloc water. With the exception of a few genes, Jang said that mRNA expression is strongly affected by total suspended solids (TSS) concentration of treated biofloc water. He added that vannamei shrimp, using their third maxilliped structure, utilise biofloc as a food source better than japonicus or chinensis shrimp.

In Indonesia, **Dr Julie Eskari**, Bogor Agricultural University, Indonesia showed that vannamei shrimp challenged with IMNV in biofloc ponds with different carbon sources significantly increased immune response, notwithstanding the source of carbon. The phenoloxidase activity was higher in the shrimp. In a study on co-infection of shrimp with WSSV and Vibrio under laboratory conditions, **Dr Peter Bossiers**, University of Ghent, Belgium said that cumulative shrimp mortality showed that WSSV infected shrimp become more vulnerable to bacterial infection (in this case, *V. campbellii*) and die faster because of Vibrio infection rather than WSSV. Whether this happens with other Vibrio species is yet to be determined as well as whether a biofloc system allows for the steering of microbial community away from infectious Vibrio species.

Bioflocs and probiotics were reviewed by **Dr Wilson Wasielesky**, Universidade Federal Do Rio Grande, Brazil and **Dr Oliver Decamp**, Inve Aquaculture, Thailand. In Brazil, Wasielesky said that a biofloc system (stocking density of 100-118 PL/m^2 and 38% protein diet) that relied on the application of a commercial probiotic led to nine successful crops despite WSSV being prevalent in the area. Decamp reported on published research from Brazilian and Belgian universities that documented the improved nutritional profile of floc and the lower Vibrio abundance in floc, when a selected mixture of *Bacillus* had been applied, together with the carbon source. In Indonesia, Decamp said biofloc combined with probiotics show better shrimp performance in fully lined ponds where siphoning out waste was conducted frequently. Results from a farm in Indonesia gave 20.3 tonnes/ha of size 50/kg shrimp at a stocking density of 10^6PL/m^2. The challenge is what probiotics to use and how to use, without ignoring the management of the pond. For example, in some cases in Vietnam, farmers applied a semi-biofloc system in ponds that did not allow the removal of excess sludge, which led to poor production.

Co-culture in biofloc

Co-culture of red tilapia juveniles in net cages in shrimp ponds with low water exchange at the Shrimp Genetic Improvement Centre in Thailand was discussed by **Dr Boonsirm Withyachumnarnkul**. He showed that co-cultured SPF monodon shrimp grew faster probably from feeding on biofloc which has good digestibility. A preliminary study on AHPND challenge supports the possibility that this co culture is effective against pathogens. In laboratory trials at UAZ, **Dr Loc Tran**, showed that tilapia can be used to develop health promoting algae and green water. When challenged with AHPND bacteria, vannamei shrimp in the green water induced by tilapia showed highest survival.

A future with bioflocs

A general message from the workshop was that flocs must be seen as a culture method to achieve target production and not just as a technology. However, it was clear from the discussions at the workshop that at the farm level there are still gaps in knowledge, such as what is biofloc and what works. Currently determining the right biofloc and the best density are still empirical. Decamp said that the farmer will require more assistance; markers, or on-farm indexes, similar to those being used in wastewater systems like the activated sludge, that can be correlated with good performance of biofloc or semi-biofloc systems. This will require a detailed description of the products (such as probiotics) being applied to the pond, and the rearing protocols. McIntosh said that flocs are now domesticated where bacteria and can be screened and blended to present the best flocs for a given pond condition. This brings us to another level in shrimp farming.

On the role of selective breeding to improve shrimp growth performance in biofloc systems, Moss said that growth and other commercially important traits can be affected by the interaction of the shrimp genotype and environment. Biofloc systems with high stocking densities, chronic exposure to nitrogenous wastes, high bacterial loads and high TSS differ from traditional systems. Some of the responses are under genetic control and it will be possible to select for improved growth in biofloc systems.

With regards to the efficacy of biofloc in disease mitigation, farm managers questioned the timing as it takes at least 30-40 days for biofloc to develop in new systems or 14 days where flocs are transferred into the pond. However, EMS sometimes occurs as early as 10 days and before 30 days. Prestarting ponds to develop floc communities and use of nursery systems were discussed. Although it was clear that many gaps remain in the scientific application of biofloc technologies against EMS, the wide ranging presentations and discussions at the workshop have helped to define research priorities and management directions.

Browdy suggested research areas that can help to better define optimal microbial floc communities to meet the needs of farm managers for exclusion of bacterial pathogens, to target crop growth and to manage water quality and shrimp health. "There is no magic bullet to solve disease problems- rather we need to develop holistic health management solutions that focus on pathogen, host and environment. We need to better understand how to optimise the makeup of the exogenous microbial community by maintaining a healthy and biosecure biofloc system which will help to maintain an optimal shrimp pond environment and shrimp performance by providing balanced nutrient dense feeds in highly efficient feeding programs. We need also to apply strategies to enhance shrimp fitness and immunocompetence while improving gut biota, structure and function through the effective use of selected feed supplements."

Innovative ideas in shrimp farming

By Poh Yong Thong

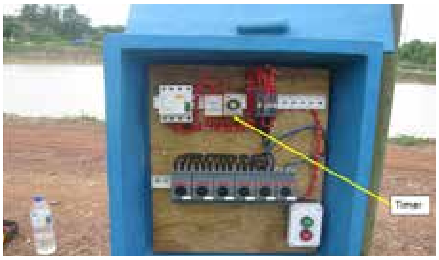
Success is from innovation: this article presents several new ideas.

During the course of my work, I was able to travel to many farms in Indonesia, Malaysia and Thailand and have seen many interesting innovations developed by farmers. These novel innovations are the results of many trials and errors of creative farmers, to whom we sometimes forget to pay tribute. In this article, I would like to acknowledge and thank the originators of these ingenious ideas and to those who shared them with me.

Auto-on paddlewheel switches

Some of the most critical moments for many shrimp farms happen at night. When the sun sets and photosynthesis stops, all pond life forms that respire start to extract oxygen from the water. If there is a power failure and the aerators are not switched on immediately, the consequence is oxygen deficiency leading to shrimp dying.

In addition, when a paddlewheel is first started (as is in the case of any heavy electrical machinery), due to inertia, more current is needed to kick start the machine. This is analogous to the need to use low gear to start your car. There is a spike on the power consumption many times more than the running power of the paddlewheel. Imagine a farm with 100 paddlewheels. If they are to be switched on simultaneously, the power delivery device may burn out. Usually, farms manage this by getting the farm workers to switch the paddlewheels one after another or in groups.



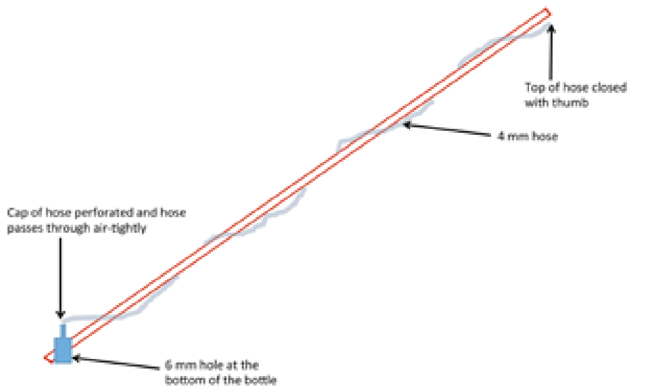
A timer-starter allows phased starting of sets of aerators.

In a small farm in Kudat in Sabah, Malaysia, one farmer has an ingenious innovation: an auto-on device. This is a first in a small farm. This ingenious innovation has a timer starter and each one controls five or six paddlewheel switches. When the power supply resumes or when the standby generator is switched on, the auto-on device starts switching on the paddlewheels in sets of 5 or 6; each set can be arranged to be switched on by perhaps a time differential of 10 seconds. So the spike will not be simultaneous and there will be no burn-out. This sounds simple but it took more than 20 years for someone to apply the technology to switching on the aerators in a shrimp farm.

Water sampling bottle

The scientific device which is used in limnology studies for water quality analysis may be expensive for small shrimp farms. This ingenious implement is assembled using recycled materials as shown in the illustration below.

Figure 1: Schematic drawing of the construction of a water sampler



The top of the hose is closed with the thumb and the bottle lowered into the desired water depth. When the thumb is released, water gushes into the bottle. The top of the hose is then closed again with the thumb and the bottle lifted out of the water. The hole at the bottom is aimed at a receptacle and when the thumb is released from the top of the hose, water flows into the receptacle to be used in water analysis.

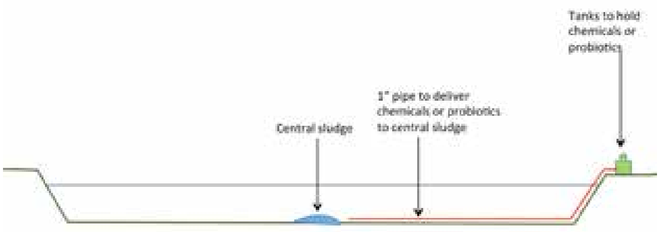
Water sampler being used.

Dispensing chemicals/probiotics directly to the sludge area

The area with the worst water quality in a pond is invariably around the sludge area and normally at the pond centre. Chemicals or probiotics aimed at improving water quality can be delivered directly to this area instead of all over the pond. The design consists of a 30 or 50 L tank connected by a 1 inch pipe (2.5cm) or hose controlled by a valve to the central sludge area.

Chemicals or probiotics are added to the tank followed by water. The mixture is stirred and then the valve is opened. The mixture flows by gravity to the central sludge area.

Figure 2: Schematic drawing of delivery system for chemicals or probiotics directly to the sludge area



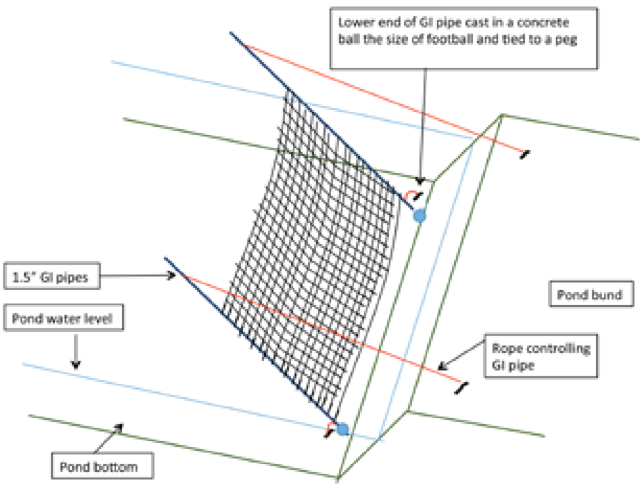
Delivery system for chemicals or probiotics directly to the sludge area.

Partial harvesting from the bund

This large lift net design used for partial harvesting of shrimp was first found in a Tuaran shrimp farm in Sabah in 2007. The net measures about 6 m x 3.5 m and has galvanised iron (GI) pipes of 1.5 inch (3.75cm) diameter on both sides.

Each of the bottom ends of the GI pipes is cast in a ball of concrete about the size of a football and the lower end of the pipe is tied to a peg near the slope of the bund. The net is weighed down by leads. To begin harvesting, the ropes holding up the GI pipes are released and the GI pipes fall flat but almost perpendicular to the bund. Feed is broadcasted onto the net and left for about 10 minutes. The GI pipes with the net are lifted up using the ropes. Around 100 kg of shrimp can be harvested when the net is lifted.

Figure 3: Schematic drawing of partial harvest net.



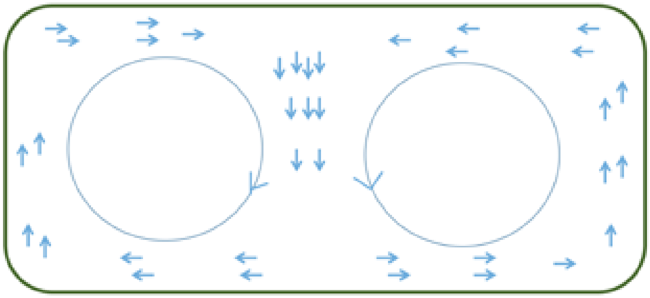
Photos showing partial harvest net.

Paddlewheel arrangement in long ponds

In the first decade in shrimp farming, most ponds are rectangular in shape. Since water moves in circles, the currents will always cut across rectangular ponds midway of the longer side. Nowadays, most ponds are designed in square shapes. In the Google Earth photo, the ponds are about 8,000 m^2. The farmer is able to position the paddlewheels in such a way that the pond has two currents. There are two sludge areas.

Google Earth image to show arrangement of paddlewheels in a long pond

Figure 4: Arrangement of paddlewheels in a long pond. Two central sludge areas are created.



Central sludge removal system

This system is found in many Indonesian farms especially in Sumbawa. The central sludge is removed through an 8 or 10 inch (20 or 25cm) concealed pipe to the outlet canal. In a farm where the same canal is used for inlet and outlet, this system is not advisable.

Photos showing central sludge removal system

Perhaps it is very pertinent to point out here that of all the farms found in Asia, Indonesia has the most elaborate sludge removal system. Most farms (more than 80%) have built in sludge removal systems. In addition, siphoning of the sludge is very common in Indonesian farms. Some farms even employ breathing aids to allow their workers to siphon the pond up to 2 hours continuously without surfacing (see article on 'Prevention and Control of IMNV in vannamei shrimp in Indonesia', p12, issue September/October 2013). Could this practice to reduce accumulation of sludge in pond bottoms be a way to avoid EMS/AHPND in Indonesia?

Water mover airlift

Paddlewheels are good in moving water, but aeration using tubing with fine pores can add oxygen more efficiently to the water. What about a design which aerates, but at the same time also moves water forward? This design is already quite widely used in Indonesia. It is difficult to say who is the originator of this design. The best designs that I have seen are in a farm in eastern Lampung, Sumatra and in another farm in Probolingo, Java. We salute these creative farmers. It is through them that new and more efficient ways of farming shrimp are being developed.

Sometimes the electrical cables to the aerators are too short. So the farmer has to join two together. In the salty pond water, one way of keeping the joint above the water is to use a polystyrofoam as in the picture.

The airlift not only aerates the water but also helps to move the water.

The polystyrene keeps the cable joint afloat.

Using bags of soil to partition canal

The ability to improvise allows shrimp farmers to succeed in their endeavours, especially when facing difficult situations. In the example here, the Thai farm was located in a low-lying area, with the outlet canal at a higher water level most of the time. The farmer blocked the canal using bags of soil and pumped out the water, thereby allowing harvest through the water gate.

A makeshift dam made of bags of soil allows draining of the outlet canal to enable harvesting in low lying area.

Concluding remarks

These innovations make shrimp farming more efficient and are examples of evolving ideas which have contributed to increased productivity.

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Tilapia production using biofloc technology (BFT)

By Yoram Avnimelech

In intensive systems, the recycling of feed with minimal water exchange lowers production costs.

The demand for tilapia is growing and international trade of tilapia is rising. Higher production levels of tilapia are needed to meet future demand. However, increasing aquaculture production is limited globally, by the severe shortage of water and availability of suitable land. The only feasible and environmentally acceptable way to raise aquaculture production is by the use of intensive systems. The choice of suitable intensive systems to produce fish is restricted by the need to produce fish at a cost lower than the market price. Biofloc technology (BFT) holds much potential as it facilitates intensification, fast fish growth, high feed conversion ratio, lower incidence of diseases and cost effective investment.

Basis of biofloc technology

Biofloc technology is based upon a few principles:

- zero or minimal water exchange,
- subsequent development of dense microbial population,
- managing the microbial population as a part of the pond eco-system,
- adjustment of the carbon: nitrogen ratio (C:N) to about 15 in order to control inorganic nitrogen concentration in the water.

The bacteria, forming bioflocs, assimilate ammonium to produce microbial proteins that are consumed by fish, thus recycling the unused feed protein. (Details in Avnimelech, 2012). Tilapia is ideally adapted to BFT systems. It can grow and flourish in dense biofloc systems and is overall a highly tolerant fish.

Nitrogen control and feeding with bioflocs

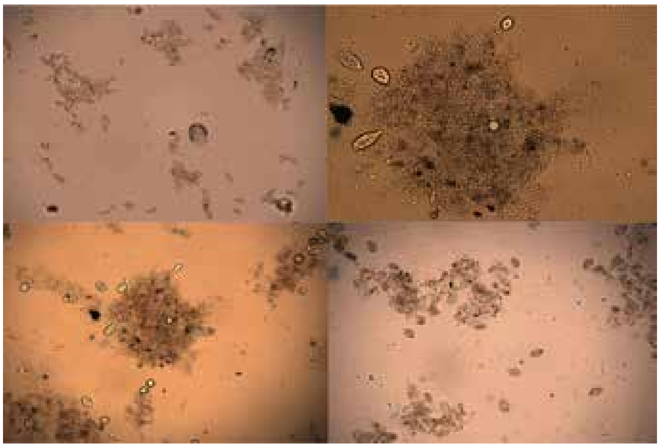
Intensive culturing of fish in a closed system invariably leads to the accumulation of feed residues. Ammonium (total ammonium nitrogen, TAN) accumulation is a major problem. Ammonia, NH_3, the un-ionised component of TAN, is highly toxic. The daily TAN release is about 75% of nitrogen added with the feed. If untreated and left in the water, the concentration is high enough to lead to fish mortality. Two microbial mediated processes are acting in BFT systems to control TAN concentrations.

The first process is the assimilation of TAN by heterotrophic bacteria into microbial protein. Bacteria utilise the carbon as a building stone for new cell material. However, since microbial cells are made of protein, they need a nitrogen source. They thus take up ammonium from the

water and assimilate it to form microbial proteins. TAN concentration is kept low by adjusting the feed and carbohydrate levels in the pond to a C:N ratio of about 15. To keep the C:N ratio at the desired level we can reduce the protein in the feed (i.e. feeding with 20% protein feed as compared to the conventional 30-35%), and to add carbonaceous substrates such as molasses, cassava flour or similar.

The second microbial process taking place is nitrification that converts the toxic ammonia and nitrite to nitrate. It is important to note that both processes can take place only if the proper microbial consortia are present in sufficient levels in the water. The heterotrophic consortium develops rather fast following the build-up of organic matter in the water. Nitrifying community develops slowly and it takes about 4 weeks before it reaches its peak capacity, unless proper inoculum is applied. When C:N is higher than 15 (15-20), TAN can be controlled and kept at an acceptable level.

Microbial assimilation of TAN to microbial proteins has a high capacity and can be easily maintained to control nitrogen levels in the water. In addition, the microbial protein may serve as high quality feed sources to fish. In dense microbial systems (bacterial density in BFT systems is 10^6 up to 10^9 cells/mL), the bacteria stick together with many other organisms and organic particles, forming bioflocs that range in size from 0.1 to a few mm (see below). Such particles, unlike individual bacteria, are easily ingested and assimilated by tilapia.



Floc associated microorganisms founded before stop feeding, visualized by a Leica inverted microscope, under regular light, using a x10, x20 and x40 objective lenses.

The protein stored in the bioflocs is contributing significantly to feeding. Even more, unlike the applied feed, the bioflocs are ingested and utilised by the fish continuously all day long. Observing feeding behaviour of tilapia growing in BFT pond with tilapia in equivalent control ponds, it could be seen that fish in the control ponds were very hungry and rushed wildly to the feed pellets applied 2-3 times a day, while tilapia growing at the BFT ponds ate quietly, showing that they were not starved between feedings. The semi continuous feeding through the ingestion of the bioflocs help the smaller fish (that can hardly compete with larger fish in regular ponds), and thus higher size uniformity can be expected in BFT ponds.

The extent of tilapia feeding on bioflocs can be estimated by determining FCR, or by using isotopic tracing, which tags the bioflocs with the stable isotope ^{15}N. The isotopic method is fast and accurate. It was found that tilapia derive 30-50% of its protein through bioflocs ingestion. This recycling of protein can lead to a significant saving of feeding costs.

Control of biofloc concentration

An essential feature of BFT tilapia production systems, especially as compared to shrimp systems, is the very high biomass. In our experience, tilapia biomass can reach 20-30 kg/m^3 (200-300 tonnes/ha), as compared to shrimp biomass of about 2 kg/m^3 (20 tonnes/ha) in intensive ponds. Feed addition to tilapia ponds is about 10 times higher than in shrimp ponds.

Total suspended solids (TSS) accumulate in the pond at a rapid rate when fish biomass and feeding rates are high. Microbial community density and feed wastes are associated with TSS. Thus we should not release TSS indiscriminately out of the pond. However, excessive levels of TSS are not favorable since it adds to oxygen consumption and at very high levels may clog the gills of the fish. In addition, if water mixing is not well controlled, or when TSS concentration exceeds the mixing capacity of the system, solid particles settle down and may accumulate and create anaerobic pockets.

The existence of anaerobic sites in the pond bottom leads to the production of toxic reduction compounds which eventually severely hamper fish growth. TSS levels may be controlled by a daily or twice daily drainage of sludge, proper mixing of the water and appropriate design of pond bottom. TSS levels in bioflocs should not exceed limits of about 600-800 mg/L or 40-60 ml/L, respectively. These are essential controls in BFT tilapia production systems.

An added value

Biofloc technology for the production of tilapia helps to maintain good water quality and acceptable TAN levels in ponds, thus practically doubling the efficiency of protein uptake and reducing feeding costs. However, there are additional benefits. It is believed that feeding with bioflocs is associated with the supply of beneficial feed components which support the growth and metabolism of tilapia. A recent work done by Julie Ekasari and co-workers (Bogor University in Indonesia and Ghent University in Belgium) demonstrated the effect of bioflocs on the number of eggs produced by a tilapia female and total fry production. It was higher by 65% as compared to a control). The investigators found high concentrations of vital fatty acids in the bioflocs. Blood glucose and cholesterol levels were higher in fish fed with bioflocs. The high glucose is an indication for high energy mobilisation while the cholesterol is related to egg development.

Another added advantage is minimising disease. One of the problems of tilapia farming is the infection of the fish by *Streptococcus iniae*, an infection leading to significant losses. Several observations indicated that infection with *Streptococcus* and fish mortality are low, almost negligible in biofloc ponds. These empirical observations were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confirmed in a controlled replicated experiment. Tilapia (*Oreochromis sp.*, all male) were grown in tanks at a density of 7 kg/m^2 using two treatments: exchanging water at a rate of 7 times/day (conventional control) and a limited 10% daily exchange, (BFT) which leads to the development of dense microbial population (10^6 to 10^7 per mL). Some of the fish were challenged by injecting a dense *S. iniae* dose. The infected fish were tagged. Fish were sorted according to whether they were healthy, sick and dead after 20 days. No significant differences were found with respect to infection in the challenged fish. However, for the non-challenged fish, the rate of disease in the BFT treatment was significantly lower (25%) when compared to the control treatment. It was concluded that the biofloc system provides a protective coating to the fish, much like a probiotic effect.

Biofloc technology helps to maintain high densities of tilapia fry during cold winter season. Tilapia can be held in a plastic covered pond to conserve heat. Such systems are possible only if water is not exchanged, thus possibly exposing the fish to high TAN concentrations. This is prevented by maintaining high C:N ratio. It was found in such systems that in addition to high fry survival, the fish grew even at a water temperature of 15-21°C, significantly lower than the optimum temperature. BFT is still a new technology, attracting scientists and practitioners to develop it. Every year we learn of additional aspects of this system. We can expect new insights and applications in the coming years.

Economics of BFT

Data on the cost and revenue of BFT tilapia production is not easily available and in many cases, there is not enough data. Furthermore, financial data are kept confidential. However, some years ago we compared the feed expenses in intensive tilapia ponds in two treatments: conventional control (30% protein pellets) and a biofloc treatment (20% protein).

Table 1: Fish growth and yield coefficients of tilapia fed with conventional pellets[1], in two pond experiments

	Treatment	
	Conventional control (30% protein)	**BFT, C enriched (20% protein)**
Feed C:N Ratio	**11.1**	**16.6**
Experiment No 1: 51 days, average of 3 replicates		
Fish weight (g/fish)		
Initial weight	112	112
Final weight	193	218
Daily gain*	1.59a	2.0b
Mortality (%)	14.6	10.3
Feed conversion coefficient	2.62	2.17
Protein conversion coefficient -PCC	4.38	2.42
Feed cost coefficient –FCC (USD/kg fish)	0.848	0.583
Experiment No 2: 30 days, average of 3 replicates		
Fish weight (g/fish)		
Initial weight	205	205
Final weight	254	272
Daily gain[2]	1.63a	2.22b
Mortality (%)	3.4	0
Feed conversion coefficient	2.62	2.02
Protein conversion coefficient -PCC	4.35	2.18
Feed cost coefficient –FCC (USD/kg fish)	0.848	0.543

(1) 30% protein, C:N = 11.1) and low protein pellets (20% protein, C:N = 16.6
(2) Values not sharing a common letter differ significantly (p=0.05).

Drain bottom sludge twice daily till you get clear water

The results of two series of pond experiments (three replicates) showed that growth performance of tilapia in the BFT treatment was better than that of the control. Survival was about the same. Feed conversion ratio (FCR) was lower in the BFT treatment (though, overall FCR was a little high, probably due to over-feeding).

An interesting concept presented in the table is the protein conversion ratio (PCC), is equivalent to FCR. The protein conversion is kg protein fed during the experimental period divided by the quantity of protein added during this period to the harvested fish. FCC in the control treatment in the two experiments was 4.35-4.38 (average 4.37). This meant that 4.37 kg protein was added in order to produce 1 kg of fish protein. The PCC in the biofloc treatments was 2.18-2.42 (average 2.3), meaning that on average 2.3 kg feed protein were needed to gain 1 kg fish protein, i.e. doubling the protein efficiency.

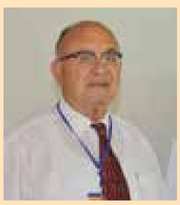
Another important concept is the feed cost coefficient. This is the cost of feed needed for the production of 1 kg fish (The nominal cost is related to cost paid to the feed mill at the time). The feed cost coefficient for the control was USD 0.85/kg fish, as compared to 0.54-0.58 (averaged USD 0.56/kg fish). The feed cost in the biofloc ponds was 66% as compared to the control. It has to be remembered that feed is the major expense in any commercial fish farming.

There is a need for a comprehensive economic analysis on tilapia production using BFT. A preliminary study done recently, which considered the costs per kg fish production (not per pond area), suggested that power consumption (kWh/kg fish) in BFT ponds is lower than in conventional systems.

Conclusion

Biofloc systems are able to intensify tilapia production. Fish adapted to conditions in BFT systems, grow well and utilise bioflocs as a feed source. The recycling of feed and minimization of water exchange are important contributions to the cost of tilapia production. However, further understanding the biofloc system, monitoring the culture system and fast response to negative developments in the system are essential to the success of the culture.

Reference
Yoram Avnimelech, Biofloc Technology, A Practical Handbook, Published by World Aquaculture Soc. 2012).



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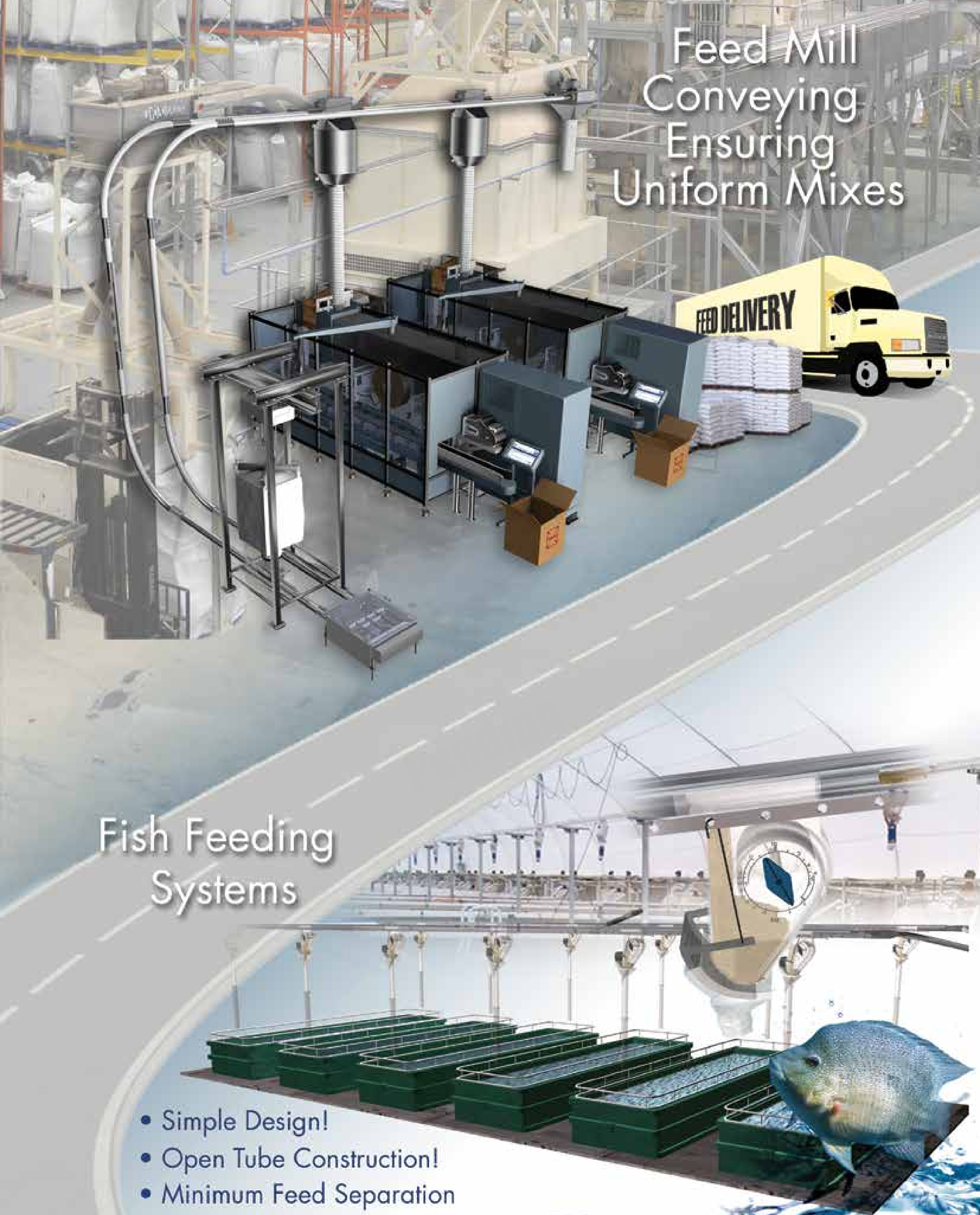
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Selective growth in 2013

By Zuridah Merican

Good demand for fish and shrimp feeds but selective for the latter

The surge in shrimp production due to higher ex-farm prices in 2013 benefited feed producers in Indonesia and India. Better shrimp production helped industry in Vietnam, after two years of a depressed feed market. A decline to almost half of feed production of 2011 was estimated in Thailand whilst the feed market continued to decline in China and Malaysia as shrimp farmers battle early mortality syndrome or EMS.

The demand for fish feeds in 2013 was higher in Indonesia as the country focussed on fish production for domestic consumption. It was also higher in Vietnam with expansion into tilapia and marine fish farming. In Malaysia, cheap imports of marine fish and low prices hindered local production affecting feed sales. In India, fish feed producers compete for a slow growing pangasius feed market.

Aqua feed producers continued to face high raw materials cost and this was accentuated by a depreciation of some Asian currencies. Fish meal prices were very high from early 2013 and only dropped in October 2013. In mid-2013, the European Union authorised the use of processed animal proteins (PAPs) derived from non-ruminant farmed animals in fish feed. According to Dr Thomas Wilson, Thailuxe Feeds, Thailand, "The effect was not only higher prices but also a short supply. Producers in Europe preferred to supply closer to home."

Some estimates* by industry on aqua feed consumption (tonnes) in 2013 in selected countries

Estimates in tonnes	Shrimp feeds	Fish feeds
Thailand	430,000-480,000	450,000 [a]
Vietnam	600,000	1,900,000 [b]
Indonesia	270,000-350,000	1,300,000 [c]
India	500,000-535,000	560,000 [d]
Malaysia	60,000	140,000-150,000[e]

** Estimates by industry stakeholders and feed producers including Ajaya Baskar, Manoj Sharma, Mayank Aquaculture and G. Ramesh, Wenger, India. GMPT, Indonesia; Nguyen Thi Minh Huong, Behn Meyer, Vietnam; Sheng Long Bio-Tech International, Vietnam, Supis Thongrod, Thailand.*
a includes marine fish feeds at 5-7%.
b mainly feeds for the pangasius catfish
c shrimp; open and integrator market, includes marine fish at about 5-10%
d Pelleted feeds for fish, 30,000 tonnes, G. Ramesh, India
e mainly tilapia feeds; marine fish feeds, includes marine fish at about 30%

Puspita Dewi Prijadi, Thomas Wilson and Denny Indradjaja

Higher prices

With the currency depreciation in most Asian countries in September, feed producers began to pass on the additional costs of raw materials to end users in November. In Malaysia, there was a one- time increase for both shrimp and fish feeds at the end of the year. Shrimp feeds rose to as high as RM 3.9/kg (USD 1.2/kg) and for tilapia feeds, MYR 2.75 (USD 0.83/kg).

In Vietnam, aside from a one-time increase in shrimp feeds, raising prices to VND 28,000-29,000 (USD 1.33-1.37/kg), feed costs can be as high as VND 35,000-40,000/kg (USD1.66-1.90/kg) depending on credit terms. There was also a one-time increase in Thailand, raising shrimp feeds to USD1.40-1.50/kg. Wilson said Thailuxe did not increase shrimp feed prices because farmers were already beset by hardship with EMS.

The Indonesian rupiah depreciated by almost 30%. Denny D. Indradjaja, head of the aqua feed division of the Feed Mill Association in Indonesia or GPMT (the Indonesian acronym) said, "It was inevitable that cost of feed production was passed to consumers. The last increase was in mid-2012 and this increase in 2013 was less than 20%, just to compensate for the change in exchange rate. We depend on imports for 80% of raw materials. We use 75,000 tonnes of fish meal from Peru and Chile and use only 50,000 of local fishmeal. With the increase, average costs of shrimp feeds are IDR12,000/kg (USD 0.99/kg) and fish feeds IDR 7,000-8,000/kg (USD 0.58 to 0.66/kg).

"It is not only high costs of raw materials but also higher costs of energy which has been increasing every three months. Some shrimp feed producers have increased prices, whilst other wait and see," said Puspita Dewi Prijadi, president director, PT Matahari Sakti (MS), Indonesia.

Expansion

In 2014, Indonesia will see more shrimp feed capacity with a new plant in Lampung for PT CJ Feed Jombang with a capacity of 1,000 tonnes per month. PT CJ now has the second largest market share in the shrimp feed market. PT MS will have a new plant in West Java, operational in 2015 for shrimp and fish feeds production. This will bring it closer to clients in West Indonesia, from Sumatra to Kalimantan. PT MS is a market leader for shrimp feeds in Lampung and Bali.

"Our success is attributed to innovation and feed quality. We have a demonstration shrimp farm where our target was 25 tonnes/ha but we have managed to produce 30 tonnes/ha. The stocking density is 125/m^2. Here, the farmers learn about farming in bioflocs and with probiotics and how to adjust conditions to the situation in their ponds. Our strategy is also to be close to our customers and have a community spirit. We organise annual badminton games and 2013 was our sixth year," said Puspita Dewi Prijadi.

In preparation for an increase in fish consumption in Indonesia, PT Central Proteinaprima Tbk (CP Prima) has began to increase its fish feed production with new mills in Lampung, Sumatra and Sidoarjo, West Java. It already has three fish feed mills with a capacity of 420,000tpy.The Lampung mill with a capacity of 30,000 tpy started production in 3Q 2013 with 240,000 tpy. These additional mills will increase its capacity to 480,000tpy. The Sidoarjo mill is scheduled to begin operations in 3Q 2014. However, there no plans to increase the capacity of shrimp feed production which is now at 200,000 and is only 50-60% utilised (industry.kontan.co.id).

In India, CP India is expanding into fish feeds with the acquisition of the 5,000tpy Shree Vijay Aqua Feeds whilst in Thailand, Cargill expanded into shrimp feed production with the acquisition of Siamakme Aquatic Feeds. By July 2013, currently shrimp feed producer, Sheng Long Bio-Tech International, Vietnam expects to produce feeds for the grouper, seabass, tilapia, goby and snakehead fish feeds at its new plant with a capacity of 30,000tpy in phase 1.

Freshwater fish feeds

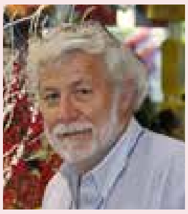
Vietnam's pangasius integrators continued to expand feed production, either by adding feed lines or acquisition. Hung Vuong (HV) the second largest pangasius catfish integrator in Vietnam recently bought into Viet Thang, a leading pangasius feed producer. HV already produces its own feeds at Hung Vuong Tay Nam Panga Feed Joint Stock Company. The largest pangasius integrator, Vinh Hoan has diversified into marine fish feeds as well as increasing feed lines for pangasius feeds as it expands fish production areas. Similar moves are being taken by others such as CL-Fish. In general, pangasius integrators are building a complete supply chain from hatchery production, grow out, and feed production and processing. This also fits into the strategy on sustainability and certification requirements of importers.

With this development, independent feed producers are being squeezed out of the pangasius grow-out feed market. In addition, large integrators are also buying out small farms or entering into contract farming. The expanding use of feeds for tilapia farming balances the poor demand for pangasius feeds, said Marc Campet, Ocialis Vietnam (see box). However, competition will be tough as these large integrators are also launching large scale tilapia farming to stabilise their business.

Pangasius farmers grapple with low ex-farm prices, sometimes at below cost of fish production when supply is high. Feed costs VND10,000-11,000 (USD 0.47-0.52/kg) and feed conversion ratios (FCR) range from 1.6 to 1.7. In replacing soybean meal with cheaper raw materials, formulators encounter issues with digestibility and anti nutritional factors. Feed consultant, Philippe Serene, says that this is because little is known on the nutritional requirements of the pangasius catfish, despite a long history of culture (see box).

Indonesia's production of fish feeds, both for freshwater and marine fish, has been on the upward trend in the past three years, from 905,000 tonnes in 2011, 982,000 tonnes in 2012 and for the first half of 2013, 548,000 tonnes, according the GPMT data. In 2013, the estimation is 1.3 million tonnes. The industrialisation of fish farming includes the national policy to farm large size (800g) pangasius catfish for export, farming the Clarias catfish in biofloc systems and a new strain of saline tilapia called Anjani for the domestic market. PT CP Prima is increasing its pangasius production to 70 tonnes/month from 30 tonnes/month. PT Mabar Feed Mill is integrating into pangasius farming. Pangasius production was 651,000 tonnes in 2012 and the target for 2013 was one million tonnes (metrotvnews.com). Denny

Industry Comments...



Philippe Serene

On nutritional requirements for the pangasius

The farming of the pangasiuscatfish started in Vietnam in early 1960 with large development starting in 1992 -1993 and 10 years later, production reach 1-1.5 million tonnes. Only 6,000ha of pond area is used for this production. Today, production volumes fluctuate between 800,000 to 1 million tonnes because of high production costs and low selling prices. The feed market expanded rapidly but with little attention on nutritional requirements. Feed is a major cost and the industry has been struggling with increasing costs of feeds as well as poor management of diseases affecting survival rates.

On the state of feed development, **Philippe Serene**, one of the pioneers in feed production for the pangasius, has this to say.

"In the initial years we pushed hard for quick production of feed to help farmers. It was easy and less work when we began. We developed feeds for the fish by 'copy and pasting' the nutritional requirements for the tilapia. As the industry developed with high stocking densities, this is now not tenable. Despite the massive volumes of feeds produced – around 1.2 -1.8 million tonnes at the height of production, sadly, to this day, we still do not know much on requirements at the nutrient level i.e at the amino acid level. Now we are facing high prices for raw materials such as soybean meal (SBM) and fish meal. We need to bring down feed costs, but we cannot do much with replacements such as using local sources of plant proteins and also fish meal produced in Vietnam (50% crude protein), as we do not have clear data on the complete nutrient requirements. Thanks to the work by Brett Glencross (CSIRO, Australia), we now know more on energy and digestible carbohydrate.

"In 1999, the average FCR was 1.3. Nowadays, we have a large range from 1.45 to as high as 2.3 to 2.5. Feed costs USD 450-550/ tonne for 47% crude protein and we try to use local ingredients such as rice bran and local fish meal but we are back to square one, as we do not have complete information on the nutrient requirements of the pangasius. The nutritional characteristics of rice bran, cassava, soy bean, DDGS, fish meal, meat and bone meal, blood meal, and others are variable and changes with the batch origin and seasons. The pangasius has also changed in terms of genetics most probably due to large inbreeding developments. I also think that although companies have a large data base for raw materials, such as Proconco which has in 2008 data from 8,000 analysis done per year, the information is not always properly incorporated into the matrix and used in formulations, so to updated the real nutritional values of these raw material.

A combination of a few decimal points of nutritional value of some important raw materials with nutritional requirement of pangasius can mean USD 2- 10 cost reduction in feed. We should also investigate the functionality of these raw materials to have a better understanding. Today, there is a large availability of functional additives such as enzymes. We could for example look at protease which may have a positive impact on the reduction of the cost.

"The budget by feed companies in R&D have been cut as margins become smaller. However, what is important is that we should work on short/medium term issues to help farmers".

said that GPMT has been working with the government to reduce costs of production. With the catfish, we have managed to reduce FCR to 0.6-0.7 in high density culture with probiotics.

The demand for freshwater fish feeds in Malaysia, namely the tilapia, did not change in 2013. "The ex-farm price for the tilapia was low in the beginning of 2013 and did not pick up until October 2013. A higher price of MYR10/kg was an incentive for farmers to increase stocking density. We also expect our feed demand to be higher when the next module for Malaysia's largest tilapia producer, Trapia comes on line," said Sean Lai, Star Feedmills, part of the Charoen Pokphand group.

Production capacity for extruded fish feeds expanded rapidly in the last three years in India. This was in anticipation of large uptake of extruded feeds for various freshwater species. However, to date only the pangasius uses extruded and pelleted feeds. Moreover, production has not expanded, mainly because the market is limited to fresh fish in some states. According to G. Ramesh, Wenger, India, the feed production in 2013 was only 560,000 comprising 530,000 tonnes of extruded feeds and 30,000 tonnes of pelleted feeds, whereas the total fish feed capacity is estimated at one million tonnes. Ex-farm prices for the pangasius have been around INR60-65/kg (USD 0.97-1.0/kg) whilst feed cost INR 29-30/kg (USD 0.48/kg). Farmers also demand that pelleted feeds, now with 18% crude protein, also match that of extruded feeds with 27% crude protein. Feed producers would like to use excess capacity to produce floating pellets for the rohu fish, an Indian carp, but with little success. Rohu has a higher ex-farm value at INR95/kg (USD 1/54/kg) and is now fed with rice bran.

The author acknowledges the contributions and assistance of industry in various countries in the preparation of this article.

Marine fish feeds

In Malaysia, feed volumes for the marine fish have not changed either. The production of seabass was lower because of fish imports at prices as low as MYR6.00/kg (USD1.8/kg). Local production costs for 400 to 600g fish starts at MYR8.00/kg (USD2.42/kg). Prices only increased later in the year to MYR12/kg (USD3.63/kg) spurring a restart of its farming. Low prices for the pompano, possibly because of cheaper imports, also dissuaded farmers from stocking cages. The range of prices for marine fish feeds is MYR4.20-4.40/kg (USD 1.27-1.33/kg) for 40% crude protein.

"However, feed demand was balanced with the increase in farming of the hybrid tiger x giant grouper, a fast growing and easy to farm fish. Ex farm prices are high, MYR25-28/kg (USD 7.57-8.48/kg) for a 4kg fish and MYR48/kg (USD14.5/kg) for smaller fish of 1.2-1.5kg. Farmers now stock 20 to 30% of this fish in the cages," said Lai.

Feeding enclosure for seabass in ponds in Thailand

Shrimp feeds

The rise in feed volumes in 2013 was most apparent in India where the estimate of production was 535,000 tonnes, comprising of 470,000 tonnes of feeds for the vannamei shrimp and 90,000 tonnes for the monodon shrimp, according to G. Ramesh, Wenger, India. He added that many farmers continue to use monodon feeds for vannamei shrimp with the expectation of better growth or in times of a short supply of vannamei shrimp feeds. Dr Ajaya Bhaskar, nutrition and feed consultant said that shrimp feed production was still below feed production capacity. "Despite this, a few fish feed companies have entered into the shrimp feed business. This also gives farmers a large choice of good quality feeds. There is a large price variation from company to company as the demand is high with increased vannamei shrimp farming. The current price of shrimp feed is from USD1.2/kg for starter and USD1.0/kg for finisher"

Leading producer, Avanti with the second largest market share will be expanding with its third plant in Kovvur, Andhra Pradesh. It is already producing at 90% capacity, said KV Raju. "There is a feed shortage in the east coast and south of India. Our total capacity is 850-900 tonnes per day. We have about 50% market share in some areas and higher in areas closer to the factory. The number of ponds operating is 30% more than in 2012." Avanti attributes its success to good feed performance, teamwork as well as to its collaboration with Thai Union Feed Mill in Thailand.

In Indonesia, Denny estimated up to 350,000 tonnes of shrimp feeds were produced in 2013. The sales figures for the first semester in 2013 was 122,000 tonnes. The top 4 producers are PT CP Prima, PT CJ Feed Jombang, PT Suri Tani Pemuka and PT Matahari Sakti. Shrimp feed producers have benefited from a surge in production activities with high shrimp prices.

"Here in Indonesia, we have been lucky as farmers are showing consistent and increasing harvests. After successful harvests, farmers usually increase stocking density by 10 to 20%. Up to mid-year, we already saw production increasing but later in the year, it was a surge as more farmers restarted operations. We also saw a pattern in feed usage related to high shrimp prices. After good harvests, farmers do not hesitate to spend more on feed and buy our premium Feng Li feeds for the next crop," said Puspita Dewi Prijadi.

In Vietnam, feed volumes went up in 2013, but uncertainty on future demands remain. After more than 2 years of crop losses, the financial situation of farmers is still poor. This is despite better and

Industry Comments...

Pangasius in ponds and tilapia in cages

Marc Campet

As pangasius catfish farming goes into a downtrend with lower farm gate prices of fish, as low as VND20,000/kg (USD 0.95/kg) in June 2013, tilapia farmers are doing better with prices as high as VND35,000/kg (USD1.66/kg) depending on size. The downturn in pangasius production in the first 6 months of 2013 affected feed producers selling into the open feed market.

The development of tilapia farming in Vietnam benefits feed company Ocialis which has the tilapia feed market in Brazil and Mexico and heavily invested in R&D. In Vietnam, **Marc Campet**, Aquaculture marketing manager said, "This is because tilapia farming has not reached an industrial level in Vietnam. The cost of production for the tilapia is VND26,000/kg (USD 1.23/kg) and FCR is from 1.5, depending on the size. Feeds cost from VND12,000 to 20,000/kg (USD 0.57-0.96/kg). There are advantages with the physical separation of tilapia in cages and pangasius in ponds as this helps in preventing disease outbreaks. The fast water currents is suitable for tilapia farming, similar to conditions in Thailand.

"However, the industry is still behind that of Thailand. Local hatcheries get their source of fry and fingerlings from hatcheries in Thailand. There is no clear distinction in using monosex strains. Red tilapia is preferred to the black tilapia, because of the live fish market. There is now a modern hatchery in Vinh Long. Although times are hard with pangasius farming, we should not dismiss the pangasius. The next evolution with pangasius farming will be biosecure hatcheries where we have vaccinated fingerlings."

As a feed producer, the expanding use of feeds for tilapia farming balances the poor demand for pangasius feeds. In 2013, the estimated usage of tilapia feeds was 300,000 to 500,000 tonnes for production of 200,000 to 300,000 tonnes of 500-600g tilapia. In 2012, feed producers did what they could to bring down the costs of feeds to help farmers, even with 18% crude protein feeds. The company has two aqua feed mills in Vietnam both located in Binh Duong.

"On our part, we have maintained our Ocialis Technical Centre, initially created in 2005 to provide technical advice to pangasius farmers, especially on health management. Today, we work with farmers farming any fish species. As some pangasius farmers have changed to snakehead fish farming, Ocialis is ready with feeds with 40% crude protein.

In the marine fish feed business, Ocialis already is well known among the large Asian sea bass (*Lates calcarifer*) farms in the central part of Vietnam. One of them, Australis in Nha Trang produces large size seabass (2.2kg) for frozen products to be shipped for export. Ocialis plans to have a specific program with a new range of feeds. Here the company is using their expertise and knowledge of nutrient requirement with sea bream and sea bass in the Mediterranean to develop high protein diets, such as those with 54-45% crude protein with high fat levels of 25%. Extensive work has been done within Vietnam but also on the regional basis in order to have a feed perfectly adapted to farming conditions and environment.

"Here in the tropics, we know that large Asian sea bass can take a high fat diet, following their requirement on protein: energy ratio (P: E).

Next, Campet said, "Ocialis in Vietnam will be focussing on the shrimp feed business. We have been working with a genetic company to develop a new strain of brood stock. This has been running on an international basis for the past 1.5 years now. Of course genetics is not the silver bullet, it has to go with better/new farming technology in order to prevent as much as possible disease treats. The shrimp industry must enter a new era focusing on stability like other animal production systems did in the past."

G. Ramesh

Ajaya Bhaskar

high profit margins from good shrimp prices. EMS is still a threat but the likelihood of success is higher as farmers are more conscious of good quality post larvae, better management practices and use probiotics and treatments for water quality. To the advantage of the feed producer, farmers have become more receptive to new feed models especially those combining health and nutrition. Uni-President Vietnam is now marketing new feeds containing probiotics.

Extruded shrimp feeds

The marketing of extruded shrimp feeds remains a challenge. In India, Indian Broiler (IB) has introduced its extruded feeds for the monodon and vannamei shrimp under its ABIS range. Thai Union Feed Mill (TUFM) is the second company in Thailand to introduce extruded shrimp feeds. According to Dr Supis Thongrod, R&D director, TUFM, have installed the oblique die which will increase the throughput. Currently, they have the starter feeds for feeding shrimp after 20 days. "Next will be to work on all sizes of starter feeds to replace crumble diets. Unfortunately the industry standard for pelleted shrimp feed is 7-8 feed sizes, depending on company. There is no rational basis, even for extruded feeds, we may need to follow this trend," said Supis. "The extruder was installed initially for fish feeds but we then installed the oblique die and will now use this for shrimp feeds."

However, Ajaya Bhaskar, believes that some farmers like extruded feed especially the starter feeds. Through extrusion we can make feeds as small as possible and can avoid crumbles which generates lot of fines in transportation. Similar to farmers elsewhere, our farmers are conscious of feed prices. Feed companies must explain to farmers the benefits of using quality extruded feeds and convince them. Furthermore, as long as pelleting technology produces feeds that meet the requirements of farmers, it is difficult to change their mind set and move to more expensive extruded feeds. In India, some extruded feed have the floating problem of 5-10% and still needs to work in the formula and extruder settings to overcome this."

An expanded aquafeed R&D centre

The expanded facilities will fine tune formulations for several species for Thailuxe in Thailand.

In October, Thailuxe Enterprises Public Ltd organised the official opening of its newly expanded R&D centre at the Samutsongkhram compound. This facility uses a recirculating aquaculture system (RAS) and has 24 fibreglass tanks, each measuring 2.4mX1.2m; 6 tanks of 4mX1.2m and 16 conical tanks specific for digestibility studies with fish. The aqua team will be conducting trials on feed performances, protein and digestibility of complete feeds and raw materials. There are also 12 10m^3 outdoor concrete tanks, not connected to the RAS, for growing fish under more natural water conditions.

Dr Thomas Wilson, vice president said, "I have always had a small R&D facility since I first started in Thailuxe to carry out some basic research. We also had to depend on customers' ponds to run some larger trials. But then two years ago we were given this area, unused for several years after all our workers were moved to the factory in Petchaburi province. This is an investment of USD 400,000. We plan to use the facilities to learn more on nutritional requirements of all the species that we are working on. With the exception of tilapia and the Asian seabass, which the Australians have worked a lot on, we know so little on the other species that we are farming in Asia. It will also allow us to fine tune our formulations.

"What we should also target will be information such as digestible energy: digestible protein ratios (DE:DP) which are required if we want to formulated better feeds and move away from formulations based on just crude protein basis only. We will also use the facilities to carry out performance studies to compare results at our commercial shrimp/ tilapia ponds," added Wilson

"At the moment, we produce feeds for marine shrimp, *Macrobrachium* prawn, pangasius catfish, tilapia, seabass, gourami, as well as aquarium fish, crab and frog feeds. We also want to carry out amino acid digestibility experiments so that we can work towards replacement of fish meal based on amino acid requirements."

Listed Thailuxe Enterprises Public Co Ltd is one of the leading aqua feed producers in Thailand. It was established in 1987 and now has two feed mills; a shrimp and fish feed factory at Petchaburi province which produces 80,000 tonnes per year (tpy) of shrimp feeds and 61,000tpy of fish feeds and a new shrimp and fish feed factory in Songkhla is under construction. Originally, the feed mill in Songkhla which started construction in 2012, was planned for the production of 60,000tpy shrimp feeds only, with expansion into fish feed production planned for the future. But with the slowdown of demand for shrimp feed obvious after the first half of 2013, Thailuxe decided to install a 10 tonnes per hour fish feed line too. This new project was initiated in August and the installation of a Wenger extruder and Buhler Aeroglide dryer will be completed in the second quarter of 2014. Annual fish feed capacity for this plant will be 70-80,000tpy.

"In southern Thailand's freshwater fish feed market, Thailuxe has the second largest market share after Charoen Pokphand (CP). We have also introduced feeds for the Asian seabass, and are developing feeds for other marine fish such as red snapper."

In addition, the company has two commercial farms growing tilapia in more than 800 cages in Kanchanaburi province. In 2012, Thailuxe started developing over 200rai of land that it has owned for more than 25 years in Tambon Klong Khone, initially with 20 ponds for tilapia grow out, but eventually shrimp will be grown, and there are plans to set up a tilapia hatchery. Tilapia produced in this farm will be sent to SMP Food Limited, a subsidiary seafood processing company located nearby, and they will be processed and exported mainly to the Middle East.

Saline and freshwater Research facility

Wilson says "In this location, only piped drinking water and ground water of 3ppt salinity are is available. We worked out the costs of paying for water and decided a recirculating aquaculture system would be more economical."

Thailuxe chose to use and license a unique RAS system called Aqua-RASD developed by BIOTEC, Thailand. This is a closed recirculating aquaculture system integrated with the hybrid nitrification biofilter tanks for ammonia removal and patented Tubular Denitrification Reactor (TDNR) for nitrate removal. According to Dr Sorawit Powthongsook, BIOTEC researcher, in this system, the water can be recirculated efficiently within the system leading to the cutback of water exchange from 15-20% per day to 0.5% per day. In addition, this technology can prolong water exchange for a year or more as well as reduce the expenses of chemical preparation, seawater transportation and also prevent aquatic animal farming from infectious diseases transmitted in the water.

The centre buys hypersaline water (200ppt) from salt farms in Samut Sakorn and Petchaburi, which is then diluted down with either ground water or rain water to attain the salinity of water required for the experimental tanks. There are three RAS zones in the centre, and currently one is dedicated for research with marine species and the other two for freshwater species, with stocking densities of only 10 kg fish/m^3. The system is actually oversized as it can handle up to 40kg fish/m^3 with additional filtration media.

Central R&D, local delivery for aqua

An interview with Nutriad CEO Erik Visser

Erik Visser at the Nutriad seminar in Ho Chi Minh City, Vietnam

In the past 50 years, the global company Nutriad, with a presence in 80 countries, has been focussing on the livestock industry specialising in the fields of feed additives, preservatives, flavours and sweeteners. This changed in 2009, when the feedmill specialties division of INVE Aquaculture was integrated into the company.

With this came a dedicated research team specific for aquaculture, which covers a wide area of R&D, from formulation and processing of aquafeeds to farm-to-fork traceability in the aquaculture food supply chain. Its strength is in the knowledge to resolve bottlenecks in production and developing nutritional and health solutions specific for commercial fish and shrimp farming.

In recent years, Nutriad has grown rapidly in the market for aqua feed additives and health solutions for the fish and shrimp farming sectors. It has a large presence at major global aquaculture industry events such as at the recent Asia Pacific Aquaculture 2013 in Ho Chi Minh City, Vietnam. Nutriad organised a seminar for clients and partners to discuss worldwide challenges in aquaculture and the solutions available or in progress.

Erik Visser, CEO since 2010, talked to AAP on Nutriad's commitment on aquaculture in Asia. In contrast with the mature livestock industry, Visser sees aquaculture at a growth phase requiring knowledge and technology.

"In poultry, we have seen explosive growth through the use of technology in the last 30 years and I expect aquaculture to show an exponential growth curve as it moves towards industrialisation. The aquaculture industry is hungry for new solutions. With the R&D team in aquaculture, we have the solutions but needed to bring them to the industry. In 2011, we took an important step and established an aqua division and developed commercial people in Asia Pacific and Latin America, exclusively for aquaculture. We made the move from research to commercial activities.

"For many years, we had technical people meeting potential clients and explaining the specificities of our products. However, as we make headway in a country, we realise that clients need to be attended to by local counterparts and also to process the registration of products. In the last three years, it has been our approach to build up teams of local counterpart staff. They know the culture of the region or country, have detailed knowledge on what the industry needs and of course the 'ins and outs'. We view this as a more focussed approach in countries where we see potential."

An aqua business unit

Since his appointment, Visser has been working hard to reposition the aquaculture unit within Nutriad. He said that since 2011, aquaculture has an independent business unit with its allocation of resources and investments in production, research and marketing.

"I believe in the market, people and products. With the Aqua Business Unit we have a commercial entity instead of just a 'niche' area within the company. This also shows our commitment to aquaculture and our direction. We have defined our focus: to increase sales volumes in specialty products.

"Bringing industrial science to the industry is important, but we need to get our customers to understand. We need to transform concepts to markets. Our team will define the strategy. We hire staff who are passionate in the aqua business as we are here not only to sell but to add value to the market."

Crossover R&D

"The Aqua R&D team focuses on the development of new products with the customers in mind. At Nutriad we work at true innovation for the aquaculture producers. Our product developments are based on species-specific and practical research from the first design, through laboratory and field evaluations, and finally released to market following verification trials with reference customers. During our research we use processing technology and feed formulations that are relevant to those used in the industry; this is key to any aquaculture research program. It guarantees that the outcome of our research is directly applicable in the conditions of our customers. Whether in aquaculture or livestock, the company's strength is its ability to develop innovative products on a regular basis," said Visser.

"The R&D teams in livestock and aquaculture work together and exchange ideas and knowledge. Dr Tim Goossens is working on quorum sensing across species. Although livestock leads in production knowledge, there will always be ideas which the livestock sector can learn from aquaculture. Dr Peter Coutteau also participates in many multispecies discussions. The benefit is that we have participation from all and is challenging for the business."

Expanding the aqua business

The marketing of existing and new products in the specialities range is performing well in Asia. The early mortality syndrome in shrimp farming in some Asian countries has created interest in some products such as the Sanacore range of products for modulation of gut health. According to Visser, there are promising results where the product slows down shrimp mortality in trials in Vietnam, Thailand and Mexico.

"With our progress in quorum sensing and Sanacore, we are seeing positive results and this is sparking some interests in the industry.

"The current development of aquaculture specialties is focussed on resolving key problems in health and nutrition. The developments on nutrition are aimed at getting a better return from increasingly expensive raw ingredients. We have seen relative improvements of 5-8% in terms of growth, feed conversion and protein efficiency by applying the right combination of digestive enhancers to feed of different species of fish and shrimp. Regarding health research, Nutriad has a long history in natural anti-microbial products. Many concepts and ideas have already been applied in agriculture using a variety of ingredients including organic acids, botanicals, yeasts and medium chain fatty acids. Since 2010, Nutriad has pioneered the application of quorum sensing inhibition as a new mode of action in natural anti-bacterial feed additives. We are applying this know-how to develop specific solutions for the many and diverse disease challenges in aquaculture. We are currently developing potent natural anti-bacterial additives where we combine different modes of action to reduce the impact from bacterial and viral diseases. We have also produced specific natural anti-parasitic products to reduce the impact from gut and gill parasites in fish," added Visser.

Outlook on industry in Asia

According to Visser, in the fragmented aquaculture industry in Asia, not all players have access to the same level of knowledge.

"Unfortunately, many players are convinced that they are doing their best but is often not true. We wish to challenge them to dare look beyond their current practices. Our team is working directly with customers and we encourage openness as through this we can work together to achieve improvements. We want to bring an exchange of ideas from other parts of the world to Asia and vice versa.

"Despite Asia's growth, it may just take a longer time to reach the same level of openness as in the livestock feeds industry or in the aqua feed industry in Europe."

Room for growth

Is there room for growth for aquaculture in Nutriad? Yes, Visser believes that with the current portfolio, there are ample opportunities for growth. He targets a 20% annual growth potential for the business unit in the next three years. Currently, the aqua business is active in most countries with a significant aquaculture industry including Greece, Turkey, Mexico, Ecuador, Brazil, Chile, Central America and Southeast Asia. Vietnam is a strong market for feed additives. Other countries are India, Indonesia, Thailand, Malaysia and Taiwan. "We are targeting organic expansion. In Japan we have already started trials. Japan will be a challenge for us in marketing as well as registration of products. In China, we have started the product registration process and with interest in products against EMS, we will be mapping our strategy.

"Nutriad is not a huge multinational. We need to combine strategy and operational challenges into a hands-on philosophy. We think as a global company and execute all over the world as a small family."

Marine shrimp in Asia in 2013

Total production is pulled down by EMS in Thailand whilst Indonesia and India gain volumes

In mid-2013, there was a short global supply of marine shrimp due to mortality caused by early mortality syndrome/acute hepatopancreatic disease (EMS/AHPND). EMS hit Thailand in late 2012 and Thai Shrimp Association projected a 40% decline in production for that year. The disease had already brought down production in China, Vietnam and Malaysia, since 2009, 2010 and 2011, respectively. At the end of 2013, industry's estimate of Asia's production was 2.6 million tonnes.

The 'Shrimp in a Crimp' report by Rabobank in August 2013 noted that EMS is responsible for a contraction in global shrimp supply. Whilst EMS created losers, the report also said that it was an opportunity for second tier producers namely Indonesia, India and Ecuador to step up production to be winners.

The short supply raised prices to record highs which help producers with better margins even though survivals are low. India and Indonesia have been increasing production to take advantage of high prices. In Vietnam, industry reported production gains, as more farm areas were converted to intensive vannamei shrimp culture from extensive culture of monodon shrimp.

At the end of 2013, a further decline in global supply was expected when Mexican producers said the 2013 production maybe between 35,000 to 50,000 tonnes (F.Garcia, pers comm) because of EMS.

Preventing EMS

The announcement on the cause of AHPND (see page 4 & 6 for updates) may be a breakthrough to disease experts, but little is known on its prevention in ponds or its spread. Unsurprisingly, postulations on the route of infections abound - ranging from post larvae with poor resistance because of selection for growth traits in new genetic strains, poor quality post larvae from multi-generation brood stocks, pathogen transmission through fresh feed and poor culture management, during the larval to grow-out phase. A PCR method (page 6) will help detect the pathogen and provide answers to the route of infection. Recently, India reported shrimp mortalities, but the actual impact on crop losses due to EMS is difficult to ascertain as samples show co-infection with WSSV, according to an industry source.

Meanwhile, Indonesia and the Philippines, countries where EMS has not been reported are on the alert. In his presentation on the success in shrimp farming in Indonesia during the Asia Pacific Aquaculture (APA 2013) in December, Haris Muhtadi, PT CJ Feed Jombang, listed the actions taken by government and stakeholder groups such as Shrimp Club Indonesia (SCI), feed producers, hatchery operators and processors to prevent EMS from entering Indonesia. Measures include the establishment of early warning and early detection systems, task force as well as diagnostic laboratories to detect AHPND. Public awareness workshops have been carried out in 10 provinces. There is a ministerial decree to prohibit the importation of shrimp and live feed from countries which have EMS outbreaks. The government also imposed a ban on all probiotic materials imported from EMS affected countries, at least until the end of 2014.

Since March 2013, the Bureau of Aquatic Resources (BFAR), Philippines decreed that only imports of brood stock from the US will be permitted. In April, BFAR banned the imports of live shrimp species from EMS affected countries, and installed a watch on the development of the disease in Singapore, Myanmar, Brunei and Cambodia.

India's Coastal Aquaculture Authority (CAA) has also suspended temporarily the imports of brood stock from EMS infected regions. CAA's list of nine approved suppliers includes four suppliers from Thailand and Singapore. The Hawaii based Oceanic Institute is now working with the Rajiv Gandhi Centre for Aquaculture (RGCA) in a brood stock multiplication centre program for India, "By default all other designated suppliers are from the US and with acquisition of High Health Aquaculture by SIS, we are now limited to only two suppliers in the US. Furthermore with logistical issues from Hawaii, every hatchery in the country is now importing from SIS in Florida," said Ravi Yellanki, Vaisakhi Bio-Resources, a leading hatchery in India.

Rise in farm gate prices

The impending shrimp shortage in international markets was evident at the end of 2012 and accentuated when Thailand announced outbreaks in the eastern provinces in early 2013. Despite this, international buyers were still optimistic on the supply situation until March 2013, when they were ready to replenish stocks. The realisation of a long term supply shortage leads to increases in offer prices to match local prices. Since July 2013, prices have escalated. The White Shrimp Index (Urner Barry) rose from USD 4.5/lb in July to USD 6/lb in December 2013. In Thailand, prices for size 70/kg rose to THB 260/kg in December 2013, a 49% increase over that in March at THB 175/kg (see graph). The high cost of raw materials forced the closure of some processing plants. Operations resumed when international offer prices kept up with local prices.

A comparison of farm gate prices for vannamei shrimp (January 2014 for size 70/kg)

Size 70/kg (14 g)		
Country	**Local currency/kg**	**USD/kg**
China*	CNY 30	4.9
Thailand	THB 260	7.8
Vietnam	VND 180,000	8.5
Indonesia	IDR 83,000	6.9
Malaysia	MYR 27-28	8.2-8.5
Philippines	PHP 280-290	6.3-5-6.4
*December 2013 price in Guangzhou		

Price evolution of vannamei shrimp in Thailand, 2011-2013 (source:http://www.samutsakonshrimp.com/wsPriceP.php)

Higher costs

Throughout the region, producers lament on the higher costs of production. The increase is around 10-14% in Indonesia mainly due to higher feed costs. In farms affected by EMS, cost increases range from 20-30% because of low survival rates. However, as farm gate prices increase, these compensate for lower survival rates in terms of better margins. To reduce risks, it is now common for producers to harvest at size 100/kg and 120/kg. The small shrimp sizes also come from emergency harvests.

Furthermore, with the exception of China, from September 2013, most countries in Asia experienced currency depreciation. The main effect was on the cost of feeds which began in November 2013 when some feed companies announced increases in feed prices because of higher costs of raw materials. India and Indonesia had their currencies weakened by 20% and 30% respectively which favoured companies with high volumes of shrimp exports.

Less of monodon shrimp

Production estimates in 2013 showed the decline in the production of monodon shrimp. However, the availability of specific pathogen free (SPF) post larvae is encouraging some farmers to farm monodon shrimp, such as in Malaysia. Although in Vietnam, EMS affected both vannamei and monodon, anecdotal data elsewhere showed that no EMS infections were reported for the monodon shrimp. In Thailand, SPF monodon shrimp post larvae from the Shrimp Genetic Centre in Songkhla were used to co-culture with red tilapia in lined tanks using bioflocs (see p12).

In his presentation at Asian Pacific Aquaculture (APA 2013), Dr Manoj Sharma, Mayank Aquaculture in Gujarat said, "India grew on the platform of large monodon shrimp but now we can produce 24-33 g vannamei shrimp. We stock at 40-60 PL15-20/m^2 from our own hatchery.

"The demand for large shrimp is during the Christmas period for size 10-20/kg and 20-30/kg size. In terms of cost of production, it is USD 3.22/kg for the vannamei shrimp and USD 3.59/kg for the monodon shrimp. However, I can harvest 5-6 tonnes of vannamei shrimp but only 3 tonnes of monodon. Q.E.D," said Manoj.

China

China's official data indicated a total production of 1.5 million tonnes of vannamei shrimp in 2012, comprising 690,747 tonnes in freshwater ponds and 762,494 tonnes in marine ponds. This is higher than the estimate of 1.3 million given by industry for vannamei shrimp production (620,000 tonnes in freshwater and 680,000 tonnes in marine ponds, cxfish.com). This is similar to the estimate presented at the GAOL 2013 meeting (Andersen, 2013). Nevertheless, a common estimate by some members of the feed industry is a 30% reduction for the 2013 production. They have predicted a higher production in 2014.

In 2013, low survival rates were reported in the main shrimp culture areas such as Hainan, Guangxi, Fujian and Guangdong. However, farms in Zhanjiang, Jiangsu, Shanghai, Liaoning provinces were still successful. Some remedies against EMS include polyculture with fish, use of fermented shrimp feed and low density stocking combined with good management of ponds. A feed producer also said that farmers are using first generation postlarvae or healthy post larvae, high quality feed, probiotics and are learning to manage water quality.

Not all crop failures were a result of EMS. A survey showed that in Zhanjiang, about 85% of farmers have crop failures attributed to erratic climatic changes such as typhoons, continuous rains, and wet weather in April to May. Rains in the second half of the year delayed stocking (feedtrade.com.cn). In south China where land is limited, high density culture systems with 200 PL/m^2 in ponds of 2-2.5 m deep are helping to increase shrimp supply.

Industry also attributes the high mortality of shrimp on poor quality of post larvae. There are suggestions that China should have its own selective breeding program. “Small scale farmers have been using biofloc technology to combat EMS but with few successes,” said a shrimp feed producer.

Vietnam

An industry estimate for 2013 was 273,000 tonnes of vannamei shrimp, an increase of 50% of the 2012 production. Vannamei shrimp is farmed intensively at a density of 120-150 PL/m^2 in the north and central regions to 80-100 PL/m^2 in the south and western region. Industry reported that farmers in the central region are faring better than their counterparts in the south, such that the former can continue culture to harvest the target size. In the south, harvest size is usually 100/kg.

“In the early part of the year, we already saw a mild increase in the number of ponds resuming operations but towards the second part of the year, there was a large increase in the number of ponds operating. Farmers have reduced stocking density to 50-80 PL/m^2 and with colder weather, at the end of the year, this will be decreased further to 60 PL/m^2. Other steps to ensure success is the use of pond probiotics and only one harvest, replacing partial harvesting,” said James Hung, Uni- President Vietnam (UPV).

“UPV started two nurseries in the south and west of Vietnam where we grow the shrimp to PL16. However, although we offer the same price as that for direct stocking (PL9-13), farmers still prefer the younger post larvae.”

Some of the steps taken to resume production include the use of selected or quality PL, better pond and water management, and use of pond probiotics. Maple Hung, Sheng Long Bio-Tech International, said

Thailand by Soraphat Panakorn*

As a leading supplier of farmed shrimp and also as the technology leader in shrimp farming in Asia, the announcement in Q1 2013 of massive mortalities due to EMS in other parts of the country aside from Chantaburi (which reported some mortalities from EMS in late 2012 till now) illustrated the pathogenic nature of EMS. In June, the Thai Shrimp Association announced that production would drop by 10% and later in the year, Towards the end of 2013, the estimate was further reduced to 250,000 tonnes.

During the Suratthani Shrimp Meeting in February, shrimp stakeholders accepted that EMS would be a major problem and the strategies to control the spread was initiated. The Department of Fisheries (DOF) and industry leaders such as Dr Chalor Limsuwan are playing an active role to help farmers overcome problem; mainly in post larvae quality to stem the progression of EMS at the hatchery and its spread in ponds. Several groups including feed companies conduct seminars, some as many as 10 times in a month to help managers of large farms understand the problem. DOF campaigned for production of better quality post larvae among the small hatcheries and implemented a protocol to check post larvae quality. DOF also allowed the imports of new stock of broodstock in June but these were only used for spawning up to a period of 4-6 months.

In Thailand, there are various groups working on solutions to prevent EMS. They work separately to tackle different aspects of the problem, including tracing the causative factors of the disease and to develop solutions. Even if some of these solutions are only 50% effective, this is regarded as a step forward. Farmers keep track of developments and quickly follow proven recommendations. The aim is a survival rate of 60-70%. The steps taken include: methods proposed by the top shrimp culture researchers and industry leaders and those developed by aquaculture suppliers with the participation of leading farmers. In Trad, there are step by step solutions arising from the combination of efforts by groups of farmers and hatcheries.

Leading aquaculture suppliers such as the Aran group have solutions which they convey to farms through a school, live on reality shows, blogs via mobile phones ‘line’ application and the internet. Another model to combat EMS proposes the culture of post larvae in semi-biofloc in part of the pond which has been sectioned off and is lined with HDPE liners. Stocking density is only 20-30 PL/m^2 for culture in the grow-out pond. Another group proposes the use of only PL20 fed entirely on Artemia. Pond management uses a combination of products from various companies. A group in Suratthani proposes fallowing ponds. Members of the group called Trat Model, proposes a balance of the pond ecosystem, control of hydrogen sulphide in ponds and maintain a complete nitrogen cycle to stabilise the pond conditions. These members now have harvests at levels before they were hit by EMS.

The consequences of EMS have affected the production of shrimp in Thailand. A common stocking density is now 100 PL/m^2, although some have decreased this to as low as 60 PL/m^2. Stocking density is further reduced in November. It is still possible that higher mortality is due to white spot syndrome virus-WSSV. In Thailand, with current prices (THB 225/kg, December 2013) it is still profitable to harvest size 100/kg shrimp at a cost or production of THB 110/kg. Previously farmers in Thailand sometimes faced farm gate prices below cost of production.

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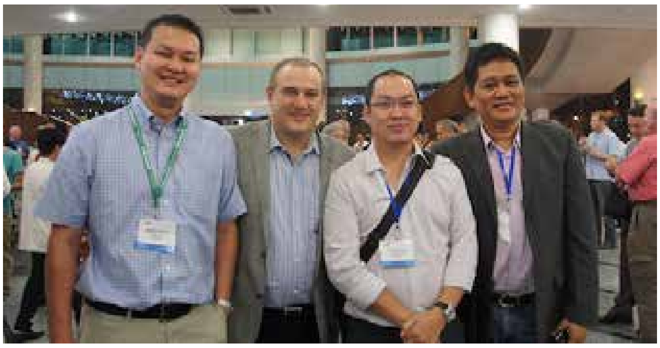

At APA 2013, Haris Muhtadi (right) with, from left, Henry Widjaja, PT Prima Larvae, Indonesia, Dr Farshad Shishehchian, Blue Aqua, Thailand and Frans Antony, Indonesia

that farming in bioflocs is still at the experimental stage and is not as popular as depicted by reports. Polyculture with fish is limited. A report said that Minh Phu, the largest shrimp producer in Vietnam and farms in Soc Trang have been successful with biofloc co-cultured with tilapia and snappers, respectively (vasep.com.vn).

Indonesia

High shrimp prices fuelled resumption of culture activities in abandoned ponds. Industry has estimated a production of 400,000 tonnes in 2013, with vannamei comprising 250-280,000 tonnes. Two programs also contributed to the rise in vannamei shrimp production: the Ministry of Fisheries and Marine Affairs started the revitalisation of shrimp ponds since 2012 and the 'vannamei village' project initiated by PT Central Proteinaprima (CP Prima), Indonesia's largest integrator. The vannamei village program resuscitated abandoned ponds, initially with 'traditional plus' system (stocking density at 20 PL/m^2). With consistent harvests, farmers increase stocking density to 60-80 PL/m^2 with partial harvesting. In 2013, production at CP Prima's shrimp farms was estimated at 40,000 tonnes.

Haris attributed culture success to changes in culture technology, biosecurity measures and health management with the assistance of 15 diagnostic laboratories throughout the archipelago and 34 planned laboratories at the provincial level. Prior to the infectious myonecrosis virus-IMNV outbreak, stocking density ranged from 125-250 PL/m^2 in 2010. This was lowered to 80-150 PL/m^2 with partial harvesting at 70, 85 and 100 days and use of aeration at 30-60 HP/ha and SPF post larvae. Productivity ranged from 12-20 tonnes/ha/crop. Average size of production are size 70-80/kg and 30-40/kg, depending on location. In December 2013, farm gate prices rose to IDR 83,000/kg for size 70/kg up from IDR 51,000/kg in June 2013.

High density culture with zero water exchange in small cement ponds complete with a waste siphoning system is popular. Another system being promoted by the Fisheries School for Advanced Learning (BAPPL-STP) proposes small 600 m^2 HDPE lined ponds. Stocking density is 200 PL/m^2 which produced 1.8 tonnes of size 65/kg shrimp in 100 days. The average feed conversion rate is 1.3 and production cost is IDR 29,104/kg (Trobos Aqua, June 2013).

India

The surge in shrimp farming in 2013 will increase production of vannamei shrimp to 300,000 tonnes, according to industry. In 2012, the production volume was high at 180,000 tonnes (Rabobank, 2013). In 2013, it was apparent that the monodon shrimp has lost its position as the leading species with almost 95% of production of vannamei shrimp in the main shrimp production states of Andhra Pradesh and Tamil Nadu. Monodon shrimp farming is now concentrated in Gujarat, Bengal and Orissa. The estimate was 60:40 ratio (vannamei: monodon) in 2013 and KV Raju of Avanti Feeds, said, "Perhaps we will have 85% of vannamei in 2014."

In 2012, production continued over the winter months (November to February) and farmers reported good harvests. However, this was not the case in 2013, as there have been reports of shrimp mortality which led to the suspicion of EMS affecting India. But industry sources concurred that it could be more of WSSV rather than EMS. Nevertheless, the controversy over EMS in India is still there. "These high year-end mortalities will actually decide production in 2014," said an industry stakeholder.

One main constraint in shrimp farming in India is the frequent brown-outs. Most farmers use generators, albeit at higher costs for energy. The estimate is some 28% increase in costs as farms migrate to more intensive culture systems. To avoid the possibility of any mass mortality during the early stage of culture, aeration is increased, stocking density and feeding are reduced. According to Raju, "Andhra Pradesh farmers use higher stocking densities ranging from 30-60 PL/m^2. Production sizes varies. Most farms produced shrimp sizes 35-45/kg followed by size 50-70/kg. The smallest volumes are size 25-30/kg. In eastern Orissa, farmers usually stock at 22-30 PL/m^2 or even lower at 10-12 PL/m^2 for the monodon shrimp and usually harvest at size 20-25/kg.

The culture seasons are February to mid-June and then July to October. Hatcheries usually stop operations in November. The worry is that farmers risk culture failures in November by using poor quality post larvae. There is still a need to bridge the gap between demand and supply of post larvae. "We still have a shortage of post larvae and as such prices are high. Post larvae prices vary from USD10-14.5/1000 PL. Farmers are also asking for bigger post larvae," said Ravi Yellanki.

"In terms of sustainability, it will be good if we can maintain a stocking density of vannamei at 50-60 PL/m^2 and of monodon shrimp at 20-30 PL/m^2. We should only have two crops a year, leaving some time for pond preparation," said Raju

Malaysia

In 2013, a further 40% drop in production in 2013 to less than 40,000 tonnes was expected by industry. The general pattern with EMS in Malaysia is that older farms have been more susceptible, such as those in Sitiawan in central Peninsular Malaysia. However, production estimates in 2013 indicated that in Sabah, farms fared better than those in Sarawak and Peninsular Malaysia. Sabah contributed to nearly 25% of the total production. The loss in production is also compensated by several new farms which in 2013 contributed almost 20,000 tonnes.

Producers are adopting various methods to recover from EMS (see p 56). These include reducing stocking density, polyculture with tilapia or seabass, nursery culture of post larvae, a higher level of biosecurity and improvements in culture management. One nursery method is sectioning a part of the grow-out pond. There has been more interest in biofloc but in smaller farms, there are practical hurdles.

Malaysia provides a large domestic market at 23,000 tonnes and the export market to Singapore for live and chilled shrimp absorbs 18,000 tonnes. A short supply was already evident in 2011, before farms were affected by EMS, resulting in prices higher than in neighbouring countries. In 2011, as the fall crimped supply of live and chilled shrimp, the jump in prices was rapid. In January 2013, the prices for size 70/kg shrimp was MYR 18/kg and by April 2013, this rose to MYR 21/kg. In December, prices shot up almost 30% to MYR 27-28/kg. Prices were lower at MYR 21/kg in Sabah where there was a small local market.

Philippines

There has been a rapid change in vannamei shrimp farming in the Philippines (see p37). Production is expected to be 18,000 tonnes in 2013 and in 2014, industry expects this to double. The leading hatchery company run by the Alegre family, expanded to five hatcheries in Bohol, Cebu, General Santos, Negros and Luzon and have planned for two more in 2014 to meet demand. Some leading producers are expanding farming areas. Vannamei shrimp culture has reached the once dominant monodon farming regions, Negros and General Santos, with almost 80-90% of farms shifting to the former. In Negros, some farms culture both species at a ratio such as 80:20 (monodon:vannamei). The other change is the size of shrimp harvested which has increased to 20-25 g, where it is usually sold to local markets or frozen for export. However, with the recent typhoon, the size dropped back to 10 g.

"WSSV is the main threat and destroyed crops in General Santos and Batangas. After the recent typhoon, WSSV was reported four days later in DOC 30 shrimp in Negros," said Roselyn Usero, Negros Prawn Producers Cooperative Analytical and Diagnostic Laboratory. At his farm, Stan Tanchan maintains a stocking at 80-90 PL/m^2 and harvests 25 g shrimp after 100 days. In Cebu Island, Professor Valeriano Corre, University of Philippines Visayas is introducing biofloc culture as well as the use of immunostimulants as part of the R&D under the Department of Science and Technology (DOST). The culture season is from late April to October/November but may be extended to year round with lined ponds.

Table 1 *Production of vannamei and monodon shrimp (tonnes) in 2011 to 2013*

	Production in 2011[a]		Published and estimates of production in 2012[b]		Estimates of production in 2013[c]	
Country	*P. vannamei*	*P. monodon*	*P. vannamei*	*P. monodon*	*P. vannamei*	*P. monodon*
China	1,325,549	60,691	1,453,241	64,554	910,000	60,000
Thailand	511,443	2,042	480,000	not given	250,000	na
Viet Nam	187,000	300,000	177,817	298,607	273,000	253,000
Indonesia	246,420	126,157	251,763	117,888	280,000	120,000
Malaysia	59,355	7,150	55,000	3,000	40,000	8,000
India	70,000	111,700	180,000	60,000	300,000	45,000
Philippines	4,182	47,495	5,000	48,196	18,000	48,000
Others	2,364	107,770		100,000		100,000
Total Asia	**2,457,520**	**711,804**	**2,204,420**	**692,245**	**2,071,000**	**634,000**
Ecuador	178,392		208,181		213,555	
Mexico	120,000		100,000		50,000	
Brazil	72,000		65,000		90,000	
Others	126,000		128,000		146,900	
Total Americas[d]	**496,392**		**501,181**		**500,455**	

[a] Published production figures in 2011 (Fishstat Plus, 2012). India, estimate, S. Chandrasekar (2012)

[b] Published and estimates. China; 690 747 tonnes in freshwater ponds and 762, 494 tonnes in saline water ponds, yearbook of Chinese Fisheries, 2013; Published by the Agricultural Press of China; Thailand - total production of 480,000 tonnes (Thai Shrimp Association, 2013); Bureau of Agricultural Statistics (BAS), Philippines; Ministry of Marine Affairs and Fisheries, Indonesia (2013)

[c] Estimates from shrimp and feed industry; India- Manoj Sharma, Mayank Aquaculture; Vietnam-Sheng Long Bio-Tech International, Thailand- Thai Frozen Shrimp Association

[d] Data and estimates for Americas provided by Fernando Garcia, Epicore, USA

The vannamei makes a splash in the Philippines

By Rafael D. Guerrero III

Shrimp farming in the Philippines has always been dominated by the production of the native black tiger shrimp *Penaeus monodon* in the more than 10,000 ha of brackishwater ponds throughout the country. Owing to the shrimp disease debacle of the 1990s, the country's shrimp production dropped from 76,220 tonnes in 1996 to only 34,997 tonnes in 2003.

With the spectacular success in the culture of the Pacific white shrimp *Litopenaeus vannamei* in China, Thailand and Vietnam in the 2000s, shrimp farmers in the Philippines followed suit. Although the species was introduced in the Philippines in the 1980s from South America, it was only legalised for farming in the country in 2007 by the Bureau of Fisheries and Aquatic Resources (BFAR) after a 'rigid import risk analysis'. Pathogen-free broodstock of the species were imported from Hawaii and Florida in the United States and spawned in BFAR-accredited hatcheries for the post larvae (PL) production for grow-out farmers.

Local shrimp growers find the culture of the vannamei shrimp simpler and with a lower cost of production than the native black tiger. The vannamei shrimp has higher survival, grows faster up to an average body weight of 20g and has a lower protein requirement for growth. Although smaller in size at harvest than the black tiger which is mainly grown to large sizes for the export market, the vannamei shrimp is more affordable for local markets.

The vannamei shrimp is farmed intensively in Southern Luzon, the Visayas and in Southern Mindanao, according to Daniel Cabrera of Tateh AquaFeeds. At an average stocking of 100 PL/m^2, the shrimp grow to an average body weight of 15g after 90 days of culture with good feeding and water quality management regimes. The feed conversion ratios are 1.3-1.5 and the survival rates are 70-90%. Cost of production ranges from USD3.50 to 4.20/kg and farm gate prices are USD5.80 to 6.00/kg. In local supermarkets, the frozen shrimp can sell at USD8.40/kg.

The Philippines produced 48,196 tonnes of the black tiger shrimp in 2012 with a value of USD43.2 million (FOB). In 2010, the country exported 7,662 tonnes of the shrimp with a value of USD52 million (FOB). Although no official figures are available for the production of the vannamei shrimp in the country, it is estimated to be around 5,000 tonnes by aquaculture consultant Fred Yap.

With the current prevalence of EMS in shrimp causing a heavy toll on the production of China, Thailand, Malaysia and Vietnam, we are fortunate that the Philippines is EMS-free.

"We have banned the importation of live shrimp to protect our shrimp industry," says Director Asis Perez of the BFAR. "We are reviving our shrimp industry with the strict implementation of phyto-sanitary requirements and are aiming for a production of 100,000 tonnes within the next five years."

Philippine exports for the vannamei shrimp are rising . In September 2013, 50 containers, each with 26 tonnes of the frozen shrimp, were shipped to the US, China and Korea. Another shipment of 60 containers was made in October 2013 and thereon with an estimated monthly value of USD7.5 million. The shrimp is priced at USD6-8/kg (FOB).

Vannmei shrimp farmed in the Philippines (Courtesy of Tateh AquaFeeds)

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Attractability of probiotic-coated shrimp feed

By Phuthongphan Rattayaporn, Srıanek Patipon, Roeland Wouters, Geert Rombaut and Olivier Decamp

An increased palatability of feed when coated with a specific probiotic was discovered in this trial.

The marine shrimp, having poor sight, need to recognise their environment by other senses, i.e. tactile, gustatory and olfactory. The olfactory sense is important because it will dictate whether a shrimp is attracted to an artificial feed. As a consequence, commercial feed manufacturers formulate their feed for their nutritional profile, their stability, but also for their attractability.

At the farm level, many farmers top dress the feed with probiotics in order to deliver favourable microorganisms to the gastrointestinal tract of shrimp. One of these products is Sanolife PRO-2, a mixture of selected *Bacillus* strains that is coated on shrimp feed. The strains were selected for their ability to inhibit pathogens, be metabolically active in shrimp gut and in shrimp pond, and improve the feed digestibility.

Typically, farmers would coat the probiotics on commercial feed, using either water or fish oil as binder. The question was raised whether the probiotic bacteria and the ingredients associated to their production, would have a negative impact on the feed attractability and palatability. Schneider et al. (2006) carried out an experiment on the attractability of bacterial slurries, compared to compound diet. They concluded that shrimp prefered the commercial diet to the aerobic slurry.

The aim of this short project was to evaluate the attractability of shrimp feed that had been coated with the commercial probiotic Sanolife PRO-2. In order to avoid interefrence with the binder, the probiotcs were coated using seawater.

Experimental details

The experiment took place at the Shrimp Culture Research and Development (SCRD) facilities, in Chonburi, Thailand. For this experiment, 175-L fibreglass tanks were used, with 4 replicates per treatment. *Litopenaeus vannamei* juvenile (6-8g) were stocked at 10 animals per tank, and starved for a period of 48 hours prior to the onset of the trial. Two feeds were evaluated:

- Control feed which was a commercial feed of Charoen Pokphand (CP feed NO.5-9505) mixed with 100ml seawater per kg feed, and left to dry.
- Treatment feed which was a commercial feed of Charoen Pokphand (CP feed NO.5-9505) mixed with 100ml seawater and 5g Sanolife PRO-2 (INVE Aquaculture) per kg feed, and left to dry.

Each tank contained two feeding trays: one containing the control feed, and a second one containing the treatment feed. One hour before feeding, the aeration was stopped. Immediately after the estimation of the feed preference test, the aeration was restored.

Shrimp were fed for 1 hour in the morning. Subsequently, all feeding trays were removed from the tanks and the amount of pellets remaining on each tray was counted. In the evening, small amounts of feed were given. All feed present on the trays overnight had to be consumed so that in the morning the animals would be hungry and a new palatability test could be done. The amount of pellets consumed by the animals during this 1 hour (morning) was registered daily over a period of 7 days.

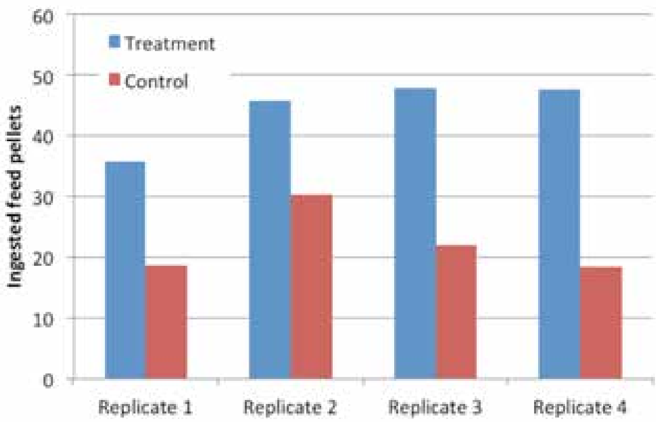
Tanks were siphoned every morning, before feeding. Dead animals were removed and replaced by other animals that had been cultured in a separate tank.

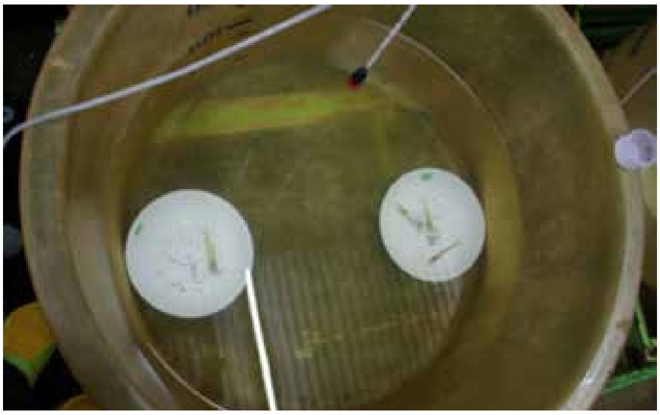
Effects on feed attractability

The number of feed pellets consumed over a period of 1 hour was recorded during 7 days and is summarised in the table below.

	Replicate 1		Replicate 2		Replicate 3		Replicate 4	
Day	Treatment	Control	Treatment	Control	Treatment	Control	Treatment	Control
1	33	7	42	9	55	11	20	16
2	36	0	25	14	37	36	23	17
3	24	10	54	35	36	29	49	15
4	30	37	39	69	47	14	47	25
5	28	21	61	20	61	4	67	13
6	40	30	40	45	62	28	48	26
7	59	25	60	21	37	32	80	17

On average the number of ingested feed pellets, after 1 hour, was 1.9x, 1.5x, 2.2x and 2.6x higher when the feed were coated with the probiotic, compared to the control feed (Figure 1).





These results confirm there is no negative effect to be expected when coating with the probiotic on commercial shrimp feed. On the contrary, the results demonstrate an increased palatability of the feed when it is coated with this specific probiotic. This faster feed intake by the shrimp might suggest a reduced amount of waste accumulating at the pond bottom originating from the uneaten feed.

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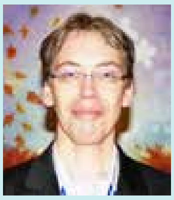

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New developments in shrimp and fish feed extrusion

By Mian N. Riaz

Extrusion is not a new technology. Since extrusion technology began in 1948, the equipment to produce aquatic feeds may look different, but the principles of processing remains the same; we cook feed at high temperatures and short time.

When a company commits to extrusion technology, it can be assured that an extruder will last for more than 20-30 years if maintained properly. The decision on which extruder is based on costs, support and commitment of the company. The latter means that the feed producer should look at not only the support that an extruder supplier can provide, but also their commitment on future developments. This is in the kind of innovations that they can provide in the short and long term and when the feed processor needs then. Essentially, this means that you do not want an extruder which can be obsolete in 5 years.

Why innovate

To achieve growth on a continuous basis the extrusion industry has developed and improved some of the processing tools for the manufacture of aquatic feeds. For any extruder manufacturer to achieve growth on a continuous basis it has to add value to existing equipment. It is also critical to develop and innovate new equipment. Innovations also target better energy efficiency to prevent wastage of energy. Therefore, most extrusion companies always look for new methods to improve the energy utilisation. In addition, equipment manufacturers seek new processes which make it easy for clients to differentiate their products from competitor products. Stiff competition and copying of technology has pushed major companies to innovate to lead.

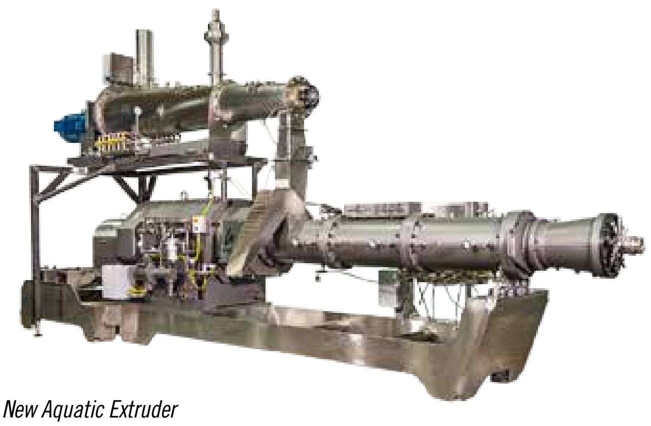
Driving new developments

In a survey conducted by the Food Processing magazine on manufacturing trends survey conducted in the US involving 249 feed processors covering the most significance issues, the number one issue was food and feed safety (Table 1). This year 59% of respondents indicated food safety was their most important concern, up slightly from 53% in 2012. Both for animal and aquatic feeds this means that food safety for animals as well as for the handlers. There is the 'green' movement which is imposing new ideas in emissions reduction and energy efficiency.

Table 1: Manufacturing priorities for 2013*

Food safety	59%
Cost control	27%
Labour	11%
Inspections/certifications	10%
Sourcing & materials	10%
Automation	9%
Water issues	7%
Environmental concerns	6%
Consolidation challenges	6%
Energy concerns	4%

*Food Processing magazine 12th annual survey. http://www.grantthornton.com.au/files/2013_gtus_labour_not_energy_the_concern_for_2013.pdf



New Aquatic Extruder

Aquatic feed development

There is a variety of methods for feed preparation for fish and shrimp. In the early days, it was hand feeding of mixed diets and trash fish, cold forming moist diets, pelleting with a pellet press and then extrusion cooking. Hand feeding of trash fish or home-blended diets simulated natural diets and were palatable. However, the availability of trash fish then became inconsistent and storage of feed was a problem. A major side effect is the likely transmission of diseases arising from pollution of the surrounding environment. Another disadvantage is that diet preparation is labour intensive.

Industry then moved into the next stage with industrialised feed processing with pelletisers. These have the advantage over hand fed natural diets. Pelleting allowed for an increase in density, better storage possibilities, reduced ingredient segregation, less feed waste and some improvements in water pollution.

However, in comparison with extrusion technology, pelleting also has its advantages such as low processing costs, high output and low complexity. Its disadvantages are the absence of control on buoyancy, production of micro aquatic feeds and that processing is not adequate for the destruction of anti nutritional factors (ANFs), and pathogenic organisms or viruses. Furthermore, each different farmed fish species have their own requirements on the buoyancy of feeds (Table 2). Extrusion technology gives us the opportunities to create feeds for this variety of species looking for different kinds of feeds; sinking, slow sinking, high fat etc.

Table 2: Buoyancy properties of feed for common aquatic species

Floating	Slow sinking	Sinking
Carp	Bluefin tuna	Cod
Catfish	flatfish	Flounder
Eel	Mahi mahi	Halibut
Koi	Salmon	River crab
Milkfish	Seabream/bass	Seabream/bass
Tilapia	Arctic charr	abalone
	tilapia	Sea urchin
	Trout	Shrimp

Sinking Aquatic			Floating Aquatic		
Shrimp	Yellow tail	Salmon	Tilapia	Eel	Catfish
	Flounder	Seabream	Flatfish	milkfish	
	Halibut	Trout	Moi		
		Turbot			

Current aquafeed manufacturing practices show that aquatic feeds seem to fit into two simple categories; floating or sinking. Today, 100% floating feeds are extruded and only 60% of sinking feeds are extruded and 40% pelleted. A feed processor can have the same extruder but it is the way, the machine is set up which will allow for the processing of wide diversity of feeds. In extrusion, there is no magic formula and basically the operator needs to learn how to set up the machine for the various processors. The same extruder can be used to make floating or sinking feeds.

Table 3 gives the guidelines to use when deciding on the density of the feeds which depend on whether it is for freshwater or seawater environments. Water temperature is also a factor in buoyance properties. If water temperatures are greater than 20°C, the product densities will be towards the bottom of the density ranges listed to make them sink and towards the lower end of the ranges listed to make them float.

Shrimp Feed Extruder

Table 3: Final product bulk density correlation with buoyancy properties

Pellet buoyancy	Seawater @20°C (3% salinity)	Freshwater @20°C
Fast sinking	>640g/L	>640g/L
Slow sinking	580-600g/L	540-600g/L
Neutral buoyancy	520-540g/L	480-520g/L
Floating	>480g/L	>440g/L

Recent innovations

The extruder is divided into four parts; the delivery system, preconditioner, the barrel as cooking device and the die. Lately, there are several different new hardware trends introduced by feed equipment manufacturers in the market for making floating, sinking, slow sinking and shrimp feeds.

The delivery system

The role of the delivery system is to give a uniform flow rate of dry raw materials to process. The recipe delivery system software can be manual where the operator controls the screw speed or loss in weight (LIW) or gravimetric. In the latter, where a control system controls screw speed. As materials have different density, the actual feed rate with LIW is determined by bulk weight. The LIW is more expensive but give accurate feeding and this is important for small feeds of less than 0.8mm when the need is to feed right and avoid fluctuations in feed composition.

Table 4: Comparison of delivery systems

Volumetric (manual)	Loss in Weight (LIW)
Operator sets feeder speed to control	Operator sets feed rate and system controls automatically
Actual feed rate affected by changes in bulk density of raw material	LIW compensates for changes in bulk in density raw material
Simple mechanical design	More complex design and control system
Low cost	Higher cost
Requires bin fill rate of 5X extrusion rate	Requires bin fill 10X extrusion rate

Preconditioner

The preconditioner plays a vital role. It hydrates and heats raw material particles and mix raw materials added in separate streams before entering the barrel. As there is little to be done for the extruder barrel design, it is in the preconditioner where there has been many changes in design. Earlier designs have many dead paths and with the focus on sanitation and food safety, the latest innovation is 100% sanitary.

Preconditioners continue to improve in design for sanitary purposes and for longer holding time. New designs in preconditioner also help in the extrusion process to develop new range of aqua feeds. Recently, we have seen several new developments in the preconditioner. The preconditioner plays a very important role in processing feed via the extrusion process, (single shaft, twin shaft, differential diameter conditioner, high intensity preconditioner and high shear preconditioner). The development in retention time controlled DDC allows the process retention time to be adjusted depending on the product characteristics. For example, this will allow the operator to make adjustments for the use of new ingredients such as single cell proteins. Some new aquafeeds with unique ingredients may require additional retention time to allow for complete hydration of raw material. New designs of preconditioners also allow for quick start-up and shut down sequences which is particularly useful for the more than 600 recipes common in aquafeed production. There is faster clean-up process. It also allows for better utilisation of raw materials and avoids cross contamination between recipes and products.

The high intensity preconditioner (HIP) is the latest innovation which has variable speeds; radial mixing, and two times more beater contacts than the original DDC. The retention time can be varied and shaft speeds can be varied from 100rpm to 600rpm. This helps to make sure that we have better sanitation and no dust.

Table 5: High intensity preconditioner: variable retention time

Process configuration setting	Small diameter		Large diameter		Retention time (minutes)
	Rotational direction	Speed (rpm)	Rotational direction	Speed (rpm)	
1	F (CC)	100	F (C)	500	1.00
2	F (CC)	250	F (C)	125	1.47
3	F (CC)	800	R (CC)	50	2.40

Next is the high shear conditioner where the shear rate is increased by compression in a smaller volume. This gives better cooking. The increased mixing results in up to gelatinisation of 85 to 90% of the starch. This also results in a much shorter penetration time of heat and moisture to the particles than conventional preconditioners. The HIP is particularly useful for shrimp feed and micro aquafeeds.

High Shear Preconditioner

Why are innovations focussed on the preconditioner? This is because with proper preconditioning, we can improve water penetration, heat transfer, degree of gelatinisation, mixing of solid and liquid ingredients and digestibility of product.

Extruder shaft and die design

We also saw the developments in the extruder shaft design (single shaft, twin shaft, two parallel tapered shafts). Old die technology for pellets smaller than 3mm diameter has its limitations. The barrel is important as it mixes, cooks and gelatinise. Here the latest innovation is the conical co-rotating system where tapered non parallel shafts give a compression ratio of greater than 5:1. There are variable speed shafts and back pressure valve (BPV) to provide cooking, restriction and friction.

This conical co-rotating system is cheaper than a twin extruder but higher than a single screw extruder. The increased screw life from 3,000 to 3,600 hours is because of better metallurgy. The initial cost if lower as well as a lower maintenance cost. Since it uses one screw, configuration changes are not required. The disadvantage is that flexibility is slightly limited.

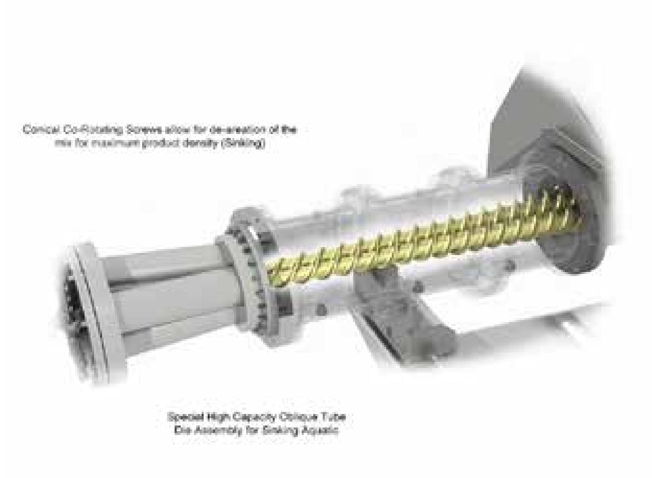
Innovation in hardware include the back pressure valve (BPV), mid barrel valve and pressure chamber. This is the restriction valve located at discharge of extruder to adjust extrusion pressure and SME inputs. In aquatic feed, BPV diverts the off-spec products for improved sanitation and quality control. It allows service of the die/knife/conveyor without stopping the extruder and gives online adjustment of SME to control product properties (cook, density, shape, water stability, oil absorption and eliminate extruder configuration changes.

The mid barrel valve gives on-line control of SME to achieve a higher SME, higher cook, bulk density even with addition of wet slurries and high fat recipes. The pressure chamber external to extruder die allows for the changing of temperature by changing pressure. A density control of ±30% will determine the floating and sinking properties. The general advantage is control on the product density.

Extrusion of aquatic feed with BPV

Back Pressure Valve (% Closed)	Wet Bulk Density (g/l)	Dry Bulk Density (g/l)	SME (kWhr/t)
50	440	438	38
60	423	420	39
70	392	393	42
80	358	348	46

In earlier designs, the final die open area was the limiting factor in production capacity of micro aquatic feeds and other products smaller than 3mm diameter. New developments in die such as like the oblique tube die and diverging cone screw has made it possible to produce smaller aquatic feed on a larger scale production. Although existing extrusion systems were able to produce a wide range of good quality aquatic feeds (both floating and sinking), small diameter pellet sizes were difficult to produce at reasonable or cost-effective throughputs. This recent developments in the basic hardware components permit smaller diameter feeds at attractive production throughputs.



Co-Rotating

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This presentation was given at the 19th DSM aquaculture conference on 22 November in Bangkok. More on the conference on pages 46-51.

Prevalence of mycotoxins in some major aquafeed ingredients; a 2012 update

By Pedro Encarnacao, Gonçalo Santos and Karin Naehrer

In the field, the presence of more than one mycotoxin is the reason for synergistic effects of contamination. Even at low mycotoxin concentration levels, there are effects on growth and health status of fish.

Over recent years several factors led to an escalation in feed ingredient prices especially fishmeal. Alternative cheaper commodities have been used, mainly plant protein sources. However as a result of this trend, aquaculture feeds have a higher risk of being contaminated with mycotoxins.

Mycotoxins are secondary metabolites produced by fungi and highly toxic to animals. The effects of mycotoxins are in general associated with reduced growth and health status of fish, shrimp and other farmed animals. The most prevalent fungi responsible for the occurrence of mycotoxins are *Aspergillus, Penicillium* and *Fusarium sp.* At the moment more than 400 different mycotoxins have been reported that can be clustered into five major classes: aflatoxins, ochratoxins, fumonisins, zearalenone and trichothecenes (CAST 2003).

Mycotoxin contamination of aquafeeds occurs especially in countries with humid tropical climates owing to many factors, among which are permissive climatic conditions to mold growth and inappropriate methods of feed processing and storage. Despite this, the international trade of commodities, make it likely that contaminated products are imported in countries where traditionally tropical mycotoxins would not occur.

Furthermore, due to the rising prices of feedstuffs feed manufacturers are looking for more economical raw materials to avoid increasing feed prices. The use of more affordable raw materials of lower quality might increase the risk of mycotoxin contamination in the feeds. For example, DDGS is an economical source of energy and protein that can be used in animal feeds, but reports show that is highly contaminated with multiple mycotoxins (Rodrigues, 2008).

Mycotoxins in aquatic species

Only recently, the effects of mycotoxins in aquatic species have been highlighted. In contrast to terrestrial animals, in aquatic species, the absence of clear clinical signs that can be attributed to mycotoxicoses kept this topic away from the headlines. At the same time, awareness of mycotoxin-related issues within the aqua industry has grown, supported by increasing scientific evidence of the negative impact of mycotoxins in aquatic species and by frequent reports on the prevalence of mycotoxins in many raw materials.

It is very difficult to guarantee the absence of mycotoxins in aquafeeds even when appropriate measures are taken, such as good screening programs, selection of high quality raw materials and feed ingredients and good storage conditions. Therefore it is urgent to find suitable ways to face the problem through an effective management of the risks posed by mycotoxins contaminations.

In general, the effects of mycotoxins are associated with reduced growth and health status of fish and other farmed animals. In terrestrial animals the toxic effects of mycotoxins are well known and can be of different nature such as carcinogenic (e.g. aflatoxin B1, ochratoxin A, fumonisin B1), estrogenic (zearalenone), neurotoxic (fumonisin B1), nephrotoxic (ochratoxin), dermatoxic (trichothecenes) or immunosuppressive (aflatoxin B1, ochratoxin A and T-2 toxin).

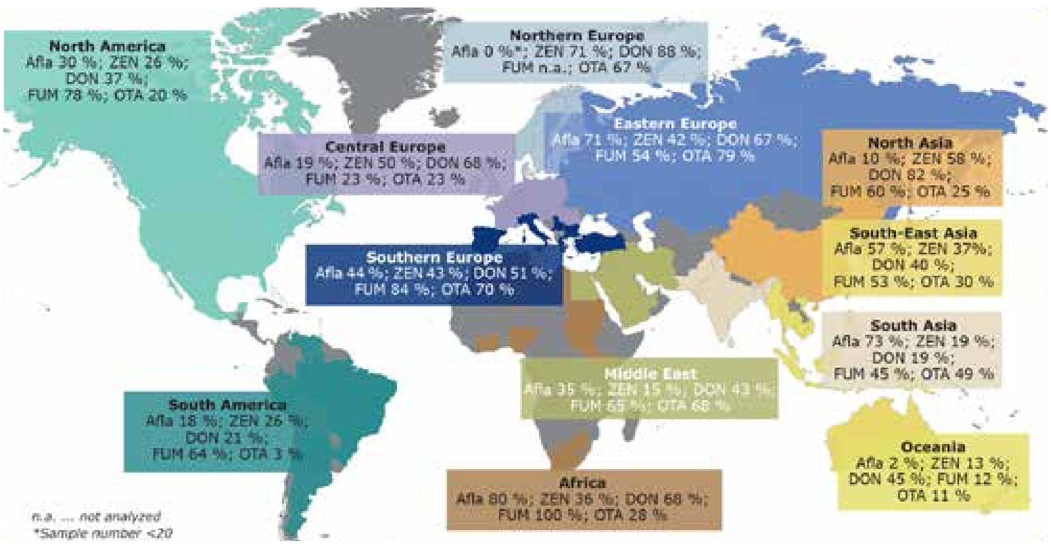
As there are serious impacts of mycotoxins in fish, it is of extreme importance that the levels of mycotoxins in feed ingredients used are known. But to which extend can we find these dangerous metabolites in feed ingredients?

Every year BIOMIN conducts a mycotoxin survey to answer this question regarding contamination of the agricultural commodities in different regions worldwide. Between the period of January and December 2012 a total of 4023 samples were analysed and 14,468 analyses were carried out for the most important mycotoxins in terms of agriculture and animal production – aflatoxins (Afla), zearalenone (ZEN), deoxynivalenol (DON), fumonisins (FUM) and ochratoxin A (OTA).

The analyses were performed at ROMER Labs Singapore Pte Ltd (Singapore) and all samples were analysed by HPLC. For the purpose of data analysis, non-detection levels were based on the quantification limits of the test method for each mycotoxin - Afla (4 ppb), ZEN (32 ppb), DON (50 ppb), FUM (100 ppb), OTA (2 ppb).

An overview of the occurrence of mycotoxins worldwide is then presented (Figure 1). It can be noted that aflatoxin is more prevalent in

Figure 1: Occurrence of mycotoxins worldwide.



tropical and temperate regions compared to cold climates. However the distribution is also related to the different commodities.

Moreover, it was possible to verify that the occurrence of more than one mycotoxin represented 50% of the tested samples and only 18% were negative for mycotoxin presence (Figure 2). This means that in field conditions the presence of more than one mycotoxin is the reason for synergistic effects and thus, even at low mycotoxin concentration levels it is possible to verify a great negative impact on the performance and health of animals.

Mycotoxins in commodities

Soybean meal, corn, corn gluten, DDGS, rapeseed, wheat flower, rice bran are important ingredients of fish/shrimp diets in aquafeeds. Therefore in the following tables, an overview of the number of analysed samples, the percentage of positive samples, the average of positive results and the maximum contamination found of the above mentioned ingredients are presented.

Looking at tables 1 through 7, it is possible to verify that corn was one of the raw materials more contaminated with DON and FUM present in 64% and 86% of positive samples and 668 ppb and 1666 ppb were the average levels, respectively. Corn gluten was highly contaminated with ZEN, DON and FUM (86%, 95% and 90% respectively). Levels were 1096 ppb for ZEN, 3049 ppb for DON and 2559 for FUM.

In DDGS, the percentage of positive samples was also very high for ZEN (76%), DON (85%) and FUM (79%). Levels in DDGS were also high ZEN, DON and FUM, 385 4241 and 1426 ppb for ZEN, DON, FUM respectively. These levels indicated that processed products are increasing the risk of mycotoxin contamination in the feeds.

In soybean meal, Afla, ZEN and OTA presented higher contaminations (18%, 19%, 26%, respectively). With regards to wheat flour, ZEN and DON were the most prevalent mycotoxins with 31% and 70% of positive samples and average levels of 38 ppb and 842 ppb, respectively. At last, rice bran was mostly contaminated with Afla, ZON and OTA testing positive at 45%, 41% and 32%, respectively.

Levels of 100 ppb of DON have been reported to cause harmful effects in trout and shrimp. Similar or even higher levels were found in several ingredients. Aflatoxin at 60ppb in most fish species such as trout, pangasius, tilapia, shrimp, catfish, and European seabass represents a risk at a low/medium level.

Table 1: Soybean meal

Soybean meal	Afla	ZEN	DON	FUM	OTA
Number of tests	71	62	65	69	61
Percentage of positive (%)	18	19	14	6	26
Average (µg/kg)	0	4	25	22	1
Maximum (µg/kg)	3.4	65.3	840	866	11.7

Table 2: Corn

Corn	Afla	ZEN	DON	FUM	OTA
Number of tests	746	734	772	712	532
Percentage of positive (%)	25	43	64	86	10
Average (µg/kg)	10	160	668	1666	1
Maximum (µg/kg)	818	6320	30200	42120	169.7

Table 3: Corn gluten

Corn gluten	Afla	ZEN	DON	FUM	OTA
Number of tests	41	42	44	41	31
Percentage of positive (%)	32	86	95	90	81
Average (µg/kg)	32	1096	3049	2559	9
Maximum (µg/kg)	1224	9854	15408	13456	103

Table 4: DDGS

DDGS	Afla	ZEN	DON	FUM	OTA
Number of tests	64	63	65	57	50
Percentage of positive (%)	31	76	85	79	46
Average (µg/kg)	5	385	4241	1426	3
Maximum (µg/kg)	105	2606	28005	11594	48.8

Table 5: Rapeseed

Rapeseed	Afla	ZEN	DON	FUM	OTA
Number of tests	10	15	15	10	10
Percentage of positive (%)	20	20	47	0	30
Average (µg/kg)	0	2	121	0	0
Maximum (µg/kg)	0	13.5	685.2	0	3.1

Table 6: Wheat flour

Wheat flour	Afla	ZEN	DON	FUM	OTA
Number of tests	172	341	434	189	186
Percentage of positive (%)	5	31	70	10	13
Average (µg/kg)	0	38	842	33	0
Maximum (µg/kg)	11.1	2991	12000	2273	30

Table 7: Rice bran

Rice bran	Afla	ZEN	DON	FUM	OTA
Number of tests	22	22	22	21	22
Percentage of positive (%)	45	41	18	24	32
Average (µg/kg)	1.5	56	128.2	181	1.3
Maximum (µg/kg)	61	165	648	220	1.7

The available studies on the effects of mycotoxins in fish and shrimp show that performance and health status are negatively affected. The analysed concentrations of mycotoxins in feed ingredients used in aquafeeds, shows the importance of management strategies for the mycotoxins problem. The awareness of mycotoxin problems in aquaculture farms must be developed to minimise the negative impact of mycotoxins on the performance and health of exposed fish. Moreover the risk for consumers needs to be addressed as mycotoxin residues were found in fish muscle beyond acceptable levels. For that, further research is needed in this topic and of course, an effective mycotoxins risk management must be taken into account.

References are available on request.

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2013 DSM Aquaculture Conference Asia Pacific

A biennial assessment on the fish meal situation and aqua nutrition updates were shared, with how to handle an industry confronted with disease outbreaks.

The year 2013 marked the 19th year of this aquaculture conference series which began in 1994. Initially the aim of the conference was to provide feed technologists and nutritionists with updates specific to nutrition and feed processing. As the years passed by, it has become evident that the feed sector cannot remain dissociated from the production side as both are stakeholders.

"Aquaculturists are used to challenges and successes. 2013 certainly provided both. The toughest challenge to deal with remains the control of infectious diseases. The early mortality syndrome/acute hepatopancreatic necrosis disease (EMS/AHPND) continues to cause dramatic disruptions in the production and global trade of shrimp. Research is coming up with answers to crucial questions on this new disease but a solution remains elusive," said Dr Jacques Gabaudan, Aquaculture Centre Asia Pacific in Bangkok.

The one-day conference was attended by 270 participants and focused on two aspects: nutrition and feeds, and production sustainability with a total of 7 presentations. Nutrition and feeds, including raw materials supply and trade trends were covered by Jean-François Mittaine; new developments in extrusion by Dr Mian Riaz; fish larval nutritional requirements and quality by Luis Conceição and indispensable amino acid requirements of fish and shrimp and the ideal protein concept by Dr Sadasivam J. Kaushik. An article based on the presentation by Riaz is published in this issue (see pages 40-43).

In production sustainability, Dr Tim Flegel discussed the latest development with EMS in shrimp aquaculture (see page 4) and Patrick Campbell showed how functional feeds are used as part of a strategy to improve production efficiency in marine fish. The final presentation by Dr Panisuan Jamnarnwej assessed the sustainability aspects in shrimp aquaculture.

Gabaudan also described some macro indicators on aquaculture which he said is encouraging for the industry.

"According to an FAO report, aquaculture production is foreseen to increase by 5.4% while only a 0.9% increase for capture fisheries in 2013 was projected. Also the recent Food Outlook report showed that consumption of aquaculture products rose by 4.4%. Volume and value increases in 2013 were driven by strong demand in emerging markets. Consumption slowed in many traditional developed country markets.

"The FAO fish price index shows an increase of 7.7% for the first 5 months of the year versus the previous year and has reached record levels. "But in general aquaculture products are priced lower than captured products. Prices on some farmed species, (salmon, shrimp) rose sharply, due to tight supply and higher feed costs. It has been good too for the tilapia but very bad for the pangasius."

From left, Bayu Sesarahardian, PT Sinta Prima Feedmill, Teddy Njoto, PT Matahari Sakti, Artiningsih, DSM NP Indonesia, Candra Yanuartin Tjan, PT Sinta Prima Feedmill, Hanna Sulaiman Harun and Suatmini Ratnawati Winarna from Japfa Comfeed, Indonesia.

Fish market at a glance (million tonnes; source: Food Outlook 2013)

	2011	2012 estimate.	2013 forecast	% Change 2013/2012
Production				
Capture	93.5	90.2	91.0	0.9
Aqua	62.7	66.5	69.9	5.4
Use				
Food	131.8	135.7	140.5	3.5
Feed	18.3	15.5	15.7	1.0
Consumption	***kg/head***			
From capture	9.9	9.8	9.9	0.5
From Aqua.	9.0	9.4	9.8	4.4

Participants from Avanti Feeds, India, from right, K.Venkata Raju and Anuj Tyagi with DSM India's Vilas Autade in the middle.

A globalised view of fish meal in aquafeeds

In the presentation on 'Key aquafeed ingredients: a global vision of supply and trade trends', **Jean-Francois Mittaine**, Fishmeal Experts Office, France and co-editor of "Fish Oil and Meal World", discussed the ingredients available for aquafeed production and how fish meal remains a significant component in animal and aquaculture feeds.

Aquaculture is a unique animal production sector. It has been growing at an annual rate of 7% in the past 10 years. Just like any other animal production, feed is a major cost in aquaculture. In discussing the role of fish meal in aquafeeds, there are three underlying factors that should be considered. These are: aquafeed is an assembly of

Dr Jirasak Tangtrongpiros, Chulalongkorn University (centre) with Dr Jowaman Khajarern (right) and Dr Sawitree Wongtangtintharn, Khon Kaen University, Thailand

nutrients which originate from a wide variety of sources; some of these ingredients are local while others are imported; and fish meal plays a special role in providing nutrients.

"Natural and recycled products are being used in larger proportions in all types of feeds. A third of fish meal produced come from trimmings etc. The feed producer has several options to get the best possible price for ingredients. Price competition is one way as we try to reduce the price of ingredients. Fish meal is always considered expensive but this is not always the case."

"The nutrients for aquafeed production come from five main groups of ingredients: grains and by-products, oil seeds, marine animal proteins which include fish meal and oil, land animal proteins such as feather meal and microbial sources such as algae and yeast. However, availability depends on the geographical location of the user and the demand and supply situation. Most ingredients originate locally and this is good as there is now concern, particularly in Europe, on carbon footprint. But most ingredients enter the volatile futures market or the less transparent physical trading. Most also come from processing activities which have limitations in capacity and supply," said Mittaine.

Fish meal and oils

Fish meal has played a historical role in feed formulation because it was the first high protein ingredient used in intensive farming of land animals. In fish and shrimp feeds, fish meal has enabled good productivity gains and improves survival rate, particularly at the early stages. In addition, there are two new considerations with fish meal: sustainability and traceability. In sustainability, we analyse how long can fish meal remains in aquafeeds. In traceability, the focus is on the origin of fish meal. But fish meal is expensive. Is this true?

"Yes, because it comes from a well organised production chain. It now has 65 to 70% crude protein and in Peru, protein content of fish meal rose as industry modernised. It has a balanced amino acid profile, 8% oil with omega3 fatty acids and phospholipids and cholesterols, no anti-nutritional factors, good palatability and micronutrients."

In the past 20 years, there has been extensive R&D to remove fish meal from feed rations and yet it is still used in salmon and other feeds. The cost of substitutes remains high as there are practical problems including price volatility of some key substitutes such as soybean meal (SBM), integration of substitutes into the operational reality of feed mixing/aquaculture chain and logistical problems.

"On the other hand, the fish meal industry in Peru and Chile has adapted to the higher requirements of the feed mixing industry. New producers in Mexico, Ecuador and Thailand have modernised and have completely changed the quality of fish meal as compared to 10 years ago. Fish meal is so easy to use!!"

Stability in fish meal supplies

In general, there is a movement towards more controlled production. In Peru, Chile and Scandinavia, the production quotas are fixed and determined by scientists. In Peru, in the new season, the government has allocated 22% of biomass for fish meal production.

"When we look at global supply and demand, we see that production and demand are moving in the same direction. This is because the fish stocks are limited. In 2014, we are looking at a recovery of various resources in South America and in Scandinavia, which will be confirmed by 2015. Probably in 2-3 years, we may have some stability in production. Some examples of changes in biomass are seen in the herring and blue whiting industry in the North Sea where the quota in 2012 was 391,000 tonnes, 643,000 tonnes in 2013 and possibly 1.5 million tonnes in 2014."

Chile and Peru are the major exporters of fish meal, although the share of Chile is declining as more fish meal is being used locally for salmon farming. But, fish meal is also produced and exported from many other countries including Mauritania, Morocco, South Africa, Vietnam and Indonesia. Thus, fish meal is heavily involved in international trade. Some 65% of production is exported and this is a big ratio in comparison to other commodities such as wheat 20% or corn at 10%.

"The major importer is China and as such the world fish meal trade is influenced by the Peru-China relationship. This is a price setting relationship. The share of China in global fish meal consumption is increasing and the share of Peru in global production is decreasing. This means that China will probably need to buy fish meal from outside Peru."

In terms of consumption, about 68% is being used for aquaculture. Asia is still the major consumer, at 59%. Mittaine said that their evaluation shows that stocks have been rather low, because production has declined. In terms of prices, there are two key markets: the Lima market (FOB Peru) and Shanghai or Chinese market. Since 2009, FOB Peru for the 'Super Prime' quality has consistently exceeded USD 1,000/tonne These markets fluctuated from USD 1,200/tonne to USD 2,200/tonne in 2013 and then declined sharply to USD 1,400/tonne in August 2013.

"We believe that fish meal prices will never go back to below USD 900/tonne and not even below USD 1,200/tonne. We are now on a solid base. In China, record prices were in 2012 but slowed in 2013 to CNY 9000/tonne (USD 1,484/tonne) which may go down further due to diseases in shrimp farming which reduce sharply shrimp feed demand in which the share of fish meal is large".

From left, Luis Conceição, Jean François Mittaine and Mian Riaz.

Competitors to fish meal

These are vegetable meals. Soybean meal (SBM) is produced in the US, Brazil, Argentina and Paraguay. Currently two third of the supply of vegetable proteins is dominated by SBM. SBM production is rising compared to other edible oil meals and emerging markets are dominating consumption. China has become a major consumer for all types of production.

"SBM prices have been volatile. Based on the Chicago price, SBM has the highest in the past 4 years. This explains why fish meal is still used in feed rations, because now it is relatively cheap. Only the balance between supply and demand will change this."

Mittaine's message was, *"The aquafeed industry is able to diversify its sources of ingredients for reasons of nutrition, safety and price, all the more when R&D enables new ingredients to enter into feed formulations. Although declining in relative importance, fish meal remains a key 'reference' ingredient. It will remain so in aquafeed production for a few more years as quality has been increasing sharply in the past decades."*

Feed millers from Thailand, from right, Dr Chen Ming Dang, CPF, Dr Supis Thongrod, Thai Union Feeds, Dr Preecha Ekatumasuit, TRF Feed Mill and Dr.Khamchai Lawonyawut, Blue Aqua, Thailand.

Figure 1: World fish meal production 1980-2013 (F). In 2013, it reached 4.45 million tonnes, higher than 2010 (El Niño year).

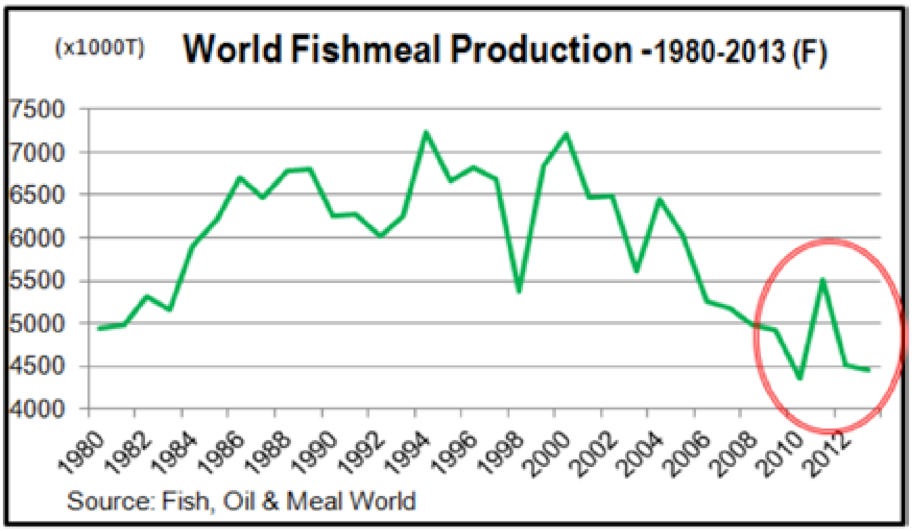
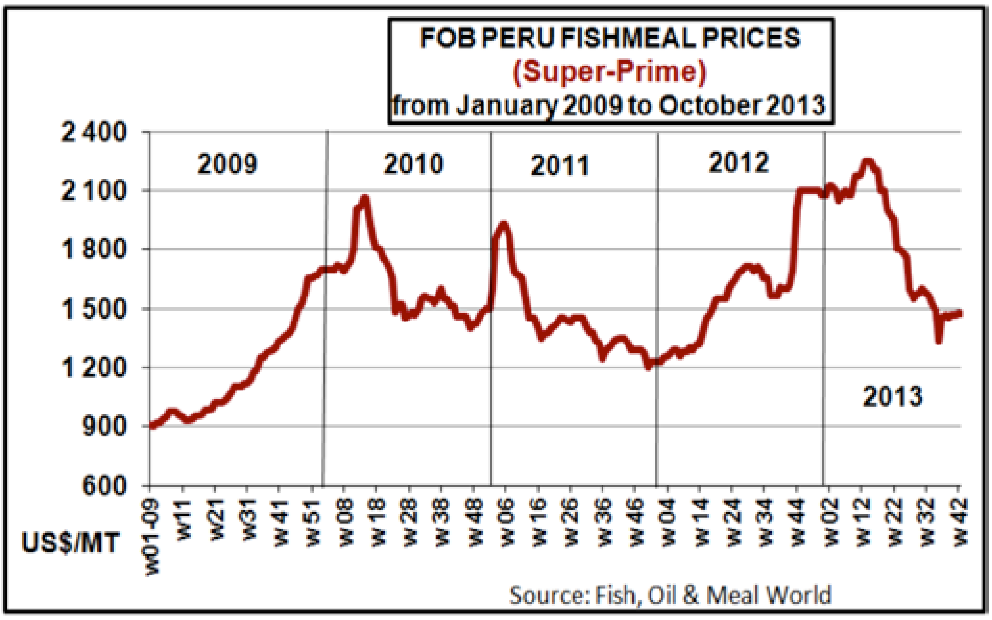


Figure 2: FOB Peru fishmeal prices (Super Prime) from January 2009 to October 2013



Advances in fish larvae nutrition

Marine fish larval rearing is still characterised by high mortalities and larval quality problems, with a high incidence of skeletal deformities. These arise partially from the fact that fish larval nutritional requirements are still very poorly understood. In his presentation on 'Quality and nutritional requirements of fish larvae', **Dr Luis Conceição**, Sparos Ida, Portugal, reviewed recent studies on how larval performance and quality may be affected by amino acids, fatty acids, vitamins and feeding regime. The presentation referred to published literature and the work under the European project LARVANET, a network of researchers and producers working with fish larvae, aiming to integrate knowledge obtained in national and European research, and practical experience, to improve quality of fish larvae used in aquaculture.

In comparison to larger fish, marine fish larvae have poorer capacity to digest and absorb nutrients. Still, they have higher growth rates from 10-20%/day to up to 50% /day, meaning higher requirements in terms of amino acids, highly unsaturated fatty acids (HUFAs) and phospholipids. In determining requirements, there are some methodological difficulties due to the small size of the animals. In addition, most species do not perform well on inert diets and the nutritional composition of live food is not easily manipulated. Assessing food intake and digestibility of diets is a major challenge and dose-response studies very difficult to perform.

Conceição said, "Small larvae relies in *Artemia* and rotifers which have unbalanced nutritional profiles and there are limits on how far we can manipulate these with enrichments. While trying to improve their HUFAs content, often leads to a high fat diet. Typical dose response studies as those available for juvenile fish are very scarce in larval fish.

"The nutritional requirements of fish larvae are for optimal growth performance,- health status and stress resistance. Establishing quality criteria should help to avoid phenotypic problems. It is also important to prepare the fish for good growth performance at the grow-out stage. However, our constraints are lack of knowledge on indicators of larval and juvenile phenotype and quality, unexplained variation in performance between batches and poor prediction of performance and lack of understanding of causes for some abnormalities."

Digestion capacity

In feeding inert diets, an important consideration is prevention of leaching of nutrients, in particular amino acids, vitamins and minerals, as fish larvae take some time to consume feed. The digestive tract is a simple tube during the early life of most species of marine fish larvae. It has been shown that prior to metamorphosis the pH is over 8 throughout the gut, while after metamorphosis a functional stomach with a pH below 4 develops in most species, which will allow for the digestion of complex proteins in older fish. As such, proteins in fish meal and traditional protein-rich ingredients, ideal for juvenile fish, are often too complex for fish larvae digestion.

Patrick Campbell (centre) with Scott Robertson, BioMar, Japan (left) and Manish Sharma, RNK Agro and Chemicals, India (right).

From left; Jacques Gabaudan, Sadasivam J. Kaushik and Panisuan Jamnarnwej

The inclusion of protein hydrolysates up to 20% is now a common practice for larval microdiets. These simpler molecules are easier to digest and also play a role as attractants (free amino acids) and stimulate enterocyte maturation. However, more that 20% inclusion led to negative effects on growth and survival in many fish species, due to leaching problems and/or the difficulties in 'handling' free amino acids and small peptides.

"Recently, it has been shown that the molecular weight of the dietary proteins has a strong effect on the larval proteome expression, affecting larvae quality and growth potential. Furthermore, diets with an imbalanced amino acid profile lead to higher protein catabolism, resulting in lower survival rates and a higher incidence of skeletal deformities," said Conceição.

Amino acids

These are the building blocks for protein synthesis and growth and are major substrates for energy production in fish. They are also involved in the synthesis of hormones, enzymes, purines and pyrimidines and enzyme cofactors. A comparison of the amino acid profiles of fish larvae and rotifers (ideal protein concept), suggest that rotifers are deficient in histidine, arginine and lysine .

Conceição described tracer studies which used ^{14}C labelled amino acids and tube feeding to determine the retention of amino acids in 32 day old sole larvae (Aragão et al. 2004: Rønnestad et al. 2001). Fish larvae seem to have a fine tuned amino acid metabolism, sparing the essential ones.

"The major fate of amino acids is for protein synthesis but several amino acids regulate key metabolic pathways and are important in defining larval quality. A balanced amino acids profile is not just for growth enhancement but is also required for high survival. In white seabream *Diplodus sargus* a balanced amino acid profile helped to reduce skeletal deformities and tyrosine supplementation improves stress resistance".

Lipids and vitamins

"We know more on the effects of lipids but still do not know precise requirements for energy membrane integrity, and eicosanoid synthesis. Dietary arachidonic acid (ARA) levels affect stress resistance and lipid metabolism in larvae, as shown from gene expression and radioactive tracer studies. But these effects are species specific," said Conceição.

Work by Betancor et al (2011) showed that phospholipids from marine sources (krill) show more pronounced effects on fish larval survival and stress resistance than phospholipids from a plant source (soybean). Vitamin requirements are also very poorly studied in fish larvae. Vitamin A requirement is species specific such as recommended levels of 1.0 X108 IU/kg for seabream *Sparus aurata* and 42,666 IU/kg for the sole *Solea senegalensis*. Diets supplemented with vitamin K did not affect growth of sole fish but reduced the number of deformities per larva and significantly affected proteome expression.

Feeding and weaning

Feeding is equally important as the diet itself, said Conceição.

"Although sole can be weaned with different feeding strategies, an Artemia replacement with 20% (but not higher) of inert diet from mouth opening promotes better growth and quality at weaning.

"Most marine fish species still rely on live feed for first feeding, and often Artemia replacement regime, i.e. a co-feeding regime with live prey and inert diet during a period prior to weaning, is still needed to sustain larval growth. Still, inert diets are better nutritionally balanced when compared to live feed that may vary according to culture/enrichment conditions," added Conceição.

The main constraints in larval microdiets are in leaching of water-soluble nutrients, digestibility of dietary protein, microdiet acceptability, and deterioration of water quality. Microencapsulation technology will help solve some of these constraints.

Larval quality

"In summary, both larval quality and performance in marine fish may be enhanced through better nutrition and feeding. Diet technology is also crucial. Dietary effects may not be apparent in the short term, but may have major consequences in terms of juvenile quality, growth potential and stress/disease resistance. These effects on larval quality and performance are more relevant when one considers the tremendous growth potential of fish larvae together with their immature digestive, immune and endocrine systems."

Participants from Charoen Pokphand Foods Public Company Ltd, Dr Donghuo Jiang (left) and Dr Sommas Soontornkit.

Amino acid requirements and ideal protein concept

In aquaculture, the amount of protein used to feed fish can be as much as three times that used to feed terrestrial animals. Protein has to supply the essential amino acids and what we know about protein nutrition can be a lot or too little. There can be protein sparing from fats and carbohydrates, said **Dr Sadasivam J. Kaushik**, INRA, France in his presentation on '*Meta-analysis of indispensable amino acid requirements and the ideal protein concept for fish and shrimp.*'

"The available knowledge on indispensable amino acid (IAA) requirements of fish and shrimp have been summarised recently (NRC, 2011) but we can see that the quantitative data on the requirements for IAA are still relatively limited. This covers less than 10 species but we are farming more than 200 species. The requirements have been determined by analysis of dose-response curves, time-consuming method with some inherent methodological problems. Here you measure growth, nitrogen gain or you can use labelled amino acids or an indirect way. Whole body amino acids profiles, single amino acid deletions and diet dilution are other ways."

"In dose response studies, we need to have at least six graded levels and sufficient replicates and the basal diet must ensure near optimal growth. In the early days of fish nutrition, we used purified diets which did not give sufficient growth and finally amounts were generally overestimated. The protein profile must reflect the whole body essential amino acid composition and there is no such thing as protein requirement but only that of individual amino acid requirements."

In terrestrial animals, the absolute unit of amino acids per body weight per day is used. In aquaculture nutrition, this is not possible as there are gaps in our knowledge on protein nutrition and as control of individual feed intake is not possible. To evaluate the protein quality of the raw material, several criteria can be used; essential amino acid index, limiting amino acid in a particular feedstuff, individual essential amino acid profile and IAA to non IAA ratios .

"There is no such thing as a limiting amino acid unless it is linked to a feedstuff. For example lysine is a limiting amino acid in corn gluten meal. This is linked to the reference protein or to the requirement of the animal. In the NRC, we do not see requirements of the pangasius, although 1.2 million tonnes is produced. This shows that there are gaps in our knowledge," said Kaushik.

A meta- analysis from the available literature, is an interesting approach to make inter-study comparisons and summarising data. He presented a forest plot of literature data for lysine for different species. This will show the robustness of the data and the variability.

Ideal protein

In aquaculture it is apparent that there is a need to produce feeds with high protein levels and this means also possible excess nitrogen wastes released into the water body. What is needed is information on the optimum or ideal protein profile. This implies that we supply the required amount of each IAA, or an ideal amino acid pattern, that would enable maximum utilisation of the dietary protein as a whole.

Lysine is used as a reference in creating the ideal amino acid profile. This is because of the ease of analysis. Absorbed lysine is used for protein synthesis and growth. Most of the other EAA have also other functions. In an example of the ideal amino acid profile of the whole body of tilapia, Kaushik showed using lysine as 100%, the relative value for leucine was found to be high in one study, compared to a number of other studies, showing the need for further investigations. In the absence of available information for a given species, we can consider that the ideal protein for that fish would be the one that reflects its own whole body IAA profile.

The importance of the use of the ideal protein or amino acid ratios is well recognised in terrestrial monogastric animal nutrition. Kaushik concluded that in aquaculture, application of the ideal protein concept gives a solid base for aquaculture to develop. This will optimise dietary protein supply for farming fish and shrimp with different protein sources and with less dependence on fish meal in aquafeeds.

Functional feeds to manage fish health

In Europe and Chile, functional feeds are increasingly being used as part of a strategy to reduce mortality and improve production efficiencies in farmed fish. What can be learnt from experiences in Europe and Chile is the focus of a presentation by **Dr Patrick Campbell**, BioMar Ltd, UK.

"Biomar's definition of functional feeds is feeds that will deliver an extra effect and benefit to the farmer above a standard feed product. It will contain nutrients or specific components that will have a specific positive effect in terms of production efficiencies. Products are divided into health and performance related products, the latter to give performance benefits during specific stages of the production cycle, for example in the case of the Atlantic salmon, functional feed helps with reduction of physiological stress during smolt transfer from freshwater to seawater. The focus of this presentation is on health products."

In Chile and Norway, salmonid production challenges are from viral (IPN-infectious pancreatic necrosis; PD-pancreas disease, ISA-infectious salmon anaemia) and bacterial diseases such as, Vibriosis, SRS- salmon rickettsia syndrome and furunculosis. Parasites are principally sea lice and AGD-amoebic gill disease. ISA (which decimated the Chilean industry in 2008 and 2009), and the bacterial disease SRS and sea lice are the main challenges in Chile. In Norway and UK, relatively newly diagnosed viral diseases HSMI, (heart and skeletal muscle inflammation) and CMS (cardio myopathy syndrome) both which affects the heart are increasing in prevalence.

"While some of these viral diseases have effective vaccines, others have vaccines that work only partially and for some viral diseases vaccine development has yet to take place. The disease situation is complicated and we need to have other effective methods to combat these health challenges," said Campbell. "In Chile, the economic impact is not just loss in biomass but also a reduced harvest weight and a prolonged production cycle. The major cause is sea lice which does not kill the fish but has to be treated at regular intervals (a costly process) but also may well lead to an increase in bacterial infections related to SRS. In Norway in 2012 a study carried out by an industry consortium showed that 10.5 million fish was lost in the mid region of Norway and when extrapolated to the whole country, resulted in a potential loss of USD1.3 billion in revenue."

Functional feed development

"The approach to functional feed development is to understand the disease, how it progresses and how we can utilise the functional feed to help control the disease in question. If we do not know the disease well, we cannot plan to control the disease."

He used the example of the PD virus which affects the pancreas as well as other organs (muscle and heart). Farms now screen via a PCR test to ascertain that fish have PD. In week 2 -3, the fish looses a functioning pancreas and the virus spreads into the muscle and heart. At 4-5 weeks the pancreas recovers. At 7-8 weeks with peak histopathology, farmers do not handle the fish at all to avoid mortality and in weeks 9 – 12 start the fish recover from the infection.

As soon as the virus has been confirmed we use functional feeds with specific immunostimulants to reduce the viral load and increase antibody response also as the pancreas recovers special diets with pre-digested / hydrolysed proteins and lipid are used. By week 9-12, when we know that the viral loads are low, we use our tissue recovery feed which contain nucleotides and antioxidants."

There is now a wide range of products designed and focused on specific diseases/production challenges. These include histidine to prevent cataract in Atlantic salmon after transfer from freshwater to seawater; arachidonic acid (ARA) as an immune modulator for reduction in mortality to IPN; Bactocell® probiotics against skeletal deformities and improved resistance in fry and mannan oligosaccharides or specific vegetable additives to reduce sea lice attachments. In the case of functional feeds against IPN, the R&D was conducted on 0.64 million smolts fed the ARA feed in Norway with very good results.

"Now in Europe, functional feeds are commonly used to improve nutrition and health. Over the last 3 years functional feeds make up an increasing % of total feed sales in BioMar. Evidence shows that decisions to use functional feed are directly related to the frequency of disease problems but also fish prices to have an impact as farmers are more willing to use if fish prices are good.

Campbell's message was, *"It is important that functional feed development is carried out using a scientific approach and we need to remember that we do not actually eliminate the disease but is just helping overcome production problems. The future of health/nutritional management will be through the use of new technologies such as gene expression and proteomics which will enable us to measure and understand the effect of nutrition on health. This is vital in reducing the impact of diseases and in moving towards the development of better more scientifically based functional feeds."*

The sustainability challenge of farmed shrimp

Shrimp aquaculture has been very successful in bringing down prices and thus increasing the volume of shrimp consumed worldwide, said **Dr Panisuan Jamnarnwej**, Pak food Public Co Ltd, Thailand in his presentation on 'Shrimp aquaculture : the sustainability challenge," on behalf of the Thai Frozen Foods Association (TFFA).

"Aquaculture is, by its nature, less costly than wild fisheries. Cost is not the only reason, though. Reliability of supply is what convinces many supermarket and restaurant chains to switch from wild-catch to farmed shrimp."

Since 1998, there has been steady growth in the export of chilled and frozen products from Thailand, averaging more than 500,000 tonnes for most years. For more than 30 years, Thailand has been a world leader in shrimp aquaculture. Shrimp is a major product for TFFA members.

"There has always been a question of sustainability of shrimp aquaculture. First it was deforestation of mangroves but this was alleviated by the movement into inland areas. Then came the depletion of black tiger shrimp broodstock that led to Thailand's adoption of *Litopenaeus vannamei*. Since 2004, with its well-developed broodstock domestication and selective breeding, the vannamei shrimp proved to be even more cost-efficient than the black tiger, resulting in rapid increase in production volumes and led to shrimp accounting for 42.63% of total seafood exports in 2012. In our annual reviews we saw 5-8% annual growth. However, 2010 was the last year of growth. In January to June 2013 period, production showed a decline of 40% in volume but only 30% in value," said Panisuan.

Marketing trends

Thailand has been the leading shrimp exporter to the US with 28.27% market share of total US shrimp imports. In the EU, it has a minor share at 8.24%. In 2013, its market share in the US did not reach 20% and imports were led by India, Indonesia and Ecuador.

"Looking at the world map for shrimp production, in 2000 Thailand produced 260,000 tonnes from 500,000 rai (80,000ha) and production peaked to 640,000 tonnes in 2010. Even with the drop to 480,000 tonnes in 2012, Thailand contributed 24% to world production. Thailand has been farming shrimp for the past 35 years but could only maintain production by changing species."

Outlook for 2013 and beyond

With the EMS, up to October 2013, production was 139,309 tonnes and the projected production for 2013 will reach 250,000-280,000 tonnes of raw materials. This means an estimate of total exports ranging from 175,000 to 182,000 tonnes. Today harvested shrimp size 100-120/kg are common as producers are not confident of successful harvests to size 70/kg over two months.

"Size 100-120/kg shrimp are sold to processing plants at THB215/kg. Imagine that when vannamei shrimp started in 2004, the industry reference price was THB100/kg for size 50/kg and THB50/kg for size 100/kg," said Panisuan.

The sustainability of its shrimp industry depends on raw materials, the graduation of the Generalised System of Preferences (GSP) tariff and the recent accusation on labour exploitation in the processed shrimp industry. By 2015, GSP could be removed. Panisuan said that at a recent seminar in Europe, the indications are that although buyers value the quality of Thai shrimp, it does not merit the 10% added cost when the new GSP duties are imposed.

"Large producers have indicated that an annual production of 400,000 tonnes would not be a problem to keep prices up. Thailand has 60-80 processors and 30,000 farmers and a good infrastructure. With the impending AEC in 2015, a free flow of raw materials will help the industry. This may also prevent processors moving to locations with lowers costs."

Finally Panisuan said, "That the selling point for Thai shrimp is that they have the volumes, but maybe not as much as before. It is a reliable supplier and deliver as promised."

Selling into China

The annual China Fisheries & Seafood Expo and Aquaculture China is the second largest event for the global seafood trade. The organisers have announced this 18th show as the largest to date, with a record breaking attendance of 30% more visitors during the three days. It was held in Dalian from November 5-7, 2013. Two major forums were also held: the Sustainable Seafood Forum in China and 10th Tilapia Industry Development Forum.

More than 1,000 companies from 39 countries participated in the exhibition which filled five halls at the Dalian World Expo Centre. Peter Redmayne, president of Seafare Expositions, organiser of the show said that this was a 10% increase from last year's show, also in Dalian. This year's show registered a record 22,000 visitors from more than 80 countries and a 30% increase over that in 2012. There were 20 national groups, and overseas companies accounted for 40% of the total exhibiting companies.

Redmayne said, "China's reported seafood imports are expected to be well over USD 8 billion this year, although the actual figure is probably significantly higher due to under reporting. China's consumption of seafood is projected to increase by 10 kg per capita which requires an additional 13 million tonnes of seafood. China's rising demand for premium and imported seafood seemingly has no bounds. In 2013, Chinese seafood buyers have the advantage of a stronger remimbi."

Marketing into China

Similar to previous years, the major seafood suppliers from Canada, US, Norway, Scotland and Ireland dominated the show with large booths and displays of products. This year, Chilean salmon producers grouped to compete with the Norwegians for the salmon market. Four large Chilean salmon farmers joined forces to vie for the Chinese market under a unified brand.

Canada sent a delegation of 26 companies and industry associations, including two Atlantic Canadian chefs to showcase the flavours of Atlantic Canadian lobster, crab, mussels, and shrimp to Chinese buyers and delegates. In 2012, Atlantic Canada exported USD 2.9 billion worth of seafood to world markets, and sales to Asia make up 23%. Market development efforts have met with success. Since 2011, sales to China have increased by 30% and sales to Asia, by 16%, according to the Canadian Ministry of Foreign Affairs.

Taiwanese companies have grouped themselves under the umbrella of Taiwan Aquaculture and offered various products. The Fish Breeding Association Taiwan (FBA) promoted the capabilities of Taiwan's marine fish hatcheries, well-known in the region for their production of new breeds of fry and fingerlings. Long Diann Marine Biotechnology Co Ltd which supplies fry and fingerlings of selected groupers; tiger *Epinephelus fuscoguttatus*, giant *Epinephelus lanceolatus*, potato *Epinephelus tukula*, leopard or coral grouper *Plectropomus leopardus*, blue and yellow *Epinephelus cyanopodus* and kelp grouper *Epinephelus bruneus*. Merit Ocean Biotech produces specific pathogen resistant grouper fingerlings and Taiwan Hung Huo Industrial produces feeds for shrimp and marine fish.

Also exhibiting under the Taiwan umbrella is the restaurant group Epinephelus Seafood Restuarant which was marketing the *Epinephelus* grouper. Taiwan is one of the largest suppliers of groupers to China, usually as live fish. The timing may not seem appropriate as in mid-2013, the Chinese authorities issued an edict to get the government to embrace austerity. This means cutting back on luxurious meals and consumption of live fish. Apparently prices of fish tumbled by half in November.

Rush for shrimp continues

The record high prices for shrimp did not diminish demand. Reports from the show indicated that China's production of shrimp is still decreasing while demand is increasing. Although some industry members indicated that production is moving up slowly to the levels before early mortality syndrome decimated production of 1.2 million tonnes in 2010.

During the welcome address at the Tilapia Forum, CAPPMA's Dr Cui He announced that China is a net importer of shrimp. Almost half of China's shrimp production goes to the domestic market but with increasing demand and poor production, the balance is sought from imports. He expects the same trend for the tilapia industry. The upmarket status of shrimp and its promotion in the local markets is set to capture a bigger share of the domestic market. Major producers such as Zhanjiang Guolian Aquatic, has rolled out packaged shrimp as festival gifts for the domestic markets.

First timers to the show include Indonesian and Venezuelan exporters entering the Chinese shrimp market. India and Indonesia are expected to make up some of the production shortfall from Asia. Weaker Indian and Indonesian currencies encouraged processors to look at export markets. IFTRA India Pvt was part of the group under the Marine Products Export Development Authority (MPEDA) of India.

Next in Qingdao

After two years in Dalian, China Fisheries & Seafood Expo returns to Qingdao next year. The 19th Annual China Fisheries & Seafood Expo 2014 will be held from November 5-7, 2014. "Finding space to accommodate more exhibitors will be a bigger challenge than ever,"

says Jennie Fu, marketing manager for China Fisheries & Seafood Expo. "The Qingdao Convention Centre has built a new hall for next year's show, but the exhibition space available will still be about the same as this year in Dalian."

XinXin Du and Paul Penaherrera M, Ecuador Trade and Investment Commission in China.

Expanding the supply of extruded shrimp feeds into China's market

Taiwan Hung Kuo Industrial Co Ltd is a well-known aqua feed producer and supplier of larval feeds for the marine fish hatcheries in Taiwan, Southeast Asia (SEA), Korea, Japan, Europe and China's Shandong Province. It is also a leading supplier of grow out shrimp feeds for the monodon feed market in Australia. "Today, it focuses on expanding sales and becoming a major player in China's developing intensive shrimp farming business with its Lucky Star extruded feeds," said Ken Hung, director and export manager. Hung, whose father set up the company in 1984, and his team were at the China Seafood and Fisheries and China Aquaculture Exposition 2013 in Dalian to promote the company's feed products.

In 1992, the company established a feed mill in Xiamen, its first feed mill outside Taiwan. The range of feeds produced by Hung Kuo includes fish and shrimp larval diets, brood stock feeds and nursery feeds with sales in 15 countries. Shrimp larval feeds are mainly marketed in the Middle East, Vietnam and SEA. It is noted as the first company to produce shrimp feeds using extrusion technology which according to Hung yields a good feed conversion ratio resulting in less wastage of feeds in ponds.

"In China, our focus is on grow out using extruded feeds for both shrimp and fish, as well as for the bullfrog. These will be primarily for the high density farms where 3-4 m deep lined ponds are stocked at 300 postlarvae/m^2. This culture system for vannamei is becoming very popular in China and is seen as a way to overcome the lower national production due to the early mortality syndrome affecting most farms in China. Today, our markets are from Jiangsu to Guangdong provinces excluding Hainan."

At the research base located 1.5 hours away from Xiamen, Lucky Star feeds are tested for their advantages over pelleted feeds. Hung said, "In comparison with steam pressed pellets, the water stability is better. It is about 2-3 hours with pelleted feeds and more than 20 hours with our feeds. The leaching of nutrients is also higher with pelleted feeds. In the first 1-2 months, the benefits may not be evident, but at a later stage, with continuous feeding, the bacterial load is much lower with extruded feeds as compared to feeding with pelleted feeds.

Ken Hung (middle left), Tie Teck Lok (middle right), Guo Hung (right) and Zhang (left), Fuxing (Xiamen) Organism Feed Co. Ltd.

"Depending on management, the FCR of extruded feed can be 10 to 20% better as compared with pelleted feeds which is around 1.2 to 1.5 for a harvest of size 100/kg. In addition, extruded feeds do not have the usual problems associated with pelleted feeds such as high levels of dust and broken pellets. Our crumble feeds are free of dust. We have noticed the higher stability of feeds in the feed tray which allows the farmer to easily detect the pellets," said Tie Teck Lok, general manager who oversees marketing in China.

"Price is our main hurdle as extrusion technology is a more costly process and 1.6 mm extruded feeds cost more by CNY 500 – CNY 800/tonne. We conduct trials to convince farmers to make the change and we demonstrated to them the benefits of extruded feeds such as the improvement in FCR by 0.2 - 0.4 points."

Hung added, "The fact is that the extruder cooks the raw materials in the feed. The preconditioner cooks the starch well and thus we do not need to use an artificial binder. We do not use land animal proteins in our feeds, which is a requirement for feed imports into Australia. We still use fish meal and have been conservative in replacing fish meal with plant proteins. Although the levels of fish meal have been reduced, it is still higher than in competitors' feeds."

Crayfish from Jiangsu

Liu Jun Fen, Yan Cheng Hai Teng Aquatic Products.

Yan Cheng Hai Teng Aquatic Products and Food Company Limited is a leading province class enterprise from Jiangsu. It specialises in the import/export of seafood products in the domestic and international markets. There are over 50 different kinds of items sold to Europe, USA, Canada, Korea, Hong Kong as well as in the domestic market in China.

At the show, the main product was frozen cooked crayfish, exported to Luxembourg and the block frozen cooked crayfish, popular in the US. Frozen crayfish up to 40 g cost about CNY 90/kg (USD 15/kg). In contrast to shrimp prices which are increasing on a daily basis, the same trend is not seen for the crayfish, according to Liu Jun Fen. The price of frozen fresh vannamei shrimp was about CNY 30-35/kg (USD 5-5.7/kg) in November.

"As we have been active in this show since the 16th expo, we found that trade visitors are increasing. This year, I am seeing more Chinese customers.Obviously, Chinese visitors are increasing and nowadays, they pay more attention on the trends in the aquaculture market. Their understanding of products is also changing for the better."

Wild crayfish stocks are fast depleting but farming is still in its infant stages as culture techniques have not yet been perfected. Nevertheless, the company believes that the future of the aquaculture industry greatly relies on excellent networking, good cooperation, seamless communication and the hard work of the entrepreneurs and scientists around the globe (contributed by XinxinDu).

Positioning quality seafood from Thailand

Thailand may have less shrimp to market at the Dalian show but it still needs to promote Thai seafood, just as it has done at earlier seafood shows in Brussels and Tokyo. The Department of Fisheries (DOF) Thailand hosted the team of seafood producers. The producers and other stakeholders of the industry were there to meet clients and connect with new ones.

"This may be the first time for us but the Thai Frozen Food Association has been coming to this show for a long time. It is unfortunate that the supply of shrimp has been down this year because of early mortality syndrome but we have to be ready when the production recovers," said Juadee Pongmaneerat, senior expert in Fishing Product Inspection at DOF.

"One of the steps taken by the DOF is to recommend optimal production targets on a per rai basis. DOF thinks that the production target of the farmers is set too high and have asked them to reduce stocking density. DOF has centres where we ask farmers to send their post larvae for quality checks and if the tests fail, farmers will discuss the next step with the hatchery operator."

Juadee explained that these are some steps that the DOF is taking to instil confidence back into the industry after the drastic damage from EMS which brought down production by an estimated 250,000-300,000 tonnes up to October 2013.

During the show, Songkhla based Lee Heng Seafood Co., Ltd was marketing monodon shrimp produced in the south of Thailand. The company has now reverted to this shrimp after attempting vannamei shrimp culture. Monodon shrimp is farmed using post larvae from wild broodstock and now this species enjoys high prices too.

Juadee Pongmaneerat, senior expert in Fishing Product Inspection (left) and Watchana Trangjaijing, marketing manager, Lee Heng Seafood.

Indian shrimp gains momentum in China

According to Anil Kumar of IFTRA Foods India Pvt Ltd, their presence at this year's China Fisheries & Seafood Expo 2013 is to gain market share in the fast growing seafood business in China. "This year the response has been absolutely amazing. Our role here is to seek more direct buyers as we plan to increase production. We want to find new markets for India's production of vannamei shrimp, from head-on, headless, peeled deveined (PD) and peeled deveined tail on (PDTO) as well as other seafood such as the octopus. In 2013 to date, imports of Indian shrimp reached 100,000 tonnes.

The vannamei shrimp supplies will come from its 100 ha farm as well as contract farms in Andhra Pradesh in the east coast of India. It has two processing plants; in Kochi and Chennai. The farm production is 400 tonnes/year. While productions in China, Thailand, Vietnam and Malaysia have been low, India has been increasing its farmed shrimp supplies. Anil Kumar expects that with an increase that with an increase of 15% of farming area, the production should be more by 20% in 2014. The recent floods did not affect production drastically.

IFTRA is a global food supply chain company with activities in processing, export trade and seafood distribution. It was established in 2006 and the business was built up initially through marketing ventures in Africa. Today, it is present in 11 countries and offers

At their booth, Aditi (left) and Anil Kumar

solutions from farm gate to retail. IFTRA says that it differentiates itself from competitors with value added services such as traceability, reliability, consistency and customisation. In May 2012, IFTRA India started to focus on vannamei farming and shrimp processing. Since then the business has been growing and expanding with markets in China, Vietnam, Korea, Thailand, Malaysia, Belize, Europe and Africa.

"Shrimp prices have been very good for the farmers. It has increased to INR 540/kg (USD 9/kg) for size 40/kg. The high price encourages farmers to venture into farming vannamei shrimp. With a strong technical team, we foresee that the prospects will be good in the near future for IFTRA and for Indian shrimp," said Anil Kumar.

SPR grouper fingerlings

China has the largest production of groupers and other marine fish. As production moves towards industrialisation and controlled systems such as recirculation systems, secure production and high yields are critical for the long term economic sustainability of grouper production. Ensuring high survival rates are crucial in the marine fish farming business. This is where Taiwan's Merit Ocean Biotech Inc, is ready to play an important role. At their booth, Alex Lin, chief technical officer, explained the products offered by the company.

"We supply specific pathogen resistant (SPR) fingerlings of the giant grouper *E. lanceolatus*, and orange spotted grouper *E. coioides*. The latter is well known as the green grouper. We also have fingerlings of the hybrid tiger grouper (giant grouper x tiger grouper *E. fuscoguttatus* and coral trout *Plectropomus leopardus*. However, our production is based on demand. What we do is vaccinate 6 to 8 cm fingerlings to increase the disease resistance ability against various pathogens for grow-out stage in the field," said Lin.

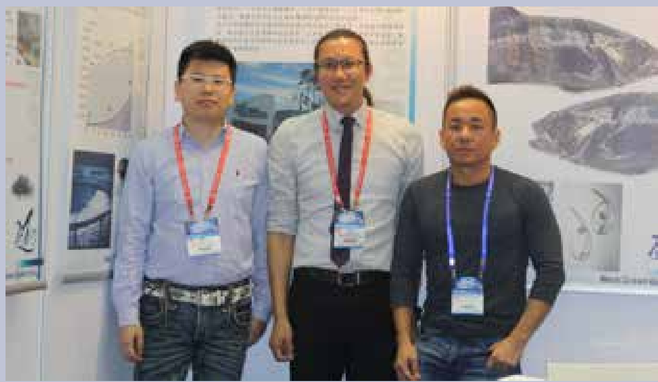
At present the company supplies Taiwan's grow-out farmers with SPR fingerlings and 10-20% of the marine farms in China. It is important that farmers understand clearly the concept of using SPR fingerlings. Lin said that the team checks on the facility and collects the pathogens widely found in the environment of the farm. They then set up standard protocols for future disease challenges.

"Currently we have vaccinations for nervous necrosis virus (NNV), Iridovirus, and various kinds of bacteria, including Vibrio and *Streptococcus* spp. For each vaccinated batch, our quality control team checks on the immunity by monitoring the fingerlings for 2 weeks post injection. Fingerlings are sold at 8 cm size."

"In addition, our grouper fingerlings are easy to use, have high disease resistance and high survival rates of more than 80%. More importantly, we want to move the industry away from the indiscrete use of antibiotics to overcome health problems."

In the process of developing vaccines for fingerlings, Merit Ocean Biotech also saw a need for developing an indoor virus free hatchery system. It has the technology for an innovative indoor recirculation system with strict biosecurity protocols to produce virus free SPR fingerlings. This NNV-free facility and digitised standard operation procedures are the trademarks of the company. Fish do not undergo further vaccination as protection is up to 1.5 years. In one cycle of farming trials in Taiwan, the company said that farmers have uniformly achieved more than 70-80% survival rates.

Lin is optimistic that with the use of vaccinated SPR seed stock, grouper production will pick up minus the threat of high mortality in the early stages. He anticipates that finally, this will translate into greater supplies in markets making the grouper into an affordable fish for the mass market.



At their booth, Alex Lin (centre) with Kobe Chien (left) and Jon Li, Tropical Aquaculture Resources, Malaysia.

From Venezuela to China

As it begins to expand production, Grupo Lamar, the 25 year-old largest shrimp farm in Venezuela is looking for new markets. At the China Seafood and Fisheries Exposition, it is taking the initial steps to have a large share of the Chinese market.

"Ecuador's Omarsa group is already well established in China's shrimp market and we would like to follow and also be a major shrimp supplier to China. We have targeted the China shrimp markets for several reasons. We only produce head-on raw shrimp and China is a huge market and does not require any certification. However, we have to contend with lower prices offered by Chinese buyers. We also prefer to trade in the Euro instead of the US dollar," said Yianni Stathakis, sales executive.

The group has a total of 600 ponds and with the setting up of a new processing plant some 10-20 minutes from the farm site, the expected production will be 1100 tonnes per year. A new hatchery is being set up which will solve the problem of limited supply of post larvae. Currently only 100 ponds are in operation.

Venezuela has the right attributes to be a major player in the Chinese market, said Stathakis. "Production is all year round in temperatures of 29-30°C. For the group, there is a daily harvest of 6 ponds of 6,000 kg of 50-60/kg or smaller shrimp. The stocking density is 25 post larvae/m^2. Our temperatures which can reach 34°C is too hot to produce large shrimp.

Taking rotifer culture to the next level

Skretting Marine Hatchery Feeds (MHF) has launched an original product for the culture and the enrichment of rotifers called ORI-ONE that could result in significant cost and operational savings for marine hatcheries. With this algae-based powder, rotifers are immediately available to hatchery staff at any stage during the culture cycle without the need for an enrichment step.

In the past 25 years, hatcheries have tended to follow a tried-and-tested but labour intensive culture system of rotifer production. This process is usually a batch culture requiring three or four days and follows a lengthy sequence of events; rotifers are harvested, then rinsed, then put into a eutrophic enrichment tank for a number of hours, after which they are harvested again, rinsed and finally fed to larval fish.

The problem with such a system is that the more the rotifers are handled, the greater the risk of damaging them. Furthermore, the fish are normally fed rotifers 3-4 times a day. This means the same number of separate rotifer harvesting and enrichment processes. Following extensive trials into whether a well formulated live food diet could avoid the use of an enrichment step, MHF officially unveiled its new product in August 2013 at the Aquaculture Europe Conference in Trondheim, Norway.

Not only does it enable hatcheries to establish far more efficient production systems, but because the rotifers are not subjected to an enrichment phase and are handled less, they are inherently cleaner and healthier. "Having enriched rotifers available at any given time to hatchery technicians is perhaps its biggest benefit," says Laurent Duprat, Skretting MHF sales manager for France.

"The product only became available to European hatcheries in September but there is already a lot of interest in France from existing customers raising seabream and turbot," says Duprat, explaining that these species, because of the size of their oral cavity, need rotifers at the first stage of growth. "While the product is very new to the market, these customers appreciate the benefits it could bring to their operations. They know that instead of the traditional enrichment method of rotifer production, this product delivers rotifers with equivalent nutritional value in one simple step."

Duprat anticipates running demonstrations with these hatcheries over the coming months.

"In the meantime, a demo is already underway at a seabass and seabream hatchery in Spain and more are expected in the near future," reveals Julio Docando Valencia, Skretting MHF sales manager for Iberia and Cyprus. "The product will bring a revolution in rotifer culture. Most hatchery staff are extremely busy, so eliminating the enrichment step will be very beneficial to them. It is going to simplify activities in the rotifer room, which means more time can be dedicated to nurturing larvae."

Docando Valencia further believes hatchery managers who are faced with high production costs, particularly for energy and oxygen, will also see the economic benefits of avoiding the second, often expensive enrichment phase. "Hatcheries can save time and money, and in using fewer products there is less waste," he says.

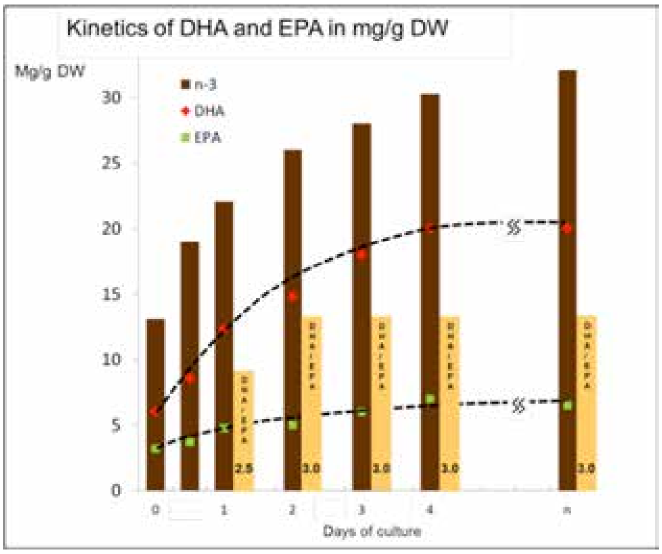
Another proven benefit is that it delivers significantly more nutritious rotifers. Following the conventional 'gut filling' enrichment process, rotifers are put into a very eutrophic environment filled with emulsions or fats, which are detrimental for rotifers. However, with this new product, hatcheries are feeding the rotifers an algae feed that they incorporate into their own biomass. The nutrients are naturally incorporated into the rotifer tissue, making their dietary value much more stable. In addition, removing the enrichment step almost entirely eliminates the emulsion discharges that can be released into the environment during post-enrichment rinsing.

Docando Valencia reveals that MHF has high expectations of the product, but confidently points to the successful pre-launch trials in which Skretting found ORI-ONE could outperform its own market leading conventional diet and enrichment process, comprising ORI-CULTURE and ORI-GREEN. In these experiments, which were conducted over several culture cycles, the enrichment seen was 100% that of the conventional procedure and the diet did not compromise the health or reproduction of the rotifers.

"We know the rotifers achieve a very stable nutritional value at the level expected by customers. In addition, due to the nature of the gradual accumulation over the culture period, with this, we now have the means to boost the rotifers with components that are difficult to incorporate during a short-term enrichment step, such as specific amino acids and minerals. This innovation, combined with the product being very easy to use, means we should have a lot of success."

ORI-ONE follows the same principles as the other ORI-GO rotifer diets and enrichments. This includes a wider particle size range, which results in a much more efficient uptake. The particles are also in a wide variety of shapes, which gives better adhesion and retention within the rotifers.

More information: Eamonn O'Brien, Products manager Skretting Marine Hatchery Feeds (eamonn.obrien@skretting.com).



Enrichment kinetics of n-3 HUFA, DHA and EPA during consecutive days and cycles.
After 1 day of culture the rotifers have already reached a DHA/EPA ratio of 2.5. After 2 days the DHA/EPA ratio stabilises at 3.

New innovations in phytogenics

These products help to improve hepatopancreas function in shrimp

Vet Superior, Thailand, a subsidiary of the VSC group, is introducing a new innovative product to reduce the rate of early mortality syndrome or EMS in shrimp. In 2007, Vet Superior received the second place for the National Innovation Award for economic contribution from the National Innovation Agency of Thailand.

In 2013, VSC Group's subsidiary, Welltech Biotechnology received the first place in the National Innovation Award for its nano-encapsulation technology 'Chitora' which is a new and innovative 'Actives Delivery system' applied in its product line for the human health, beauty, livestock, pet, aquaculture and agriculture sectors.

Vet Superior Aquaculture, has applied this award winning nano-encapsulation technology to research and develop new innovative phytogenics products under the trade name of 'Aminta-X' and 'Imnuta'. Using both products together will improve shrimp hepatopancreas function as well as increase lipid droplets. Imnuta will increase shrimp survival and growth rate while reducing the chances of EMS infection in shrimp. EMS is currently considered a disease that badly impacts shrimp culture in several countries. Aminta-X and Imnuta can solve this problem at both hatchery and grow out stages of shrimp.

Under the direction of group CEO and CIO Dr Winai Chottianchai, the VSC group is becoming one of the most innovative and highly experienced group of companies in the following processes; fermentation (microbial/ probiotic), hydrolysation(enzymes), chelation (organic minerals), extraction and purification (prebiotic/ phytogenics), phyto stem cell (phytogenics from plants) and active delivery system (nano technology/ encapsulation technology) which can be applied to a variety of products.

Dr Winai said, "VSC's new products will be able to help farmers get through this critical situation. The main benefit of natural extracts (phytogenics) is that it leaves no residues, but the drawbacks are instability and rapid deterioration. By applying our award winning nano-encapsulation technology, we are able to improve performance, stability and the delivery system to target cells and organs along with proven muco-adhesives to shrimp gut system. These products have received favorable responses from farmers and are sold domestically and internationally many countries including Vietnam and Malaysia.

Dr.Winai Chottianchai (second left) receiving the first place National Innovation Award 2013

More information:vscoltd@ksc.th.com or vsc_aquatic@hotmail.com

World Aquaculture 2014

South Australia's world-renowned aquaculture sector will be under the spotlight in 2014 as Adelaide plays host to the World Aquaculture Conference. South Australian Minister for Agriculture, Food and Fisheries Minister Gail Gago said winning the hosting rights was a coup for South Australia, with between 2,000 to 3,000 delegates expected to attend and inject up to AUD11.5 million into the state's economy.

"Hosting the conference presents a fantastic opportunity to showcase to the international industry our production techniques, regulatory frameworks, research and innovation as well as the growing connection between aquaculture and tourism," said Gago.

It is anticipated that the conference will be one of the largest ever held in South Australia. South Australian aquaculture production at the farm gate valued at over AUD241 million and the sector now making up more than 54% of the state's seafood production, the industry is a significant employer, particularly in regional areas.

"These aquaculture businesses are regional businesses, and it is testament to the ingenuity and enterprise of regional communities that they continue to grow and prosper."

Chair of the conference steering committee and President-elect of the World Aquaculture Society Dr Graham Mair said with aquaculture one of the fastest growing food producing sectors in the world, the conference and its theme of 'Create Nurture Grow' will showcase industry success stories.

"World Aquaculture Adelaide 2014 will bring together the results of research, industry know-how and the latest technological advances in one place, combined with one of the largest aquaculture trade shows in the world," he said. "It really does provide a unique opportunity for the exchange of ideas".

More information:www.aquaculture.org.au/www.was.org

Strategic marketing director for aquaculture

To support its growing aquaculture business, Cargill's animal nutrition business has appointed **Neil Wendover** as global strategic marketing director for aquaculture. Based in Singapore, Wendover, who joined Cargill in November, is responsible for helping to further refine the company's global aquaculture marketing strategy and innovation and product portfolio. Wendover will round out a team of professionals focused on aquaculture technology application, research and development and strategic marketing.

Wendover brings to Cargill more than 12 years' work experience in the aquaculture industry, including six years in global technical marketing roles with Merck Animal Health and five years managing large commercial fish production operations in Asia and Africa. He specialises in tropical finfish production and disease management.

Aquaculture represents a significant growth opportunity for Cargill's animal nutrition business, which has a unique skill set to apply to aquaculture as a result of synergies with other Cargill businesses, its global presence, and the company's world-class research capabilities.

What to look forward to in AQUA Culture Asia Pacific in 2014

Volume 10 2014					
Number	2 – **March/April**	3 – **May/June**	4 – **July/August**	5 – **September/October**	6 – **November/ December**
Issue focus *Recent developments and challenges for the next step*	Health Management	Hatchery & Breeding technology	Industrialisation	Sustainable & Responsible Aquaculture	Culture technology
Industry Review *Trends and outlook, demand & supply*	Tilapia	Marine Fish	Catfish	Marine shrimp	Freshwater Fish/Prawn
Feeds & Processing Technology *Technical contributions influencing the final value of aqua feeds*	Novel feed ingredients	Phyto ingredients Feed management	Feed enzymes Product quality	Feed probiotics Good manufacturing practices	Nutrition & Formulation
Production Technology Technical information and ideas	Genetic Improvements	Recirculation Aquaculture Systems	Hygiene & Food Safety	Certification and Regulations	Health Management
Aqua business Feature articles	Experiences from industry, including role models, benchmarking and opinion articles in shrimp/fish culture				
Markets	Market trends, product development and promotions at local and regional trade shows				
Deadlines for articles in 2014	**February 3**	**April 2**	**June 2**	**August 1**	**October 1**
Show Issue & Distribution at these events as well as local and regional meetings ****Show preview***	***FIAAP/VICTAM Asia 2014** April 8-10 Bangkok, Thailand **Global Seafood Expo 2014** May 6-8 Brussels, Belgium	***World Aquaculture 2014** June 7-11 Adelaide, Australia	**The Aquaculture RoundTable Series (TARS 2014) - Shrimp Aquaculture** August 20-21 Phuket, Thailand **Vietfish 2014** August 6-8 Ho Chi Minh City, Vietnam	**19th China Seafood & Fisheries Exposition 2014** 5-7 November, Qingdao, China	
Deadlines Advert bookings in 2014	**February 7**	**April 8**	**June 9**	**August 7**	**October 8**

2014

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

January 24 -25
Aqua India 2014
Vijayawada, Andhra Pradesh, India
Web: www.aquaprofessional.org
Email: aquaindia2014@gmail.com/ aquaprofessionals@gmail.com

February 9-11
The Fish Fair
Bremen,Germany
Web:www.fishinternational.com

February 9-12
Aquaculture America 2014
Seattle, USA
Email: worldaqua@aol.com
Web:www.was.org

March 16-18
Seafood Expo North America
Boston, USA
Email:food@divcom.com
Web:www.bostonseafood.com

April 8
Aquafeed Horizons Asia 2014
Bangkok, Thailand
Email:info@feedconferences.com
Web:www.feedconferences.com

April 8-10
FIAAP Asia 2014/Victam Asia 2014
Bangkok, Thailand
Web : www.fiaap.com/www.victam.com

May 6-8
Seafood Expo Global
Brussels, Belgium
Web: www.euroseafood.com/

May 13-15
The Asian Aquaculture Insurance and Risk Management Conference
Kowloon, Hong Kong
Web: www.aairmc.com

May 21-25
World of Seafood
Bangkok, Thailand
Web: www.worldofseafood.com

June 7- 11
World Aquaculture 2014
Adelaide, South Australia
Web:www.was.org/ www.aquaculture.org.au

June 19-21
Malaysia International Seafood Exposition
Kuala Lumpur, Malaysia
Email:mise2014@lkim.gov.my
Web:infofish.org

August 6-8
Vietfish 2014
Ho Chi Minh City, Vietnam
Email: tienloc@vasep.com.vn (Nguyen Tien Loc)
Web: www.en.vietfish.com.vn

August 20-21
TARS 2014 Shrimp Aquaculture
Phuket, Thailand
Email: conference@ tarsaquaculture.com
Web: www.tarsaquaculture.com

September 2-4
Asian Seafood Expo
Hong Kong
Web: www.asianseafoodexpo.com

October 14-17
Aquaculture Europe 2014
Donostia–San Sebastián, Spain
Web: www.easonline.org

Uni-President

CREATES THE VALUE OF PRAWN

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

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