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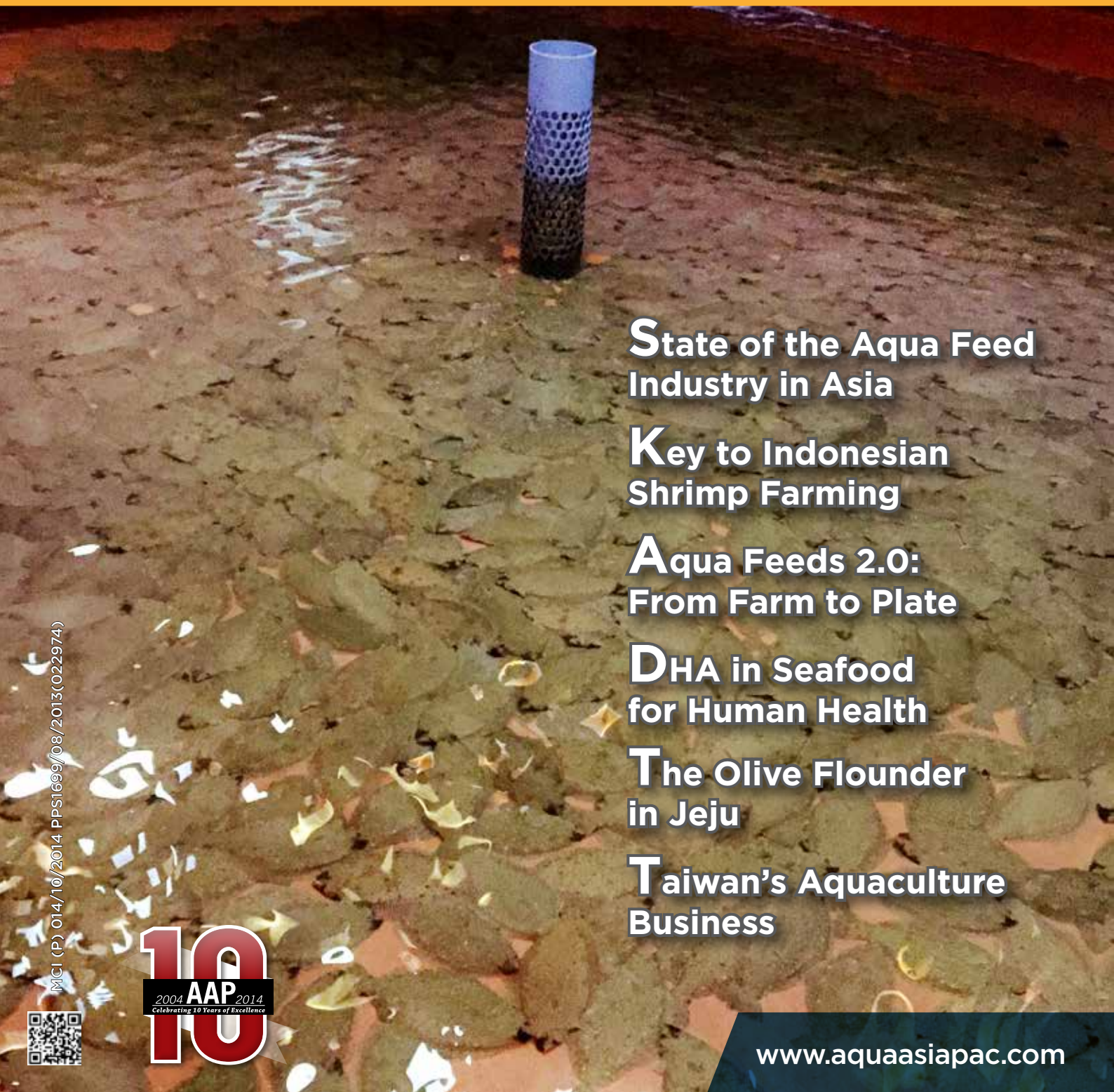

State of the Aqua Feed Industry in Asia

Key to Indonesian Shrimp Farming

Aqua Feeds 2.0: From Farm to Plate

DHA in Seafood for Human Health

The Olive Flounder in Jeju

Taiwan's Aquaculture Business

MCI (P) 014/10/2014 PPS1699/08/2013(022974)

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Contents

Volume 11, Number 5 September/October 2015 MCI (P) 014/10/2014 ISBN 1793 -056

Olive flounder farm in Jeju, Korea (p40)

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Is it 1997 all over again?

Zuridah Merican

From the recent Aquaculture Roundtable Series (TARS 2015): Aqua Feeds 2.0 – From Farm to Plate, it was evident that one of the overarching factors creating turmoil in Asia's aqua feed industry in the short term is the weakening of local currencies.

John Diener in his 'State of the Aqua Feed Industry in Asia' address highlighted the weakening currencies in Thailand, Malaysia and Indonesia as a major concern to daily operations in aqua feeds. The US Federal Reserve has signalled a pending increase in interest rates, resulting in large fund outflows from emerging market countries in Asia. This was compounded by China devaluating the yuan, prompting other countries to go lower. In a period of 3 months leading to the end of August, the Malaysian ringgit weakened 20% to MYR 4.20 per USD and the Indonesian rupiah weakened 6.5% to IDR14,000 per USD. This is reminiscent of the Asian financial crisis in 1997.

How does this affect the supply chain? In the hatchery segment, Asian hatcheries import almost all of their specific pathogen free (SPF) broodstock. The trade in live/frozen and formulated feeds for larval feeds are in USD while the post larvae and fry/fingerlings are sold in local currencies. Under status quo, margins will be squeezed and the hatcheries will have to raise prices. The alternative of using local supplies of broodstock or non-SPF pond raised stock is a dangerous route to take, recognising that the industry is already mired with disease issues.

Farms purchase seed stock and feed in local prices but they have to be ready for price increases. In Malaysia, several feed companies have already increased shrimp feed prices by 5-10%. Both seed and feed can comprise up to 60% of variable costs. The other costs should see no significant increase. In fact, energy cost should decrease with the lower price of oil, gas and coal. However, in many countries, utility is government controlled, and they are generally slow in reducing prices. Export oriented and integrated companies, especially in the shrimp sector, should see better net margins as they sell in USD which equates to more local currency today. Companies selling to the local market will see their margins crimped.

The segment which should benefit the most is processing. Processing plants generally buy their raw materials in local currencies while export sales are in USD. After suffering the last 5 years due to the lack of raw material supply and high ex-farm prices, this segment has seen consolidation with many going out of business. Some have had to resort to reprocessing imported seafood to survive and avoid retrenching workers. Today's currency woes could be an opportunity for China's tilapia and Vietnam's pangasius. The word of advice is not to squander the situation by going into a price war.

The segment hardest hit is undoubtedly the feed segment that buys the majority (if not all) of their raw materials in US dollars but sell the finished feed in local currencies. At TARS, when asked how they managed in 1997-1998, one Indonesian participant said he took a whole month off to improve his golf during that time.

Fish meal prices will add to the volatility with the impending EU decision on Thailand for IUU fishing. Due to lack of 'certified' Thai fish meal, prices have already increased locally. For shrimp feeds, it has been impossible to replace fish meal for the same performance at the same cost. One could argue it would be extremely risky to reformulate a lower cost feed sacrificing performance now.

It will be interesting to see the fate of high density, high cost feeds which are priced at USD1.80/kg (see editorial in AAP July/Aug 2015). Will we see the gap in product and market differentiation in shrimp feeds widening with low density/low cost feed below USD1/kg and high density/high cost feeds at USD2/kg?

In the global shrimp industry, Ecuador has been enjoying a boom since 2010 when prices started to increase due to lower supply from Asian producers hit by EMS. Today, the demand–supply equilibrium has changed with international shrimp prices easing and higher supplies from India and Vietnam. However, since 2000, Ecuador adopted the US dollar as legal tender. With the devalued Asian currencies, will it make the Asian shrimp producers more competitive in terms of production costs?

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State of the Aqua Feed Industry in Asia

It is not all doom and gloom and industry needs to evolve together to remain profitable.

The two-day TARS 2015 (The Aquaculture Round Table Series) was held in Hanoi, Vietnam from 19-20 August 2015. With the theme, Aqua Feeds 2.0: From Farm to Plate, TARS 2015 gathered Asia's aqua feed sector to discuss innovative approaches to optimise feeds and feeding along the supply chain from broodstock to farm.

Dr Phan Anh Tuan, Deputy Director, Directorate of Fisheries (D-Fish), Ministry of Agriculture and Rural Development (MARD), Vietnam presented the welcome address where he highlighted Vietnam's development plans in aquaculture and the role of an expanding aqua feed sector. Participation from industry in Vietnam totalled 43 and included participants from D-Fish, Research Institute of Aquaculture, RIA 1 and RIA3. **John Diener**, Managing Director, Aqua Division, Gold Coin Group, Singapore presented the state of industry address.

Dr Pham Anh Tuan (centre) with Dr Nguyen Huu Dung, Inve Aquaculture, Vietnam (right) and Dr Le Thanh Hung, Nong Lam University who presented on Vietnam's pangasius feeds and feeding. Hung says that the highly competitive pangasius feed sector, need to reduce feed costs and overcome the need for fish meal

Years of challenges

"Farming and market conditions bring challenges for the aqua feed industry. We have low prices for fish and shrimp, higher costs of major raw materials and new and old diseases continue to challenge production. On top of this, the recent devaluation of many of the Asian currencies against currencies like the USD and Euro affects those with businesses in Malaysia and Indonesia in particular."

Diener used prices of tilapia and shrimp in the US as an example of challenging trends in 2015. "There is a long term upward trend in prices and we can expect this to continue as supply will tend to be short versus steadily growing demand. However, short term we are seeing recent drops in prices. The implication for the feed industry is that many farmers respond to low prices by delaying, reducing or skipping stocking altogether. "

Fish meal price volatility

"Price of fish meal increases every year, and recently varies as much as USD 188/year. For feed companies, it is difficult to establish dynamic feed pricing to respond to cost increases because fish and shrimp farming grow-out cycles are much longer than poultry for example. Therefore, feed companies absorb a lot of this increase which hurts the margins, but this practice will continue."

According to Diener, in the future, supply of marine fish meals will continue to be constrained by declines in alternative sources such as from fish trimmings as wild catch yields continue to decline. Prices of Thai fish meal usually parallel changes in Peruvian fish meal but in 2015, lower production raised Thai fish meal prices because of the enforcement on some illegal fisheries and vessels, divorcing Thai fish meal prices from global trends.

"Can the industry find an economically and environmentally viable alternative to reduce or replace fish meal? Substitutes such as insect meal lack consumer acceptance, whereas algae and marine microbials offer promising solutions for lipid and protein substitutes for fish oil and meal. The goal should first ensure sufficient supply, followed by cost."

"There is a lot of upside in taking feed to the next level of development. Is the industry in Asia up to the task?"
– John Diener

Threats

Aside from rising ingredient costs, feed producers also face increasing manufacturing costs. In comparing costs in 2014 versus 2015, Diener quoted the example in Indonesia where minimum wages rose by 22%, electricity, 13% and fuel, 6%. These were compounded by the depreciation of the Indonesian rupiah by 10% against the USD and 23% increase in prices of local fish meal. With regard to 'environmental' pathogens, the impact of early mortality syndrome (EMS) on the shrimp feed industry has been drastic, bringing down demand in several countries. The shrimp feed estimates showed declines in shrimp feed markets in China, Thailand and Malaysia.

"Thailand has the most comprehensive and competitive shrimp industry cluster, with everything from breeding programs, disease research, hatcheries, farms and multiple stages of processing and marketing. Despite this, no recovery is evident in the Thai shrimp farming industry and the new normal is probably around 200,000 tonnes of shrimp production per year. That means at least 50% of Thai shrimp feed capacity is redundant."

Growing markets

These are in the shrimp feed market in Vietnam with the conversion of fish ponds to shrimp ponds, India with conversion of monodon farming to vannamei shrimp and Indonesia with increased stocking densities. Estimates presented also showed increases in the marine fish, tilapia and pangasius feed markets in China, Vietnam, Indonesia, Thailand and Malaysia. In Vietnam, some 30% growth is estimated for tilapia feed and 12% for seabass feed. In Thailand, 14% growth in tilapia feed is expected as some shrimp ponds are converted to farm tilapia.

Plenary sessions were followed by the breakout session where participants deliberated on innovating feeds for the future.
See pages 17-29 for a report on some plenary presentations

The industry should evolve

"The state of the industry is not all doom and gloom. Issues like disease, prices and costs are always present in any agriculture industry, and we should consider times without these challenges as unusual. Instead, we should accept these challenges as opportunities and the industry should respond accordingly. As a whole, we can take a lesson from biological systems where host and disease tend to evolve together and how both mutually survive together. The implication for this industry is that if we not evolving, we will fall behind and succumb to all these challenges. Instead, we can get ahead of these challenges through better management practice in general, more efficient feeding strategies, matching nutrition with genetic development and implementing more sustainable practices.

Diener's message, "Industry needs to work together to overcome these challenges and become robust enough to remain profitable despite inevitable adversity. There is a lot of upside in taking feed to the next level of development. Is the industry in Asia up to the task?"

Peter Coutteau managed a table discussion on the Aqua Feed Industry (AFI). On the left is Palanisamy Ravi, Waterbase, India. Among the strategies suggested by the AFI group is collaboration among stakeholders with centralised R&D on aqua nutrition by a private research centre funded by industry.

Paradigm shift in feed specifications

The aqua feed sector is dynamic and has many innovations to address industry challenges. However, in some major aquaculture countries in Asia, feed specifications are regulated. Such specifications may have delayed or limited the application of new knowledge on nutrition and functional feed additives which can improve nutrient utilisation efficiency, said **Dr Peter Coutteau**, Manager of Nutriad's Business Unit Aquaculture, during TARS 2015.

"The traditional concept of feed specifications based on absolute nutrient levels are no longer adequate to evaluate and regulate a feed industry aiming at optimal feed performance in an increasingly competitive market situation. Regulations on feed specifications are aimed at protecting farmers, and this is rightly so. Many focus on physical parameters, nutritional specifications (usually proximate composition), ingredient quality and feed/food safety issues. Feed specifications are not universally suitable for all production conditions and need to be tailored and updated in function of production requirements.

"The use of additives and their mode of action must be better understood. Natural emulsifiers are efficient in improving lipid digestion and absorption in carnivorous fish and shrimp and offer ways to compensate depressed fat utilisation in high plant formulations and reduce dietary fat levels without impacting performance. Enzymes can enhance the availability of phytate phosphate and protein in plant ingredients. More recent research shows how functional feed additives with combined anti-bacterial/quorum sensing inhibition action improved the survival of vannamei shrimp challenged by EMS. Protein sparing effects in tilapia were also demonstrated with the use of a metabolic/digestive enhancer."

Coutteau added, "However, the industry could benefit from a regulating framework setting rules for a competitive and consumer-safe animal feed market, including the authorisation and labelling of ingredients and feed additives, implementing feed hygiene and traceability, and measures to control medicated feeds and contaminants."

NCKU research team develops WSSV resistant shrimp

Lo Chu-Fang

Dean Lo Chu-Fang, College of Bioscience and Biotechnology, National Cheng Kung University (NCKU) and her team have finally cultivated black tiger shrimp *Penaeus monodon* that is resistant to the white spot syndrome virus (WSSV). This was achieved through a collaborative study with OSO Organic Shrimp Farm, a black tiger shrimp enterprise in Madagascar.

"Two WSSV resistant shrimp families have already been successfully produced. These breakthroughs have already generated a lot of interest and excitement in the shrimp farming community. Over the past two years, OSO has generously shared their shrimp farming and water quality maintenance technologies as well as their expertise in shrimp farm design," said Lo.

Lo's team and OSO have built up a good partnership since 2012, often sharing experiences and results with one another. The research team began cultivating the first generation of WSSV-resistant black tiger shrimp in NCKU in 2014, starting from shrimp post larvae. It takes an average one and half years for a black tiger shrimp to grow to the point where their reproductive organs are mature and they can be used for breeding. The shrimp were grown in a controlled room for 9 months and are now roughly 20 cm long.

"All of the shrimp are very healthy, and that not even one shrimp has become sick. A special feed is currently being used to accelerate growth, so that they can be used for breeding as soon as possible," said Lo. "Virus-resistant shrimp is just the beginning. We will continue to research and develop black tiger shrimp families that are also stress resistant and fast growing. Hopefully, we will be helping to drive a renewed and sustainable shrimp farming industry in Taiwan and other Asian countries.

(Source shrimpnews.com; More information: sonia20@mail.ncku.edu.tw)

In Brief

Breakthrough in milkfish breeding in India

The team of scientists involved in the milkfish breeding project

In July, the Central Institute of Brackishwater Aquaculture (CIBA) reported that it has achieved a major breakthrough in artificial breeding and seed production of the milkfish *Chanos chanos*, locally known as 'Paal Kendai' or 'Poo Meen'. This is a first for India. In the fish hatchery of the Experimental Research Station located at Muttukadu near Chennai, the male and female adult milkfish were reared in cement tanks for 6-8 years. Spawning was induced with hormones and fertilized eggs were reared to the fingerling stage. This was achieved by the second week in June.

Presently, milkfish farming in India is carried out using wild fingerlings which are available only three months in a year, from March-May. This breakthrough will be a boon for fish farmers, who will not only be able to get fry all year round but also lower production costs, particularly in polyculture systems with shrimp.

Milkfish can be farmed using low cost supplemental feeds, with a production cost of INR100/kg or USD 1.58/kg. Smaller size fish is a preferred live bait for tuna fishing. Milkfish is ideal fish for polyculture, including the traditional Pokkali farming practiced in Kerala. In July, the first batch of 30 day-old fish produced at CIBA were handed over to fish farmers from Kerala, Tamil Nadu and Andhra Pradesh, by Dr K.K. Vijayan, Director of CIBA.

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Experience and vision - the keys that turn art to science

By Poh Yong Thong

Some Indonesian farm technicians are changing shrimp farming to a science after years of crop losses with IMNV to unprecedented levels of success.

Even though Indonesia is free of the devastating shrimp bacterial disease called early mortality syndrome (EMS) which is rampant in several countries, let us not forget that she is still suffering from the persistent infectious myonecrosis virus or IMNV. This is an equally damaging disease. It causes flesh decomposition in the distal abdomen, slow growth and continuous mortality. The first outbreak was in 2007 in Situbondo and from there it spread to all shrimp farming areas in Indonesia. To this day, IMNV is still a threat, although manageable.

The outcome of this experience with IMNV has led to the formation of a group of innovative Indonesian farm technicians who are using their scientific knowledge to find new ways of farming shrimp. They are able to consistently produce very good shrimp harvests amidst challenging and deteriorating environmental conditions and damaging diseases. This report is an account of some of the innovations and techniques used by these technicians.

Is shrimp farming art or science?

Art is based on perceptions and may not be reproducible. Science on the other hand is exact; it follows a set of rules and is reproducible. In the past and up until recently, shrimp farming has always been referred to as an art.

Shrimp farming is a science when you can have 7 (as of August 2015) straight successful crops in 13 ponds and can account in detail the factors for the success. In all these ponds, the stocking density was more than 120 post larvae (PL)/m^2 and all ponds achieved very good survival rates, above 90%. The average yields were above 25 tonnes/ha with the highest yield at 35 tonnes/ha. The culture period was 110 days and average size of shrimp at harvest was 48/kg (average body weight at 20.8 g and feed conversion ratio (FCR) was below 1.2).

Darminto (left) with author Poh Yong Tong in August 2015.

"Shrimp farming can follow principles and the harvests can be highly predictable." – Darminto

Daminto is one several Indonesian technicians excelling in shrimp farming. He confidently states that when shrimp farming adheres to a set of principles, the harvests can be highly predictable.

Proactivity is key

Innovation is a main attribute of many Indonesian technicians and farm owners. Many of them have the courage or boldness to invest and experiment. Along the way, some may have failed but those who achieve success then cross-fertilise ideas and provide insights to other farms.

Being proactive is the key to their success. This means pre-empting problems. For most of these technicians, regular removal of pond sludge, conservative input of feed to avoid overfeeding, routine monitoring of *Vibrio* concentrations, and calculated application of probiotics to enable the full control of *Vibrio* bacteria and water quality are key steps to crop success. These measures ensure good water quality and suppress the growth of pathogenic bacteria, thus allowing excellent harvests with good FCR and survival!

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Photo from Google Earth showing Pak Kamdi's arrangement of paddlewheels.

Pond bottom hygiene and sludge removal

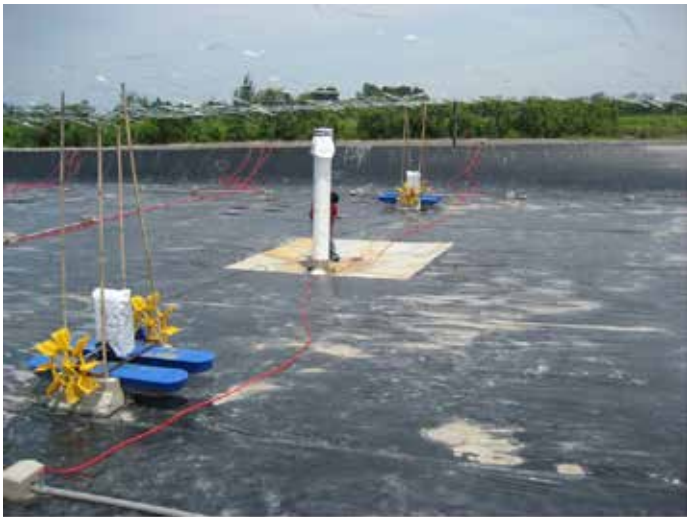
Sludge produced by dead plankton, other microorganisms, uneaten feed and shrimp faeces accumulates in anaerobic areas and produces ammonia and hydrogen sulphide, which are highly detrimental to the shrimp. The sludge tends to consume oxygen and being rich in nutrients it becomes a breeding ground for pathogenic bacteria. When shrimp feed sinks onto these areas, it will be contaminated with the pathogenic bacteria, and when eaten by the shrimp will result in shrimp diseases. Realising this, various innovations have evolved in Indonesia to routinely and conveniently rid of the harmful sludge. This was discussed in an earlier article (Poh, 2014)

"A conservative feed regime will result in slower growth in the beginning but like a marathon runner where energy is reserved for the ending,"

More than 90% of shrimp ponds in Indonesia have central discharge systems where every day the sludge was discharged 5 to 6 times. In addition, workers were deployed to siphon off sludge that has accumulated in the dead zones. This practice ensures very clean pond bottom and probably is the main reason why Indonesia is free of EMS!

Feeding regime

Technicians gave due consideration to the feeding rates recommended by feed millers and have made adjustments to suit their culture conditions. Today, many different regimes are used by different technicians in Indonesia. These are from the intensive feeding of a cumulative total of 450 kg to the less intensive of 200 kg for the first month. The amount is for 100,000 shrimp. At the later stage, at 60 days of culture, the range is from a daily



A square discharge sump in a HDPE lined pond

Probiotics activation tanks. Darminto (left) with Bambang Dwi (right)

feed amount of 70 kg/day to 35 kg/day for 100,000 shrimp. The intensive feeding regime results in very fast growth, with shrimp size of 70/kg with ABW of 14.3 g or more at the time of harvest (70 days). However, feeding at this rate may result in shrimp being more prone to diseases and may require an emergency harvest.

The more conservative or pessimistic technicians realise that at 120 PL/m^2 stocking density, the shrimp are crammed into an artificially small volume of water. The pond is the kitchen as well as the toilet for the shrimp and has to be managed holistically taking into consideration the pond ecosystem. Excess feed is one of the unsuspecting pollutants causing deterioration of water quality through spikes in ammonia and hydrogen sulphide concentrations which may lead to the proliferation of pathogenic bacteria.

These technicians also practise drastic feed reduction or even witholding feeds to the shrimp when water quality deteriorates, while increasing aeration and or adding reputable probiotics. In addition to the strict control of the feed amount, fasting has been effectively used to control water quality. It is beneficial to withhold feeds when shrimp do not feed during cold spells.

The detrimental effect of excessive feeding can very regularly be observed in IMNV infested pond during hot weather. Similarly, there is less mortality when feeding is reduced or stopped in an EMS affected pond in Malaysia and Thailand.

Theo's farm has 35 2.5m deep ponds lined with HDPE

A conservative feed regime will result in slower growth in the beginning but like a marathon runner where energy is reserved for the ending, it allows less risky shrimp farming as the water quality, pond bottom hygiene and overall pond ecology is taken care of.

Managing water quality and pond ecosystem

The adage of many shrimp farmers in Asia is "to cultivate shrimp, one must first cultivate the water". As shrimp are kept in an enclosed space with a small volume of water to maximise profit, faeces, uneaten feed and the myriads of opportunistic microbiota growing in them put tremendous strains on the pond ecosystem. Any inputs to the system can greatly affect the water quality. A shrimp farmer must always take a holistic approach in managing the pond by keeping a close watch of the pond ecosystem, in particular the water quality and pond bottom hygiene.

Two of the major parameters that greatly influence shrimp health are ammonia and hydrogen sulphide concentrations which increase with overfeeding. Ammonia is the by-product of protein degradation and will become toxic in pH higher than 8.5. Uneaten feed, shrimp faeces and dead microbiota will be degraded to hydrogen sulphide in anaerobic patches of the pond bottom. It becomes toxic at water pH lower than 6.5 and high water temperature.

In intensive shrimp ponds with little water exchange or low salinity, minerals such as magnesium (optimal 1,200 ppm), potassium (optimal 380 ppm) and calcium (optimal 400 ppm) can become deficient due to direct uptake by the shrimp from seawater. These have to be periodically monitored to ensure optimal levels.

Below are strategies adopted by the technicians to maintain good water quality

- Use a high quality feed which is highly digestible
- Use an efficient feeding protocol to reduce excessive organic loading
- Maintain the pond in a highly oxygenated state which can efficiently oxidise and decompose the organic matter
- Remove part of the excessive organic matter through proper pond design
- Practise proper water exchange to dilute the organic or toxic matter
- Maintain beneficial bacteria and some phytoplankton to assimilate and neutralise toxic substances such as nitrate and phosphate.

Monitoring Vibrio and administration of probiotics

Some shrimp farms in Indonesia are able to monitor the microbial community daily. Various phytoplankton (green and blue-green algae, diatoms and dinoflagellates) and protozoa are routinely monitored. Some farms are able to monitor total bacteria, *Vibrio alginolyticus, V. parahaemolyticus* and *V. harveyi* daily and these data form the basis of how much probiotics is to be added to each pond every day from day one until harvest.

In Darminto's farm, probiotics, both aerobic and anaerobic, are cultured in tanks and its viability assessed before they are used in the ponds. More anaerobic probiotics are used than aerobic probiotics to reduce the consumption of oxygen in the pond. He uses 3 times of anaerobic probiotics and 4 times of aerobic probiotics per week from day 1 but after 45 days, uses 5 times of anaerobic probiotics and 2 times of aerobic probiotics per week.

This is very scientific because at the later stage of farming, organic load and shrimp biomass has increased, and oxygen becomes more critical. According to Darminto, probiotics are very effective in controlling water quality. The cost of probiotics is in the region of USD 22 cents/kg of shrimp produced. The target is to keep the *Vibrio* concentration below 1% of the total bacteria and the green *Vibrio* below 100 CFU/ml.

The outlet canal for discharge of waste water in Darminto's farm is the cleanest outlet canal I have ever seen, due to the stringent control of feed inputs, probiotic usage and good water and pond bottom quality. There is very little sludge in the outlet canal and the water in the canal is clear.

Shrimp welfare

Shrimp welfare is an interesting field. Some technicians are aware of the need to look into this. For example, Kamdi, technician at Theo's Farm in Sulawesi deliberately arranges the paddlewheels in the pond so that the feeding area around the pond is not affected by strong currents. Few shrimp farmers have questioned how the shrimp are going to rest when the current in the pond is so rapid. Do shrimp need to find quieter areas in the pond for them to molt? Perhaps this is important and that is why sometimes shrimp die when they molt near the sludge in the quieter central area!

Shrimp are 'lunarphiles'

Wahyu, Technical Support for feed company Gold Coin Indonesia realises that the shrimp lifecycle is influenced by the lunar cycle, such as molting. He advocates improving the water quality of the pond 5 days before each full moon by adding sodium percarbonate to oxidise some organic matter, adding minerals and probiotics. These are to prepare for the big day – the full moon, when the majority of shrimp will molt. Molting requires immense energy and resources.

With so many shrimp technicians and farm owners being so innovative and adventurous and at the same time willing to share through forums and communications, it is not surprising that Indonesian shrimp farming is growing by leaps and bounds!

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Belgium connection for fresh shrimp

By Zuridah Merican

A year round production of 25 g to 35 g vannamei shrimp from a greenhouse farm using full biofloc.

An emerging trend in Europe is the sustainable and traceable production of tropical shrimp *Penaeus vannamei* in small closed system in indoor farms located close to markets. The small production volumes cater to a niche market for fresh and live shrimp, all year round.

In Europe, there are already several indoor shrimp farms operating using either recirculated water or biofloc systems. In 2014, Green Aqua Farming began production at the 15 tonnes/year shrimp farm using closed system technology in Grevesmühlen, Germany (Fish Farming International, 2014). In Riga, Latvia, Mere Shrimp Farms completed its pilot intensive, indoor shrimp farm of 2 tonnes/year in 2014. It will start commercial operations in 2015 using 100% water recirculation technology with bioflocs (Shrimpnews.com) and has plans for expansion to other countries. Hellenic Inland Shrimp farm in Greece targets 60 tonnes/year from the farm in Thessalonki. These two projects use CreveTope technology. In Spain, the indoor biofloc shrimp farm of Gambas Natural targets a production of at least 50 tonnes/year by the end of 2016 (AAP, 2015). Other pilot farms are in Austria, Switzerland and Sweden. The general objective of these farms is to supply fresh or live large size shrimp as required by gourmet chefs and high-end restaurants.

In Belgium, bioengineer Eric De Muylder, CreveTec bvba, has recently completed the construction of the greenhouse shrimp farm in Ternat, 10 km away from Brussels. This has a module comprising four concrete ponds, a central bioreactor and a harvesting channel. There is a separate nursery unit for post larval rearing.

"Our initial production confirmed that shrimp produced in indoor biofloc systems taste good. At this farm, I am using full biofloc with full recycling of water. I collect rainwater, add salt to get the 15 ppt salinity, which is optimal for growth of shrimp. "

Eric De Muylder is a graduate from the Catholic University of Leuven, Belgium. The farm with a sliding roof to control indoor temperature was designed using his experiences over the years in developing indoor intensive shrimp farms in Italy and China.

De Muylder designed the 1,600 m^2 greenhouse containing the nursery, grow-out and reservoir tank systems. "This is a three-phase farming system to regulate stocking density as the shrimp grows. We start with a density of 15 kg/m^3 for 5-10 g shrimp and reduce this to 5 kg/m^3 for larger shrimp (more than 20 g). Production is one tonne/month.

"There is minimal handling and maximum use of gravity flow. Post larvae for the nursery tanks are transferred via pipes to the first stage of grow-out tanks for 8 weeks followed by the second stage of grow-out for another 12 weeks. The first partial harvest is for 25 g shrimp. Harvesting is by opening the valve leading into the harvest channel. In all, the production cycle for 25-35 g shrimp is 180 days from post larvae (PL8). "

Biofloc bioreactors

Biofloc shrimp farming is an environmentally friendly way of culturing shrimp in closed systems and allows for high-density farming in small water volumes. Farms developed by CreveTec have biofloc bioreactors which are used to manage biofloc density and water quality with minimal water exchange. In this farm in Ternat, the bioreactor is key to tank water quality management. It enables a longer utilisation of culture water without addition of chemicals for pH adjustment. Nitrate levels can be controlled. This not only reduces the environmental impact, but also optimises the nutrient recycling into new protein biomass, which is used as additional nutrition for the shrimp, thus resulting in faster growth and improved feed conversion.

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A 29 g shrimp after 140 days. The farm will start to sell fresh shrimp in September.

Optimising production costs

In reality, the climate in Northern Europe is not ideal for the farming of the tropical shrimp and in addition, there are high energy and manpower costs. In developing this farm, De Muylder focused on the smart use of electricity, and minimised labour and pumping costs. Accordingly, he said that fixed and labour costs can rise up to €60,000/year in this farm whereas costs of feed, post larvae and electricity in this system is around 5€/kg. With a production of 12 tonnes/year and average selling prices of €40/kg for 30g fresh shrimp, this venture is profitable.

"The key factor in the design is to reduce manpower. I have only one staff who helps me to run the farm. With connections to the internet, we can monitor conditions wherever we are. The tank walls are insulated with foam to keep the water temperature at 26 °C. We can adjust air temperatures by opening or closing the roof. Next will be to tap solar energy and wind power."

Larval rearing

In Europe, the import of shrimp post larvae is highly regulated to avoid spread of disease. De Muylder can only import *P. vannamei* post larvae and only from Shrimp Improvement Systems (SIS) in Florida, USA.

"Because of high airfreight costs, I can only bring in PL10 or smaller. These are then grown in postlarval tanks to 1 g in 30 days. During this time, the post larvae feed on algae and artificial diets. Our starter diets are crumbles from 300-500 µ with 54% crude protein and 11% fat. Crumbles for the larger post larvae are 500-800 µ and 800-1200 µ. We include LT fish meal, krill hydrolysates, fish oil, micro and macro algae, hydrolysed proteins and cholesterol in the formulation."

This stage of shrimp culture is very familiar for De Muylder as he has been formulating and marketing a range of larval and nursery feeds since 2014. CreveTec formulates and markets a range of concentrates and feeds for shrimp larval rearing. Its markets are in Iran, Vietnam, India and Europe.

Feed processing is carried out in a nearby factory. Interestingly, the factory fulfils a social responsibility with some mentally challenged staff carrying out grinding and bag sewing functions as well as providing toll packing.

"From an environmental impact perspective, what we have here is a farm with a small footprint and for the chefs and buyers, low food miles and environmental impact. I can increase this density but I prefer to keep to a production of 12 tonnes/year. The farm will also serve as a demonstration and training centre."

Aqua Feeds 2.0: From Farm to Plate

TARS 2015 gathered stakeholders in Asia's aqua feed sector to discuss innovative approaches to optimise feeds and feeding along the supply chain from broodstock to farm

The team from PT Matahari Sakti (MS), Indonesia, was led by Dewi Prijadi, President Director (centre)

TARS 2015 looked at the aqua feed sector in its supporting role for aquaculture in Asia. There were five sessions covering the contribution of aqua feeds along the supply chain, namely, state of industry and science, broodstock and early stage feeding, targeted grow-out feeds, sustainability and health interactions, and innovation and branding to plate. Plenary sessions were followed by the breakout session where participants deliberated on innovating feeds for the future.

To start off the plenary session, **John Diener**, Aqua Division, Gold Coin Group, Singapore gave the state of industry address, a signature presentation of this conference series (see pages 4 and 5).

TARS 2015 organised by Aqua Culture Asia Pacific and Corporate Media Services, Singapore was attended by 198 participants from 26 countries. The Industry sponsors were Inve Aquaculture, BioMar, Biomin, Nutriad, Jefo, DSM, Aquativ and Alltech.

State of science

In finfish nutrition, **Dr Dominique Bureau**, Fish Nutrition Research Laboratory, University of Guelph, Canada looked at the state of science on nutrient requirements at different life stages and potential R&D partnerships between academics and aqua feed industry stakeholders to fill the gaps. Bureau said that it is fortunate that aquaculture nutrition is a dynamic field of research in comparison to that in the poultry and swine sectors. Although quality of the research is improving, it still has shortcomings.

"Companies doing or funding research are also generating lots of information. We are now interacting with industry to see what information is available and how can we use these to generate information needed by the industry. In addition, the information is not often valorised to its full potential."


Brett Glencross


Shunsuke Koshio


Le Thanh Hung


Eddy Naessens

Gap analysis

There are still gaps in our knowledge on nutrient requirements. "We are clear on 'what fish and shrimp require' which is similar for all species such as the 10 essential amino acids, fat and water soluble minerals, vitamin like compounds and minerals. But are we clear on how short chain fatty acids (which is species and life stage specific) elongate?"

Bureau added, "For juvenile fish and shrimp, we have a good handle on nutrient requirements at the juvenile stages but less is known on nutrients for which essentiality is species and stage-specific. These are taurine, types of phospholipids, cholesterol, nucleotides and other compounds. Some may not be essential but bring benefits."

"There is significant nutritional information coming from Japan which deals with species that may not be farmed in most of Asia. Information from China is increasing. Furthermore, with the large number of species and feed ingredients in Asia, there is a dilution of research efforts. In fact, there are only 9-10 species in Asia accounting for 80% of aquaculture production, but even if there are lots of data on one species, the picture is still not clear," said Bureau. "In addition, dealing with the life cycle is difficult. For example, we use 32% crude protein feeds for the tilapia weighing from 10 g to 1.5 kg!.

"We have reasonably good estimates for many species but still with major gaps. In the NRC, we have information on the essential amino acid requirements of different fish species at the juvenile stage which shows little difference in requirement for lysine, histamine and tryptophan among species. But we do not know whether the difference arose from nutrient density of diets, experimental errors, variability etc. It is also worrying that there are missing information for several species, even that for the Atlantic salmon."

Large feed companies are now using nutrient based or factorial models. These look at nutrient deposition, metabolic intake, digestibility and bioavailability of nutrients etc to calculate requirements which are matched with expected feed intake.

"These are not perfect approaches but provide rational basis for estimating the requirements of the animal. The advantage is that these are dynamic and can be used for a range of species and feed composition. These models show that requirements are changing rapidly in small animals. Usually nutritionist underestimate these changes when formulating feed."

Filling gaps with stakeholder participation

In the market, feed millers offer a whole range of feeds. The industry now produces too many different types of feed. There is no perfect method to adjust feed specifications to feed composition, and particularly in Asia, feed millers have to serve markets with different grades of feed such as 5 for the carp and 7 for the tilapia, as well as producing extruded or pelleted feeds.

In this presentation, Bureau stressed that animals utilise nutrients and not proximate components of ingredients. Nutritionists need to go beyond proximate analysis into ingredient characterisation.

"More efforts now need to be invested in developing accessible and user friendly interfaces for nutritional models so that researchers, feed manufacturers and aquaculture producers can easily access these tools and work together to generate knowledge required to meet future challenges. One example is the Feed Ingredient Composition Database (FICD) compiled by the Asian Aquaculture Feed Formulation Database (AAFFD) group which is supported by the US Soybean Export Council (USSEC)."

Nutrient requirements for shrimp across the cycle

Dr Brett Glencross, Technical Manager, Ridley Aqua-Feed, Australia gave a review on nutrient requirements for different life stages of shrimp. He started by emphasising the need to understand nutrient requirements versus diet specifications. Specifications are what the feed manufacturer determines for the diet as % diet whereas nutrient requirements are usually described in RDI (recommended daily intake) or g/MJ.

"Feeding a diet that is below requirements in critical nutrients will result in slower growth, and a poorer feed conversion but such diets can usually be made at much lower costs. Conversely a

Allen Wu, Nutriad (right) with Anwar Hasan, Biomin (middle) and D. Chandrasekaran Professor of Animal Nutrition (Retired), India.

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higher specification feed, with a more nutrient dense specification, will be more expensive, but usually deliver faster growth and a better feed conversion."

There are more than 40 essential nutrients required for shrimp. Since his last presentation at TARS 2014, Glencross said that more is now known on requirements for the vannamei shrimp (23 out of 45 essential nutrients) but this is much less than what is known for the monodon shrimp (38 out of 45). On nutrient requirements across growth cycle and whether size matters, Glencross showed that recent data and reanalysis of old data suggest that there are subtle changes with size.

"Size is marginally important as protein synthesis is highly active when animals are very young. Size effects on body lipid density and energy demands change minimally with size, and largely during the very early planktonic stages (mysis, zoea and postlarvae). Despite the absence of size-specific data on shrimp nutritional requirements, there is a tendency to use higher protein diets with small animals (<0.1 g) and as they grow to reduce the diet protein content. During the early stages from zoea to 1 g shrimp, the demands for protein, expressed as DP:DE (Digestible Protein:Digestible Energy) vary the most. Above this size (>1 g) there is minimal variation in protein demands."

The next step, according to Glencross is to better understand the interactive effects of some nutrients, role of advanced shrimp genotypes and improving our capability in modelling nutrient demand.

Feeding the pangasius

Within 10 years, farming of the pangasius in Vietnam has escalated to an annual production of more than 1 million tonnes in intensive systems (200-300 tonnes/ha) using 1.5 to 1.8 million tonnes of feeds produced by 60-70 feed mills. There are some studies on pangasius requirements for protein, energy, lysine, methionine, phosphorus, etc but in general, feed formulations for the pangasius catfish are largely based on requirement data for the channel catfish, despite of the differences in culture methods and fish physiology.

> **"There is a large gap from nutrient requirement for the pangasius and the feed specifications by feed millers." – Le Thanh Hung**

In his presentation on the current status of pangasius feed nutrition, **Dr Le Thanh Hung**, Nong Lam University showed that new information on nutrient requirements are being generated within Vietnam and elsewhere in Asia.

Alessandro Moretti (left) with Dr M A Kabir Chowdhury, (middle) and Supornchai Sri-Nhonghang Territory Manager, Jefo Nutrition Inc.

Dominique Bureau (left) with Ingrid Lupatsch, Aqua Nutrition Manager, AB Agri Ltd, UK

"There is a large gap from nutrient requirement for the pangasius and the feed specifications by feed millers. This is because of stiff competition among feed millers and the push for reduced feed cost. Commercial feeds have four levels of crude protein; 32% for 5-50 g fish, 30% for 50-100 g fish, 28% for 100-500 g fish and 26% for fish more than 500 g. Studies by Glencross showed that at low density energy (2,400 kcal of DE), DP required varies from 30% (10 g fish) to 19% (500 g fish). The estimated FCR varies from 1.25 to 2.20. At high density energy (3,350 kcal of DE), DP required varies from 42% (10 g fish) to 27.5% (500 g fish) and the FCR from 0.90 to 1.2. However, in commercial feeds, DP/DE ratios are similar in low or high energy diets which rightfully should be different according to the size of fish," said Hung.

"In the case of lipids, the general diet specification is 5-6 % lipid with gross energy values ranging from 3,800-4,200 kcal/kg feed. This is despite our work showing that a protein-sparing effect of lipid and optimal lipid levels can be 8% lipid in 32% crude protein diets and 30% protein with 12% lipid diet.

Hung listed gaps in nutrient requirement information including that of essential amino acids (with the exception of lysine and methionine), omega 3 and 6 fatty acids, phosphorus and major minerals. Work is required to determine digestibility values of these nutrients in ingredients and in the case of fatty acids, their effects on fillet quality.

With regard to ingredients, Hung said that fish meal inclusion has been reduced to 3-5% in commercial diets and zero fish meal diets have not yet been commonly used even though some studies confirmed that complete replacement is possible but with supplementation of feed additives, attractants, feed enzymes and trace minerals. There is a need to overcome the habit of using fish meal in diets; instead we should consider the use of vegetarian diets for the pangasius. Main ingredients are now rice bran, wheat bran, cassava and soybean meal. Some 80% of feed mills already incorporate phytase in feeds.

Hung's take away message was "For the future sustainable development of pangasius farming, the feed sector needs to reduce feed cost and environmental effects of feeds and incorporate feed enzymes to produce more digestible feeds. The addition of functional additives into fingerling feeds will improve health status and reduce fish mortality during the early stages."

Broodstock and early feeding

Three presenters showed different approaches on broodstock and larval nutrition. Success in finfish broodstock management comes through both good nutrition and holistic management of the broodstock, said **Alessandro Morett**i, Product Manager-Fish Hatchery, Inve Aquaculture, based in Italy. In the case of the marine shrimp, **Eddy Naessens**, Product Manager, Inve Aquaculture, Belgium, said that biosecurity is the main criterion when developing diets, e.g. whether fresh/frozen or formulated

feed for shrimp broodstock. According to **Dr Shunsuke Koshio**, Faculty of Fisheries, Kagoshima University, Japan, it is important to keep fish and shrimp healthy until the completion of early and nursery stages before reaching the grow-out stage. However, rising costs of critical ingredients such as fish meal makes it difficult to formulate suitable cost-effective aqua feeds for these early stages.

Holistic approach for success with finfish

According to Moretti, for intensive aquaculture, successfully building up a pool of broodstock is now beyond the unpredictable and risky model of using broodstock sourced from cages, ponds or from the wild. Maintaining and controlling a large stock is more expensive, but the effort is paid off by better predictability and good quality eggs.

"Broodstock quality influences egg quality, which in turn has a direct impact on fry quality and disease resistance and gives a good start for the grow-out phase. This is applicable to any fish and is a safety margin for any culture activity. Finally, broodstock quality affects the economical value of the grow-out," said Moretti, who also gave this advice, "The choice is a good start with quality of eggs or not to start at all."

Moretti described the state-of-the-art in advanced broodstock management techniques with examples from Europe and Asia, including management criteria, engineering and design of facilities and economics. However, in broodstock nutrition, the beneficial effects of a balanced diet on egg production and larval quality, the specific nutritional requirements of broodstock fish are still under investigation. "This is the reason, why sometimes broodstock is still fed with a substantial amounts of trash fish, a highly risky practice in terms of biosecurity. Conditioning of the broodstock to artificial diet is fundamental to manage a balanced nutritional program and prevent diseases," said Moretti.

Chen Ming-Dang, Charoen Pokphand Foods Public, Thailand

Kenneth Chin

"A correct feed should be formulated using high quality marine proteins, hydrolysed proteins and a well-balanced mixture of various indispensable free amino acids. The quality of dietary lipid and essential fatty acids has a major impact on the spawning quality. Lipids are the major source of metabolic energy from egg to adult stage and directly influence gamete and larvae quality because of selective retention during embryogenesis."

"Feeding is for three stages, maintenance, spawning and recovery. We do not want to grow the fish, but just keep them very well-conditioned since broodstock animals are our champions," concluded Moretti.

Biosecure shrimp broodstock diets

In the drive for sufficient specific pathogen free (SPF) or high health post larvae, Naessens proposed that biosecurity is a concept not to be forgotten at each step in broodstock management and nutrition, from growth and general condition and from shrimp maturation to nauplii production. Each step has its own operational procedures and feeding conditions. Maintaining the broodstock in

Dean Akiyama (right) with the Waterbase team, Palanisamy Ravi, Vice President (middle) and Ramakanth Akula, CEO

Le Thanh Hung and Kenneth Chin leading a freshwater fish feeds group

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good condition for maturation and reproduction (accelerated by eyestalk ablation) prepares for rapid sequences in the spawning and non-feeding stages.

"However, our knowledge of broodstock nutrition is still incomplete and this affects the performance of the animal. Two types of broodstock diets are used for shrimp: fresh/frozen feeds and formulated diets. The biosecurity issue is with the former which can be contaminated with pathogens. There is a need for SPF type of polychaetes, the main fresh/frozen feed used in Asia. The advantage of formulated diets is the possible inclusion of active substances such as immunostimulants, antistressors, hormonal substances, as well as ease of storage and use. The disadvantage is the issue of reduced uptake (attractability, palatability) in some cases. With limited knowledge of nutritional requirements, only partial replacement is possible without affecting reproductive performance.

"Meanwhile a combination of various fresh-frozen marine organisms (squid, bivalves, clam, oysters, krill, artemia and polychaetes) and formulated feeds contributes to the overall nutritional package, providing carotenoids, highly unsaturated fatty acids (HUFAs), cholesterol, amino acids and various proteins. Dry pellets can replace up to 50% of the fresh food ration but at higher feeding rates, dry pellets are not readily ingested," said Naessens.

"The elimination and complete replacement of such diets with formulated diets would be ideal from a biosecurity perspective; but these diets are not well accepted at present. There is a new generation of soft formulated feeds (semi-moist pellets) with state-of-the art formulation which have a higher acceptability and ingestion comparable to fresh feeds. Research shows that it can replace up to 70% or more of fresh feeds in vannamei shrimp and 60% in the case of the monodon shrimp. In some instances, they perform as well as fresh products," said Naessens. "These represent multiple benefits compared to fresh food such as accelerated ovary maturation, increased spawn frequency and size and improved egg and nauplii quality. Most important is the ability to have consistent composition of controlled quality of post larvae.

Naessens' take away message was, "The development of cost-effective formulated diets fulfils a dual role of eliminating biosecurity issues associated with feeding fresh/frozen feeds and ensuring high, consistent and prolonged reproductive performance."

Creating robustness

According to Koshio, coated microdiets can minimise the use of live feeds such as rotifers, brine shrimp, copepods etc during seed production. In his presentation, he discussed how supplements have been tested in microdiets for larval nutrition. These include peptides, carotenoids, and fucoidan from brown seaweeds.

At the Q&A for the session on sustainability and health interaction. Peter Coutteau, Nutriad (left) presented on 'Towards a paradigm shift in feed specifications (see page 5) and Pedro Encarnação, Biomin, Singapore on 'Feeds, feeding and environmental sustainability.

The studies showed that peptides are efficient supplements in fish feeds and hydrolysing the protein ingredients help improve nutritional quality by way of increased protein content, functional properties and digestibility. However, the performance was only moderately enhanced during a supplementation of hydrolysates.

"With the shrimp *Marsupenaeus japonicus*, carotenoid levels up to 100 ppm showed higher body weight and total body length with metamorphosed post larvae (PL1). Rate of metamorphosis is higher with increasing dietary carotenoid levels at 200 and 400 ppm levels compared to the control group," said Koshio.

"*Undaria pinatifitida* fucoidan has functional properties and with *M. japonicus* larvae, survival improved during metamorphosis from zoea1 to mysis1 and from mysis1 to PL1. The trend shows higher growth rates with higher levels of fucoidans. On exposure to *Vibrio harveyi* at $1x10^7$ CFU/ml, survival increased as the level of fucoidan in the feed increased. Effects differed slightly with *Penaeus monodon* postlarvae where 500 mg/kg of dietary fucoidan improved growth and resistance against vibriosis.

In seabream juveniles Koshio discussed the interactive effects of probiotic bacteria (heat killed *Lactobacillus*) and beta glucan added to feed. He concluded that supplementation improved growth, feed utilisation, immune responses and reduced oxidative stress conditions. There is a synergistic effect of both additives in enhancing blood chemistry and improving immunological parameters.

Targeted grow-out feeds

As a nutritionist covering the needs of industry in India and Indonesia, **Kenneth Chin**, PT Intraco Agroindustry, has the unenviable task of balancing the expectation of the farmer with the profitability of the feed producer. The farmer is constantly under pressure from the increase in operational cost of producing fish or shrimp whilst facing rising or unstable costs of feed ingredients such as fish meal, soybean and corn meal. In his industry perspective on the needs of a commercial nutritionist, Chin said, "Often we have feed ingredients which were suddenly priced beyond our reach. We run back to reprogram and too often, quality is affected and the farmer is unhappy."

Clockwise, Vincent Percier and George Marco, Aquativ, Poh Yong Tong and Dr Daranee Sookying Gold Coin Specialities and Dr Thomas Gitterle, SyAqua Group.

What the nutritionist needs

Chin outlined challenges facing the nutritionist as he or she tries to formulate optimum feeds. He called on researchers to help industry provide some answers. The challenges included the lack of basic knowhow such as with the replacement of fish meal without sacrificing growth performance, effects of processing on quality of ingredients, and in shrimp, uncertainty on the specific requirements of most amino acids and fatty acids.

"Feed may come out of the extruder or pelletizer well but we need to know their effects on the fish. Thus we need to have knowledge on the physiology of the fish being fed, how fast the

feed passes through the gut, the microbes in the gut and the negative effects of certain ingredients. Not all fish are created equal."

Doing more with less

"Most nutritionists are aware of the potential of functional additives but we see so many products in the market and need to find methodologies to measure the effectiveness of these products such as the prebiotics and probiotics. We need to be open to substitutes. Some farmers use live yeast in ponds. Seaweeds which also provide organic minerals is a potential ingredient today, but the price was prohibitive several years ago. Some studies indicated that seaweed gives better tasting fish as it contains high levels of amino acids', said Chin.

"Whether for fish or shrimp feeds, nutritionists concur that we can no longer afford to use fish meal or need to limit its inclusion. In Norway, formulators overcome this problem by using soy protein concentrate (SPC) but for us there is the cost factor as well as palatability. We are running a trial using plant meals only in vannamei feeds in India, which could be promising as stocking density is low in India. We need to explore available ingredients such as cottonseed and castor oil meal but first we need to tackle the anti-nutritional factors in these types of ingredients as well as the flavour issue."

There are also possibilities with heat treatment such as indirect heating, expansion and extrusion to destroy toxins and to breakdown NSPs, but some toxins are heat resistant and heat treatment has a negative effect on sensitive nutrients. Enzymes are effective in livestock but in aqua feeds, there is a need to determine the optimum parameters for the enzyme and effective inclusion levels. Difficult ingredients such as cottonseed meal or castor cake may require pre-treatment with heat or enzymes.

Dr Fuci Guo, DSM, Singapore, (left) with June R Sayo, Novus International, Philippines and Ma. Patricia Rico, Santeh Feeds Corporation Philippines (right).

Economy and farmer

"The nutritionist has to do a balancing act. To formulate a feed for optimal growth, FCR will not be sufficient under today's scenario. We need to focus on cost to produce a kilo of fish. We need to match technology to the needs of the farmer, produce a feed and show the farmer how to use the feed. The fish produced should be what customers want. The goal is for the farmer to remain competitive,"said Chin.

"Today, the nutritionist not only provides a good feed but has the additional role of being an economist, as well as a healthcare provider in order to serve the industry effectively."

Henrik Aarestrup (left), BioMar A/S and D. Chandrasekaran, Professor of Animal Nutrition (Retired), India. Aarestrup presented on the Next Step in Sustainable Aqua Feeds.

The shrimp feed journey

The shrimp feed industry has had its challenges and to move forward, TARS 2015 took a relook at its history. With his involvement in the shrimp feed industry for the past 30 years in Asia, it was appropriate that **Dr Dean Akiyama**, aqua feed consultant, Indonesia reviewed past development and suggests future steps for the industry.

The shrimp feed industry has moved on from the early 1980s when fixed formulations were proprietary. Exotic ingredients and those containing unknown growth factors (UGFs) were the norm and key to successful feeds. The 1990s to 2005 saw the transition to least cost formulations. There was also the change in species, from the monodon to vannamei. Feed demand rose with the rise in targeted yields and faster turnaround in production where culture cycle was shortened to 90-110 days for the vannamei shrimp as compared to 140 days for monodon shrimp.

"The big change was feed protein levels, which went from 38-45% for the monodon to 28-35% for the vannamei shrimp. Growth rates increased from 5 to 10% with genetically improved and virus-free broodstock. Protein content was artificially constrained by market demanding certain feed and national specifications, such as the 35% specification in Thailand."

Extruded shrimp feeds

Akiyama pointed out some limitations with extruded feeds, which include palatability and digestibility leading to slow growth.

"There are excellent extruded japonicus shrimp feeds produced since the 1970s with low temperature extrusion and long low temperature drying time. Extrusion has the potential to produce higher energy nutrient dense pellets of uniform one mm diameter. A major constraint is the cost of production which is 20% to 25% higher. An advantage of extrusion is waste reduction."

State of current shrimp feeds

Akiyama said, "Current feed quality standards exceed the production facilities (outdoor ponds) and farmer capability (farm management). We have no major innovations for shrimp feed and industry focused on disease issues and genetic improvements. In fact, we have many biological and farm technology constraints that greatly affect nutrient requirements in shrimp feeds.

"Shrimp are osmotically balanced at 25 ppt, yet we put them into a wide range of salinity from 2 to 35 ppt. Digestibility of nutrients will be reduced when salinity is above or below 25 ppt. A lower digestibility means higher daily nutrient intake. Shrimp metabolism and growth are regulated by water temperature. Every 1°C change translates to 8-10% difference in growth; 30°C will have 15% faster growth than 28 °C. Shrimp growing 15% faster requires higher daily nutrient intake. Water quality parameters should be stable for the animal to use less energy for maintenance. Dissolved oxygen is critical with the high performance genetically improved animals.

"In controlled systems, we have shown that PL10 stocked in raceways with minimum 6 ppm dissolved oxygen, stable temperature and pH, will reach 35 g in 100 days."

Marc Campet, Virbac, Vietnam, Dr Ei Lin Ooi, DSM, Thailand and Dr Serge Corneillie, Alltech, Japan. Campet presented on Growing the Aqua Feed Industry: Getting Communication Right, Ooi talked on Nutritional Health and Assessment and Corneillie on the DHA story: Aquaculture's contribution to human heath (see page 31).

Dr Thomas Wilson, Aquaculture Nutrition Consultant, Thailand (right) with Dr Rutchanee Chotikachinda, Feed Formulator, Thai Luxe, Thailand. Wilson presented on Replacing Fish Meals with Sustainable Alternative Ingredients.

Akiyama's message was, "We have feeds which are better than what the farmer needs. Now we have to take a lesson from the chicken industry and work towards more controlled production systems."

Feeds for a better tomorrow

In his introduction to 'Feeds for a better economy and environment', **Dr M A Kabir Chowdhury**, Product Manager-Aquaculture Jefo Nutrition Inc, Canada said industry is facing consumer demand on environmental sustainability, traceability, management practices for the food they eat. How can the feed industry innovate to address these issues?

Ingredient variability and costs

The demand for better growth performance, lower feed cost and environmentally sustainable production could be met by improving culture conditions and by increasing digestible nutrient contents in the feed. However, one major challenge is the variability in the quality of ingredients.

"There is a severe lack of industry standards such as with rendered meals. Then there is DDGS from several sources with a wide range of crude protein (CP, 24-33%), apparent digestibility coefficient (ADC) of 64-84% (CP) and 44-71% (for lysine). Algal meals have 19-40% CP and a range of ADC from 19-80% (CP). Associated with these are high levels of mycotoxin in DDGS," said Chowdhury.

"Conversely, ingredients that are highly digestible are usually expensive and often in limited supply. This is creating a major bottleneck in improving the availability and supply of quality raw materials. The solution is looking at additives to increase utilization of nutrients by fish and shrimp. Although utilisation can be enhanced by changing animal genetics, health and culture conditions as well."

Chowdhury said that recently, the industry is moving towards developing and producing 'functional' feeds to achieve desirable efficiency of metabolic transformation, growth performance,

Herve Lucien Brun, Consultant, France (middle) with Jamon Jimenez, Jefo Mexico (left) and Rafael Pena Ruelas, Nutrimar (Nutrición Marina S.A. de C.V.), Mexico

health and compositional traits of cultured animals at various developmental stages.

Economic and environmental benefits

Chowdhury focused on various enzymes, which target specific nutritional components of an ingredient or a compound feed and improve digestibility. Among enzymes, there is carbohydrase to breakdown large carbohydrate molecules (soluble and insoluble) to small molecules and provide more energy. Phytase and phosphatase release phosphorus, some bivalent cations and amino acids. Each protease have specific substrates.

"Why use them? There are various reasons such as compensating endogenous enzymes, better digestibility of target nutrients, reduced effects of anti-nutritional factors, better growth and lastly, economic and environmental benefits. As in the case of phytase in rice bran, the benefit is 90% release of total phosphorus. Phytase in rice bran binds with minerals and amino acids such as lysine and histidine.

"Benefits are species specific. In feed, multi enzymes optimise release of phosphorus with phytase, energy with NSPase and proteins and amino acids with protease."

On the economic benefits, Chowdhury described the cost savings with reformulation of feeds for the pangasius, shrimp and snakehead with less fish meal and substitution with plant meals using protease.

Chowdhury's message, "The industry must overcome its reluctance to change and throw its weight behind innovative technologies and new practices. A higher utilisation of ingredients means low nutrient discharge, reduced eutrophication, healthy animals and better welfare.

TARS 2016 will be on the shrimp aquaculture industry from August 17-18. Updates at www.tarsaquaculture.com

Next issue: Continuation of TARS 2015 report with presentations on sustainability and health interactions and growing the aqua feed industry.

Krill feed improves fillet quality and quantity

Research proves that krill-fed salmon grow faster and are bigger with no negative effects

Results from a commercial scale research project have shown that feed with krill meal improves both the yield and quality of salmon fillets. In addition, salmon fed with krill offered higher fillet yields than the control group in the research; the fillets were firmer and the incidence of gaping lower in fish fed with krill. The improved fillet quality could be very important to the processing industry and to consumers.

Nils Einar Aas, Sales Director at Aker BioMarine Antarctic, explained, "We worked with the European feed company, BioMar. BioMar developed a feed called Quick™ and carried out the research. In this major project, groups of salmon were fed Quick, with the control groups being fed BioMar feed without krill. Researchers compared 260 farmed salmon, bred in five sites in Norway between May 2013 and January 2014. In total 14 groups of fish bred by six farmers were examined."

Nofima, one of Europe's largest institutes for applied research within the fields of fisheries, aquaculture and food, analysed the fish. The research examined the yield and quality, including body shape and organ condition, for example heart and liver index, and fat content.

Colour, firmness and gaping determine the fillet quality. Another determinant is fat deposition around the organs. Fat deposition can affect metabolism, an important factor for yield quality. Good taste, smell and storage capabilities are also equally important.

The results

"The results from the project were unusually clear. Krill-fed salmon weighed significantly more than the control group (4.6 kg and 4.3 kg respectively) and had a significantly higher yield than the control group (63.7% and 60.8% respectively). This 2.9% difference correlated with thicker fillet. Fish fed with krill were 4-5% thicker and firmer than the control group. The feed with krill stimulated the development of more and firmer muscle, leading to less gaping (7% vs 20%)," said Nils. "There were no negative effects and the researchers believe the increased feed intake may be due to the improved palatability of krill-based diets."

The incidence of gaping was lower in salmon fed with feeds containing krill meal.

Nils Einar Aas (second right) with the Aker BioMarine team at World Aquaculture 2015 in Jeju, Korea; Sigve Nordrum (left), Julie Bae (second left) and Dr Alberto J.P. Nunes, LABOMAR, Brazil. During the conference, Nunes presented work on the replacement of cholesterol in diets for juveniles of the white shrimp with low inclusions of krill meal. The team also presented work on krill meal as replacement of fish meal in white shrimp.

Nofima's study supports earlier experiments on krill-fed Atlantic salmon. Independent studies at Norway's Aquaculture Protein Center showed that dietary krill meal, compared with fish meal, stimulated feed intake and growth in salmon. An earlier commercial scale feed trial in Chile also showed that young Atlantic salmon ate more and grew faster and were bigger when krill was added to their diet.

Unique properties

Krill, *Euphausia superba*, are shrimp-like crustaceans. The krill grow to 6cm and weigh up to 2g. They have large black eyes and translucent pink shells. Krill are harvested to produce krill oil as an ingredient for aquaculture feeds.

Krill meal contains a range of essential nutrients for shrimp and fish, including essential amino acids, feed attractants and cholesterol. The highly bioavailable phospholipid and long chain omega-3 fatty acids, the powerful antioxidant astaxanthin and high quality proteins contribute to improving the fillet yield and quality.

Long-term sustainability

Krill is one of the largest biomasses in the world. Though hard to measure, because of their large home range, the biomass is estimated between 120-600 million tonnes of Antarctic krill around Antarctica in the Southern Ocean.

The Southern Ocean is home to thousands of different marine life species, all dependent on each other in a vulnerable ecosystem. Antarctic krill is in the middle of the food chain between the microscopic plants and animals, and the larger animals. Krill are food for humpback whales, fish and penguins.

"Aker BioMarine and BioMar are collaborating with other companies and international environmental organisations to assure krill's essential role in the marine ecosystems. These multi-stakeholder partnerships are also important in minimizing the risk of krill fishery impacting negatively on the health of the ecosystem," said Nils.

"It is vital that research continues to ensure krill is sustainably fished today, and tomorrow."

DHA in seafood for human health

By Renato E. Kitagima, Serge Corneillie and Shuichi Satoh

As a major source of DHA for human health, farmed fish need alternative and sustainable sources of dietary DHA to replace fish oil.

Scientific studies emphasise the importance of long chain omega-3 polyunsaturated fatty acids (LC-PUFA) in human health and in particular the benefits of docosahexaenoic acid (DHA, 22:6 n-3). The minimum FAO recommendation is 250 mg DHA/day/person. However, supplies of fish oil, the most common natural source of DHA are only 100,000 tonnes DHA/year, very far from the demand of 821,000 tonnes to keep the global population of 9 billion healthy. The shortage of DHA has triggered a search for new and alternative sources of DHA including heterotrophic algae, krill oil and transgenic plants.

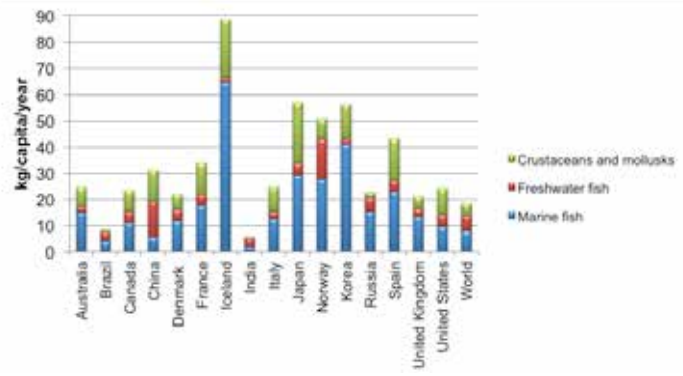


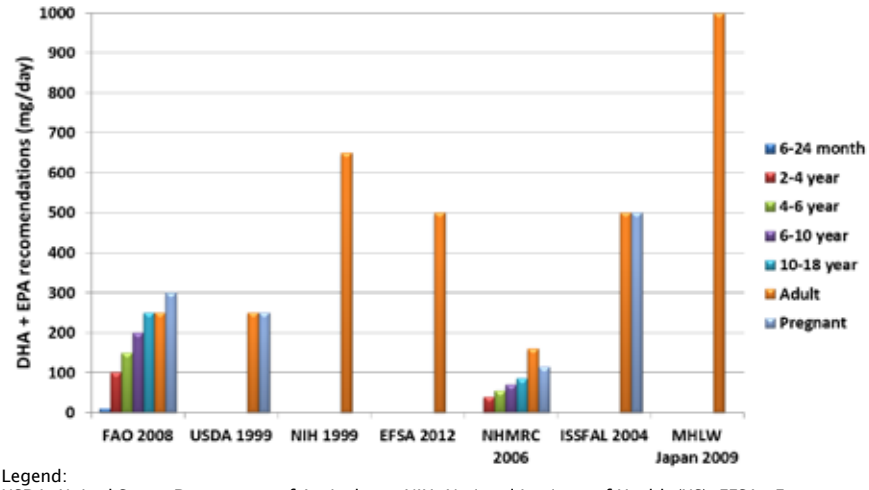
Figure 1. Consumption of fish and shellfish in different countries 2009 (FAOSTAT)

DHA in human health

Studies demonstrate that DHA is essential for brain and retina development. It is an important structural and functional component of retina photoreceptors, neurons and signalling synapses. Moreover, consumption of DHA and other n-3 LC-PUFAs reduces the risk of coronary heart disease (CHD), lowers the levels of triglycerides (TG), and reduces blood pressure (Kris-Etherton et al. 2002; Iso et al. 2006). Besides, there is evidence that DHA can be a precursor of potent anti-inflammatory Resovin D which, together with n-3 LC-PUFAs, can be used in the control of rheumatoid arthritis (Kremer 2000; Duffield et al. 2006, Kohli and Levy 2009).

Seafood and DHA

The consumption of fishery products, principal sources of DHA, varies considerably among countries. Figure 1 shows that the consumption of seafood in some populous countries such as India (5.5 kg/capita/year) and Brazil (8.3 kg/capita/year) is less than half of the world average of 18.5 kg/capita/year (FAO 2009).



Legend:
USDA, United States Department of Agriculture; NIH, National Institute of Health (US); EFSA , European Food Safety Agency; NHMRC, National Health and Medical Research Council (AU); ISSFAL, International Society for the Study of Fatty Acids and Lipids ; MHLW, Japan Ministry of Health, Labor and Welfare

> "..at least 90 g of fish per day. – Japanese Ministry of Health Labour and Welfare (MHLW)"

Figure 2. Daily recommendations of DHA and EPA for humans of different ages (mg/day)

The dietary intake of n-3 LC-PUFAs in these countries is lower than the minimum recommended by FAO (250 mg DHA + EPA (eicosapentaenoic acid, 20:5 n-3) per day).

As a comparison, the consumption of fishery products in USA is 2.8 times higher (24.1 kg/capita/year) than that in Brazil (FAO), but, according to USDA dietary guidelines 2010, Americans are consuming only 44% of the desirable quantity of seafood in order to achieve the minimum daily intake of 250 mg DHA + EPA). Countries in Africa and South America have the lowest average consumption of fishery products (10 kg/capita/year) which is less than half of the European and North American consumption.

Even with several regions recording a low consumption of seafood, there is still a huge demand for this food resource. As production from capture fisheries plateaued two decades ago at around 90 million tonnes/year, the increase in demand has been met by aquaculture to reach a combined annual production in 2011 of 154 million tonnes (SOFIA 2012).

Dietary DHA in fish oil is important to meet the fish nutrition requirements and to improve meat nutritional value. However, the production of farmed fish is facing a crisis with low supplies of fish oil. The total replacement of fish oil by vegetable oil is not possible for several marine species and a partial replacement decreases significantly the DHA content in the fillet because vegetable oils do not contain LC-PUFAs (NRC, 2011).

DHA pathways

In humans, DHA can be converted from dietary α-linolenic acid (ALA 18:3 n-3), EPA and docosapentaenoic acid (DPA 22:5 n-3) (Jumpsen and Clandinin 1995). ALA, an essential fatty acid is present in vegetable oils such as flaxseed oil, while EPA, DPA and DHA are especially found in fish and in chicken eggs. The conversion of ALA to DHA in humans is very limited, estimated at only 1% for new born babies. This capacity tends to decrease during the aging process (FAO 2010, EFSA 2010). Therefore eating n-3 supplements based on flax seed oil will not bring a lot of benefit.

On the other hand, a direct consumption of DHA sources such as salmon, fish oil or algae oil is able to increase DHA levels in plasma phospholipids and erythrocytes (Barrow et al 2009; Raatz et al. 2013; Arteburn et al. 2008). Clearly, it is much more efficient to consume DHA directly rather than ALA which may also require the control of linoleic acid (LA: 18:2 n-6) intake. LA, found in common vegetable oils, competes for the same enzymes required to elongate and desaturase ALA during the metabolic pathway of DHA synthesis (Holub 2002, Arterburn et al. 2006).

DHA recommendations

In adults, there is a considerable variation in the daily DHA intake recommendations suggested by national and international institutions. Most of them are based on the risk reduction of cardiovascular diseases (CVDs). The recommendation for DHA + EPA in adults ranges from 90 to 1,000 mg/day (Figure 2). The highest is from the Japanese Ministry of Health Labour and Welfare (MHLW) which recommends 1 g DHA + EPA per day or at least 90 g of fish per day (MHLW 2010). In 2011, the average Japanese consumption of seafood was 72.7 g/day (which is high compared to most countries, although the current consumption has decreased 26% compared to the historical peak of 98.2 g in 1997 (MHLW 2010).

A Japan Public Health Center study on fish consumption of 41,758 middle-aged adults was partly used to derive the national recommendation (Iso et al. 2006). This study also showed that the group consuming 180 g/day had the highest reduction of CHD risk events. The same study showed that the risk decreases significantly at a daily consumption rate of 51 g compared to the lowest intake of 23 g/day (Figure 3)

The government of Japan is probably concerned as it needs to reduce the cost of CVDs treatments. It has an aging

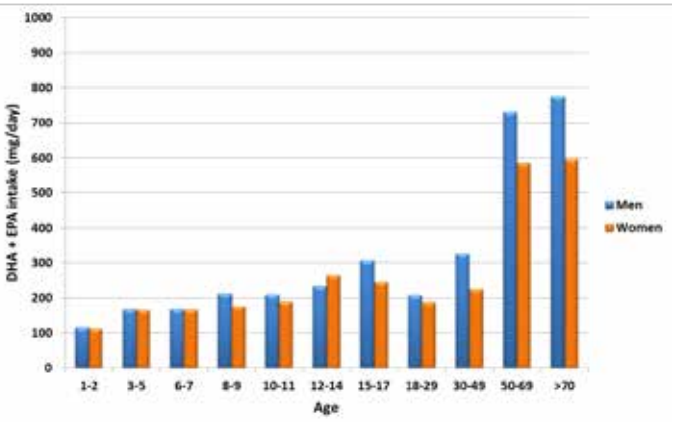
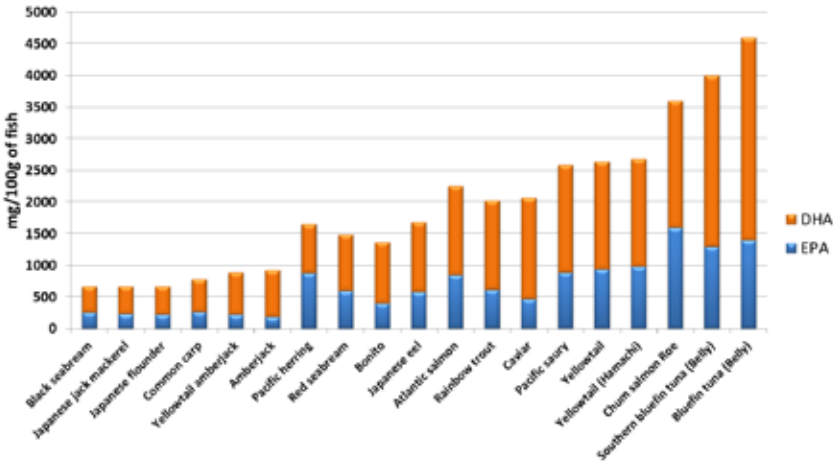


Figure 3. Japanese DHA + EPA intake 2005 (mg/day)



> **"..species rich in DHA/EPA include mackerel, Atlantic salmon, Japanese yellowtail, Pacific saury and sardines, having more than 2,000 mg/100 g."**

Figure 4. DHA and EPA (mg/100g) content in marine and freshwater fish ranked by DHA concentration (MEXT 2005; USDA 2012).

population and is using the culture of seafood consumption to support recommending such a high intake level. In 2010, the demographics of its population was: 18% young people (≤19 years old), 59% adults (20~64 years old) and 22% elders (>65 years old, HLW).

In contrast, international institutions such as FAO or the European Food Safety Authority (EFSA) have more conservative daily minimum intake recommendations of DHA + EPA at 250 mg and 250~500 mg respectively. Daily consumption of 250~500 mg of DHA + EPA appears generally accepted as a level which decreases the risk of CVDs. This range is recommended by EFSA, International Society for the Study of Fatty Acids and Lipids (ISSFAL) and the American Heart Association (AHA), although consumption of DHA + EPA up to 2,000 mg is considered safe and can be part of a healthy diet (FAO 2010).

Such high recommendations imply a huge impact on the fish oil market since many countries do not have fish-eating habits like Japan. Higher doses of DHA + EPA may be recommended in some specific cases such as for patients with documented CHD (1~ g) or hypertriglyceridemia (2~4 g) under medical supervision (Lichtenstein et al. 2006).

The importance of DHA in fetus and new born development received attention after high levels of DHA were reported in breast

milk; these levels are higher compared to common dairy milk used for human nutrition and in some infant formulas. DHA is an essential nutrient for infants because it improves the visual acuity and learning capacity when comparing supplemented to non-supplemented infant formulas. This observation further indicates that the capacity of conversion of ALA to DHA is insufficient for good development of the brain and retina of infants.

There is a positive correlation between dietary DHA and the breast milk DHA content implying that DHA consumption is preferred instead of a high intake of ALA. The FAO (2010) DHA recommendation is 0.1-0.18% of total energy intake for 0-6 month infants, while the recommendation for infants of 6-24 months varies from 10 mg/kg/day DHA (FAO, 2008) to 100 mg/day DHA (EFSA, 2010). The minimum recommendation for pregnant and lactating mothers is 100-200 mg DHA/day. The depletion of the mother's DHA levels is possible due to the DHA being re-directed to the fetus development (Van Gool et al. 2004). Perinatal depression and postpartum depressive symptoms seem to be related to low DHA intakes (Hibbeln 2002; Rees et al. 2009), although according to Leung and Kaplan (2009), the perinatal depression may be associated with the deficiency of other nutrients as well. The intake of DHA will not only improve the concentration of this essential fatty acid in the breast milk during the lactating period, but also help to keep adequate levels for the mother's general health. Recent studies also show that supplementing the diet of children with DHA reduces attention deficit disorder.

DHA in natural sources

Marine fish is the main natural source of EPA/DHA for human nutrition (Figure 4) but variation in concentration within the marine fish is very high (yellowtail: 3 g/100 g, Atlantic salmon: 2-3 g/100g, but cod: 100 mg/100g). The reason for this is that DHA is a part of the fat. Low fat fillet fish have therefore low concentrations of DHA and vice versa. Some freshwater fishes contain relative high amounts of DHA (carp: 300 mg/100 g) while others are very low (tilapia: 50 mg/100 g)

Terrestrial plant oils from vegetables, fruits, fungus, potatoes, seeds and cereals do not contain LC-PUFAs (MEXT 2005). Plants can synthesise LA and ALA and most common plant oils used in human nutrition have high n-6:n-3 ratio (LA:ALA), except canola oil and flaxseed. FAO (2010) does not recommend a specific n-6:n-3 ratio in the human diet if all the essential fatty acids are provided by the food. However, vegetarians who do not consume fish or eggs may be exposed to a high LA:ALA ratio and may require DHA supplementation despite a high ALA intake.

The highest content of DHA/EPA in marine fish is found in the belly meat of bluefin tuna (4,600 mg/100 g) which is the most expensive fish in the Japanese market (Figure 4). Other species rich in DHA/EPA include mackerel, Atlantic salmon, Japanese yellowtail, Pacific saury and sardines, having more than 2,000 mg/100 g. However, these species do not necessarily provide a best ratio of n-3 LC PUFA: total fat.

Crustaceans generally have a low content of LC-PUFAs compared to marine fish. Krill is an exception and can contain more than 500 mg of DHA/EPA per 100 g. On the other hand, shrimp have less than 100 mg of DHA/EPA per 100 g. Among molluscs, squids have DHA/EPA concentrations about 200-300 mg per 100 g and can be used as a complementary source of DHA. The small firefly squid (whole body) can provide 760 mg of DHA/EPA per 100 g but its availability is limited.

Aquaculture products such as salmon and Japanese yellowtail are excellent sources of n-3 LC PUFAs. However, recent increases in the price of fish oil used in fish feed is forcing the industry

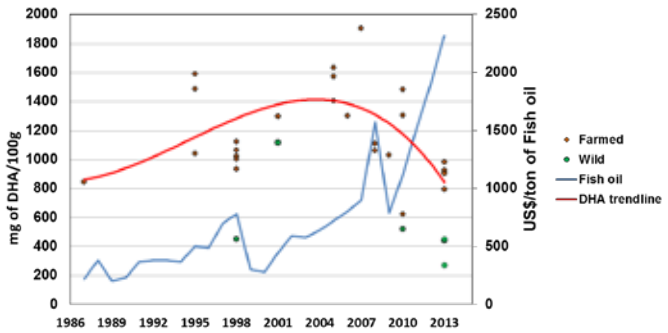


Figure 5. DHA content in farmed and wild Atlantic Salmon (mg/100g)

to partially replace the fish oil with vegetable oils (NRC, 2011). However, this tends to decrease the levels of DHA and EPA in the flesh of fish because the profile of the fillet is similar to the profile of the diet (NRC, 2011) hence leading to a decrease in the nutritional value for humans. Figure 5) shows that there has been a decrease in the DHA content in commercial Atlantic salmon in recent years, while the price of fish oil limits or makes impracticable its use in diets for some fish species.

> .. “while fish oil supplements are a good source of fat, DHA, EPA and added antioxidants, they do not contain other important nutrients for the maintenance of good health..”

DHA enriched products

Recent research on the importance of DHA in human health and the relatively low intake in some populations such as vegetarians, encouraged many companies to develop DHA enriched products and supplements in the market. Among these are dietary supplements made wholly from fish oil or krill oil with DHA concentrations ranging from 8 to 170 mg DHA and EPA/pill (Japan) depending on the fish oil source or fish oil processing technology. However, it is important to emphasise that while fish oil supplements are a good source of fat, DHA, EPA and added antioxidants, they do not contain other important nutrients for the maintenance of good health such as essential amino acids, selenium, choline, iodine and taurine that are present in a more complete food such as fish.

Future demand

The demand of LC-PUFA products is increasing due to their health benefits. In the case of aquaculture, an estimated increase by 2 billion people in the global population by 2050 and basing on an FAO recommended daily dose of 250 mg of EPA/DHA per person means a salmon aquaculture production of more than 8.1 million tonnes or 6.8 million tonnes of Japanese yellowtail per year will be required. Fish oil, as a DHA source, is already scarce and to meet future demand, it will be necessary to find alternative and sustainable sources of DHA.

Some alternatives include krill oil, genetically modified yeast and DHA produced by heterotrophic fermentation of marine algae. The use of krill oil is controversial because harvesting is energy intensive, trawling of small zooplankton is technically difficult and there is a catch quota to conserve resources (NRC

2011, Sæther 1986). A second possibility is DHA extracted from transgenic plants. Research on enzymatic elongation and desaturation of the natural fatty acids contained in oil seeds and transgenic technology studies are undergoing, but better yields of LC-PUFAs are still to be reached (Walsh and Metz 2013; Jiao and Zhang 2013). Besides, transgenic plants need to pass through a rigorous environmental and human health safety assessment before approval and commercialisation.

A more natural, more sustainable and more environment friendly approach is to produce natural strains of algae high in DHA content. DHA produced by heterotrophic microalgae in a controlled industrial process is available in the market and this constitutes a more sustainable production with lower levels of contaminants compared to fish oil. Alltech has shown that these algae are potential supplies of large amounts of DHA. Alltech's Algae factory can produce more than 10,000 tonnes of dry weight of algae per year with fat levels of over 50%. Many studies have shown that these algae can be used to produce DHA enriched eggs, broiler meat, pork meat, fish as well as to completely replace fish oil in fish diets.

References are available on request

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Dr Serge Corneillie joined Alltech Japan as the General Manager in 2009 but has an additional role in technically coordinating the aqua sales of Alltech in Asia. In 2013, he was appointed regional manager of Japan, Korea and the Philippines. He holds a M.Sc in fish endocrinology and a Ph.D in fish ecology and nutrition from the Catholic University of Leuven, Belgium. He has over 25 years of experience in managing fish farms and hatcheries in Spain, Portugal, Greece Japan. Email: scorneillie@Alltech.com

Dr Shuichi Satoh is Professor of Marine Biosciences Department of Tokyo University of Marine Science and Technology and heads the Fish Nutrition Laboratory. His research is focussed on eco-friendly feeds.

Fish meal substitution with land animal proteins in Nile tilapia

By Wutiporn Phromkunthong, Mélanie Guédon and Christian Roques

Trials show that total substitution of fish meal by land animal proteins is possible in tilapia diets and provides similar growth performance.

Tilapia is the world's second most farmed fish, and according to experts its global production could double by 2025 to reach 9 million tonnes (Rabobank, 2015). Tilapia is an important food fish, due to its very good market acceptance. A major animal protein source used in the formulated feeds of tilapia is fish meal but its limited supply may not meet the increasing demand for fish meal in the growing aquaculture industry. It has become a very expensive protein source compared to other macro-ingredients.

Rendered animal protein ingredients such as poultry by-product meal, feather meal and blood meal, are amongst the most promising protein sources for the replacement of fish meal due to their high protein content, good digestibility, competitive pricing and steady supply. They are also sustainable alternatives to fish meal as they are by-products from an industry for human consumption. Moreover, they do not compete with available agriculture areas for human food production unlike plant ingredients.

The present study was conducted to assess the effect of using land animal proteins on growth performance. Poultry proteins, two types of feather meal, and poultry and pork blood meal were tested to replace 100% of the fish meal in diets for the Nile tilapia *Oreochromis niloticus*.

Experimental trials

A typical commercial diet with 10% fish meal (FM control) was used as a control diet. Four experimental diets were formulated with zero fish meal where fish meal was replaced with either poultry by-product meal (diet PBM), two different hydrolysed feather meals produced in 2 separate plants (diets FtM-A and diet FtM-B) or blood meal from poultry and pork (diet BdM). A second control diet was designed with no animal protein source and containing only plant-based ingredients (veg control, Table 1). The ingredients were produced in France and provided by Soleval (Akiolis Group), a key player in European rendering.

Experimental diets were formulated to be isonitrogenous (30% crude protein) and isocaloric (gross energy 350 kcal/100g feed). They were not formulated on amino acid levels and were not supplemented with any exogenous amino acid. All of the ingredients were mixed and pelletised using a Hobart Mixer and stored in a freezer at -10°C.

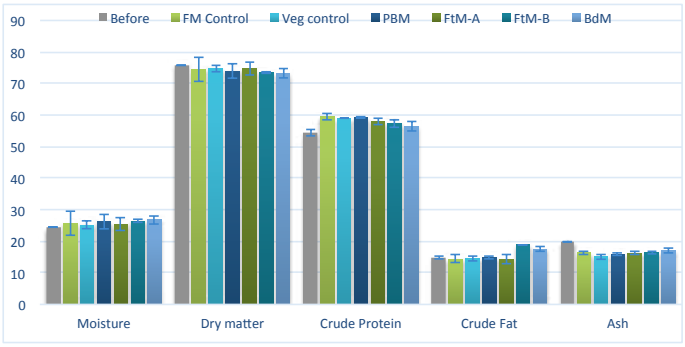
The trial was conducted at the indoor facility of the Kidchakan Supamattaya Aquatic Animal Health Research Center, Prince of Songkla University, Thailand. Nile tilapia juveniles with average body weight of 1 g from a local fish farm were fed with a commercial diet for a month in the research facility. Fish were checked in the university's laboratory to ensure that they were not infected with any bacteria or parasite. After one month, when they reached the target size to start the feeding trial, they were randomly released into 180L glass aquaria at a density of 20 fish/tank. There were five replicates for each diet. The average body weight was 9.01 g at the beginning of the trial.

During the 8-week trial, water parameters were regularly monitored to ensure that fish were cultured under optimal environmental conditions: continuous aeration, sufficient water flow, temperature at 25-27°C, pH from 6 to 7, dissolved oxygen at no less than 6 mg/l and low levels of ammonia and nitrite.

Table 1. Composition (% inclusion) and proximate analysis (% product) of experimental diets

Treatment Diet	FM control	Veg control	PBM	FtM-A	FtM-B	BdM
Fish meal (local)	10	0	0	0	0	0
Soybean dehulled	35.2	45.15	35.2	35.2	35.2	35.2
Canola meal	5	10	5	5	5	5
Poultry by-product meal	0	0	9.94	0	0	0
Hydrolysed feather meal A	0	0	0	7.36	0	0
Hydrolysed feather meal B	0	0	0	0	7.35	0
Blood meal (pork & poultry)	0	0	0	0	0	6.88
Other ingredients	49.8	44.85	49.86	52.44	52.45	52.92
Proximate composition						
Dry Matter	93.6	92.1	92.8	92.3	92.8	92.7
Crude Protein	30.3	32.4	30.7	30.8	30.8	30.4
Crude Fat	7.3	6.6	7.9	6.5	7.0	6.3
Ash	8.8	7.9	8.2	6.7	7.3	6.9

Graph 1. Proximate body composition of fish (% dry matter)



For 8 weeks, fish were hand-fed twice a day (8.30 am and 2.30 pm) to visual satiety and apparent feed intake was recorded. Bulk weights of the fish were recorded at the beginning of the feeding period and at the end of the 8-week feeding trial in order to calculate weight gain. Initial body composition was also determined from a minced sample of three fish. Final body composition was analysed from three fish from each tank.

Digestibility measurements were conducted after this trial with new batches of each feed containing 0.5 % of chromic oxide (Cr_2O_3). Fish were fed these diets for 2 weeks during which faeces were collected daily by siphoning. Statistical analyses were performed using ANOVA and the differences between averages were compared using Duncan's multiple range test, with significant differences at $p<0.05$.

Equal growth with fish meal controls

During the 8-week feeding trial, mortality rate was low (6% on average) and comparable in different tanks. All fish showed good growth performance: final weights were from 45.33 to 49.61 g with no significant difference between the two control diets (fish meal and plant based) and any test diets containing land animal proteins instead of fish meal ($p>0.05$) (Table 2). Moreover, there was no indication of a decrease of palatability or feed acceptance with any diet.

The specific growth rate (SGR) of the fish fed diets PBM, FtM-A, FtM-B, BdM were not significantly different from fish fed the FM control diet. However, fish fed diet PBM showed higher SGR as compared to fish fed other land animal proteins or plant-based diet. Likewise feed conversion ratio (FCR) was good for all fish batches although it is slightly better in fish fed with diet PBM (Table 2). These results show that tilapia fish were able to produce acceptable growth out of the feed they received, and even a little more with feed containing poultry by-product meals instead of fish meal.

Table 2. Zootechnical performances of tilapia after the 8-week feeding period (means±SD)

	FM control	Veg control	PBM	FtM-A	FtM-B	BdM
Final Body Weight (g)	47.12± 0.80	45.82± 1.84	49.61± 5.60	45.71± 1.51	45.33± 1.81	45.48± 1.04
SGR (Specific Growth Rate, %/day)	2.95± 0.03^{ab}	2.90± 0.07^{a}	3.03± 0.19^{b}	2.89± 0.06^{a}	2.88± 0.07^{a}	2.84± 0.05^{a}
Rate of Feed Intake (%/fish/day)	3.17± 0.15	3.08± 0.16	3.01± 0.19	3.11± 0.07	3.11± 0.08	3.10± 0.08
FCR (Feed Conversion Ratio)	1.35± 0.13	1.33± 0.04	1.30± 0.03	1.35± 0.05	1.33± 0.04	1.32± 0.03
PER (Protein Efficiency Ratio)	2.43± 0.22	2.32± 0.06	2.49± 0.05	2.39± 0.08	2.43± 0.07	2.47± 0.05
ANPU (Apparent Net Protein Utilisation, %)	41.16± 3.66^{bc}	38.30± 1.04^{a}	43.04± 1.12^{c}	38.99± 1.33^{ab}	41.08± 1.12^{bc}	41.67± 0.88^{c}
Means with different letters across rows are significantly different ($P < 0.05$).						

Protein efficiency ratio (PER) showed some variations between diets but with no significant differences ($p>0.05$). Regarding apparent net protein utilisation (ANPU), there was no significant difference between diets containing land animal proteins and the FM-control diet ($p>0.05$). On the other hand, plant-based diet shows significantly lower ANPU, indicating an insufficiently balanced diet for muscle deposition.

It was noted that ANPU in fish fed both diet PBM (43.04%) and diet BdM (41.67%) were significantly higher than for diet FtM-A (38.99%). Higher ANPU meant that protein may be utilised for growth rather than for energy. This is linked to the influence of protein:energy (P:E) ratio variation on growth and protein utilisation. This was confirmed by proximate composition of whole body fish at the end of the trial (Graph 1). In the case of fish fed diet FtM-B and diet BdM, fat content was significantly higher as compared to fish fed diet FM-control (18.91% and 17.50% versus 14.38%) and protein content is significantly lower (57.35% and 56.49% compared to 59.45%). This suggested that ingested protein was consumed by the tilapia as a source of energy rather than for muscle deposition, and ingested fat was stored instead of being consumed as energy source. Digestibility measurements showed similar results.

Conclusion

The results of this study showed that it is possible to replace 100% of the fish meal in diet of the Nile tilapia with land animal proteins such as poultry by-product meal, hydrolysed feather meal or poultry and pork blood meal, with equivalent fish growth. Growth performance was even slightly better with poultry by-product meal.

Further trials are recommended to investigate whether this could be explained by different amino acid profiles of the diets, given that formulas were not supplemented with amino acids. These land animal ingredients are better candidates for total fish meal replacement than plant proteins, most certainly because they bring similar nutrients to fish meal, which are needed by fish for good growth performance. Differences in composition of the fish were observed, suggesting that monitoring the P:E ratio in the formulation (or even better: digestible protein over digestible energy ratio) would help to optimise protein utilisation by the fish and consequently optimise economic efficiency of these diets.

Land animal proteins used in this trial were produced in France by Soleval, following the highest European standard regarding food safety and product quality. Results would most certainly be different with products from different origin and different processes.

Besides being a sustainable alternative to fish meal, using land animal proteins also leads to lower diet prices. If nutritionists replace local Thai fish meal with these land animal proteins the formula price will decrease by 5% to 8%. If they replace Peruvian fish meal, the price will decrease from 10% for plant and poultry by-products based diets but up to 15% for feather meal based diets.

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Aquaculture Centre for Applied Nutrition

Biomin continues its collaborative commitment in Vietnam by setting up a new research centre

The new Biomin Aquaculture Centre for Applied Nutrition (ACAN) located at Nong Lam University, Ho Chi Minh City, had its grand opening ceremony on June 30, 2015. The new 900m^2 research centre will drive the research and development of innovative and effective solutions to pressing challenges in the industry. It was attended by more than 150 guests, including representatives from local government, academia and the aquaculture industry.

This centre signifies the continued collaborative efforts of Biomin in conducting innovative and high impact research, which is supported by partnerships with the local government and university. It aims to provide effective solutions to the aquaculture industry, focussing on several key areas, namely: nutrition and feed formulation, gut health and immune modulation and waste management and feed safety.

Research will be centred on several of the most important species in the region's aquaculture such as catfish, tilapia, sea bass and shrimp. Biomin's collaboration with Nong Lam University in R&D activities is coordinated by the Biomin Research Centre in Tulln, Austria together with the technical staff at the facility.

The facility is a testimony of Biomin's dedication to the aquaculture industry. Jan Vanbrabant, Managing Director, Biomin Asia-Pacific said, "The wider benefit is to build the academic and research pipeline in Vietnam, by creating undergraduate research opportunities and mentorship for local students."

The 60 year-old Nong Lam University is a major agriculture university. Bachelor and masters programs in aquaculture were added in 1974 and doctoral degrees from 2013. According to Luu Thi Thanh Truc of Nong Lam University, there are several ongoing programs. "The nutrition group focusses on fish health and is looking at the effects of dietary inclusion of various components. The work is usually with the tilapia and pangasius. We have a faeces collection system for digestibility trials and also facilities for disease challenge tests. Field trials are important to us and some recent projects are the culture of seabass and shrimp, biofloc in farms and improving growth of the local eel."

In addition, Sanphar, a veterinary products and services company, runs a state-of-the-art microbiological laboratory also located in Nong Lam University. Sanphar and Biomin are both part of the Erber Group. According to Kai Grathwohl, Managing Director at Sanphar Asia Pte Ltd, this is one of the few laboratories with such complete diagnostic facilities in Vietnam for livestock and, in the future, also aquaculture. For aqua diagnostics, the centre has conventional and real time PCR and results will be available within 1-2 days. Bacteriological analysis is completed in 3-5 days.

ACAN in Vietnam has cutting-edge recirculating systems and two challenge rooms. There are five systems, each with 24 tanks of 100L, 340L and 1000L capacities to run trials for freshwater and marine fish and shrimp. There are four quarantine tanks each of 2000L. A feed formulation laboratory for preparation of test diets, includes a laboratory scale feed extruder. This will allow testing of different ingredients and solutions under conditions similar to those found in the field.

R&D at Biomin

Prior to the opening ceremony, Biomin held a half day seminar to present the 'behind the scenes' work of researchers leading to the development of natural solutions for industry. In Austria, the Biomin Research Centre is staffed by 80 scientific researchers and supported by eight centres for Applied Animal Nutrition (ACAN) and a research network of 150 academic and research institutions globally. The areas covered are in the poultry, swine, cattle and aquaculture sectors.

In June, tanks were used for product testing with the snakehead, seabass and vannamei shrimp. High saline water is transported from Vung Tau and diluted to 15ppt for the experiments with marine fish and shrimp.

R&D is the cornerstone of Biomin's success, said Franz Waxenecker, Director Development Department. He described the transformation of research into products for industry. "In general, the research teams continue to pursue ideas. One such development is FUMzyme, the first and only enzyme to completely degrade fumonisins into non-toxic metabolites. The success after several years came with a side charge to the formulae. It took 6 years from the development of FUMzyme to market stage.

"Biomin research teams are clustered in a matrix organisation. Central to our success is the co-development between corporate groups, research teams and scientists at universities. One significant output from this co-development was LC-MS/MS techniques which could identify 39 mycotoxins in one run in 2006 and by 2015, more than 380 fungal and bacterial metabolites. This knowhow is helping the industry. For each product development, the final step is to conduct in vivo trials to test prototypes at our ACAN network. In Asia, it is in Vietnam and Kasetsart in Thailand."

The Biomin team (from right, Franz Waxenecker, Jan Vanbrabant, Pedro Encarnacao and Goncalo Santos) with Luu Thi Thanh Truc, Nong Lam University (third from left) and Yongwee Liau, Managing Director Romer Labs (second left).

Dr. K. C. Patra, Biomin India (middle) with industry from India, from left, N.V.S.S Narayana Reddy, Nexus Feeds Limited, Bhimavaram, S. Devaki Reddy and S. Sharat Reddy, Sharat Industries Limited, Nellore, P.K. Rout, (second right) and P.K. Nayak, Pasupati Feeds, Odisha (right). Also in the picture, Bor Yu Leu, Pingtai Enterprises Ltd, Taiwan (third right).

Product development for aquaculture

"Behind the scenes, it is more the science that we generate in the laboratory," said Goncalo Santos, Aquaculture R&D Manager. "In the development and evaluation of probiotics for aquatic animals, we know that the environment is dynamic and therefore using beneficial bacteria to improve water quality is essential. Different bacteria have different specificity and so when we start the R&D process, we need to assess in vitro in the laboratory and in vivo in the field. In the laboratory, it is isolation, safety, pathogen control, water quality, nitrogen degradation, enzyme production and survival whereas in the field, it is to assess the animal performance, productivity, immune modulation etc."

On probiotic inhibition of the EMS (early mortality syndrome) Vibrio, Santos said, "Not all strains have the capacity to inhibit the EMS Vibrio and no single bacteria can do this either. Our earlier studies showed that some strains have the capacity for quorum sensing to inhibit *Vibrio harveyi*. But phytogenics can do this too.

Solutions for sustainable aquaculture

In aquaculture, there are three main sustainable farming practices; management of the water environment and its quality, and feed and health management. Pedro Encarnacao, Business Development Director said that now Biomin has a product portfolio which can cover these areas but this was after considerable product development. "In the case of phytogenics, we know that there are applications but how to get this into the animal as the additive has a strong smell. So, we have the matrix encapsulation of various phytogenics in Biomin P.E.P. Trials in ACANs and the research Institute in Portugal showed the utilisation efficiency with the tilapia, seabass and pangasius. An interesting outcome in the trials with Vietnamese integrator, Hung Ca in Vietnam, was the improvement in fillet quality with 28% white fillet."

"Mycotoxins is a main business of Biomin and the effects on fish are reduced growth, mortality and lower weight gain. A student at Nong Lam University carried out a 56-day trial on effects of aflatoxin B1 (AfB1) on growth performance in pangasius catfish. The effects of aflatoxins on the immune system were studied and pangasius was fed with AfB1 contaminated feed and later challenged with *Edwardsiella ictaluri*. We showed the extent of liver damage with histology. Mycofix applied to feeds was able to bind the toxins."

"Overall, we can see how these products are connected and we try to have a complete portfolio of natural solutions. But here in Asia, farmers are too focussed on cost as compared to the salmon industry where farmers work to improve production efficiency."

Jeju's olive flounder

The olive flounder is a symbol of the aquaculture industry in Jeju Island. Producers are well organised and are proud of the quality of the fish produced. The Jeju-do Marine Fish Culture Co-operative actively promoted the fish at the Olive Flounder's Day at World Aquaculture 2015.

The olive flounder, *Paralichthys olivaceus*, is the most important farmed marine fish in Korea with a production of 42,133 tonnes in 2014. Korea is the leading producer (Bai, 2015) after Japan. Jeju, located southeast of the Korean peninsula, has 350 out of the 500 licensed farms producing the fish. Unique to Jeju is underground seawater from 100m deep aquifers and two thirds of its olive flounder farms depend on this water.

Jeju is ideal for the farming of the olive flounder with constant water temperatures of 16-18°C, safe supply of underground water, and the warm Kuroshio Current (Lee, 2015). With such constant water temperatures, the fish reach market size 2-3 months earlier than elsewhere, giving Jeju farms a competitive advantage. In 2013, Jeju produced 23,002 tonnes of the olive flounder, accounting for 62.3% of national production; but recently increased mortality rates due to diseases, has decreased per unit production. (Myung, 2015).

Operations

Insights into the operations at three farms were made possible during a post conference farm tour. At the farm of Daejususan Co Ltd, Lee Seong Yul, President, said that the farm uses a flow-through system; and since water is drawn from the shallow parts of the sea, water is sand-treated and channelled into reservoirs before use. Regulations dictate that used water have to be treated prior to discharge, but there are still concerns regarding pollution, as most farms are close to each other along the coast. The production at this farm is 100 tonnes per year and the indoor square or octagonal tanks of 140 m^2 have a water depth of 60 cm. Dark netting provides a dark environment for the fish. The 36 tanks consume 2,000 tonnes of water per day. The farm uses soft pellets.

Nursery culture starts with 7 cm juveniles and after 45 days, 12 cm juveniles are transferred into grow-out tanks. There are about 20,000 juveniles per tank, with a stocking density of 20 kg/m^2 for 1.3 kg fish. One of the problems encountered during the grow-out phase is adult fish with black colouration due to poor water quality; in such cases, fish are discarded after 2 days. In general, survival rate is 60% during the early part of the grow-out because of diseases.

Lee said that although the minimum harvest size is 1.2 kg, his main markets are US and Europe which demand larger fish; the US requires at least 2 kg fish which takes 18 months and the European markets, a minimum size of 3 kg which will take 22 months. Harvesting is once a week. The farm is compliant with HACCP and GAP (Good Aquaculture Practices).

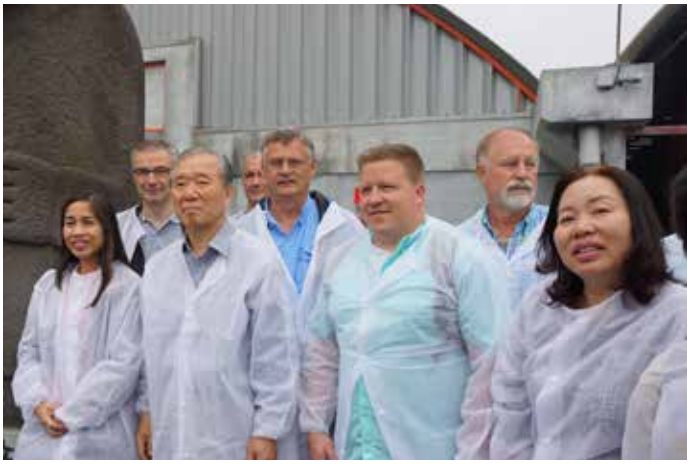
At the larger DaeKyeong Fish Farm, located a few kilometres away, Song Cheol Kim, President, said that the production is 400 tonnes per year of the olive flounder and Korean rock fish. The flounder is the main product and the market size is 1 kg, although larger fish are more profitable. Oh Dong Hun, Jeju Fish Culture Fisheries Cooperatives, said that this farm has some modern features, setting it ahead of other farms. There are raised ledges along the walking platforms for better biosecurity. The roofing material includes a plastic liner, in addition to the commonly used black netting. The farm also oxygenates the water. There are 12 workers, 5 of them from Indonesia.

The Jeju Olive Flounder's Day, organised by the Jeju Special Self Governing Provincial Council and Jeju-do Marine Fish Culture Co-operative. It included sampling of olive flounder and a cooking competition.

Extruded feeds

A recent trend is the use of extruded pellets instead of moist pellets. This serves two purposes, protecting natural resources and introducing improvements such less labour intensive practices. Previously with moist pellets, 2-3 kg of feed are required to produce 1 kg of fish. With extruded pellets, the feed efficiency ratio improved to 1.2 (Myung, 2015).

Further inland on the west of Jeju Island, there is the USD10 million central and local government funded SUHYUP (National Federation of Fisheries Cooperatives) feed plant project at Bogeurak. The aim is to manufacture extruded pellets for industry to use at a low cost. The production is 10,000 tonnes/year of feeds for the flounder, breams and rockfish. The factory is fully equipped with two extruder lines with 80 mesh pulverisers, mixers, twin-screw extruders and DDCs which produce 2.0 to 15.5 mm pellets. The equipment was sourced from Muyang, China.



Lee Seong Yul, Daejususan Co Ltd (second left) with WA2015 post conference tour participants.

These tanks with 60 cm of water depth hold more than 2,000 fish each of 1.3 kg.

There is also a vacuum coater to produce 25% fat pellets, as the demand is for pellets with more than 20% fish oil added. Packing and loading uses a robot.

"The reason for this feed plant is to get the farmers to move away from preparing feed using raw fish, etc. We want the farmers to use pellets and not pollute the water. This was the government's stand some 10 years ago. The amount of fish meal is still high at 20% and the protein level is 53%. We also add krill meal as an attractant.

"Currently, we are at the intermediate stage where we are encouraging farms to use the pellets by supporting some of the costs of these pellets. The factory is now producing at half its capacity. Feed is sold at USD 50 for a 20 kg bag. Feeds for the flounder are packed in LDPE bags," said Jaepoong Um, representative director.

Markets and promotions

The olive flounder is very popular in Korea and is usually consumed raw because of its flavour and firm texture. The highest farm gate price was KRW 11,576/kg in 2013, but lower domestic demand has brought down prices to KRW 10,000/kg in 2014. This is equivalent to, or lower than the production cost. In 2009, when production volume was at its highest at 30,900 tonnes, farm gate prices were as low as KRW 9,878/kg (Lee, 2015). (1 USD = 1,194.17 KRW)

Jeju Fish Culture Fisheries Co-Op is very active in generic marketing of the fish at various seafood shows. There is a ban on the use of antibiotics in its farming, and to maintain the integrity of Jeju's olive flounder, the Jeju Fisheries Agency conducts random tests on fish before harvesting for 36 types of antibiotics, including oxytetracycline and chloramphenicol. Fish failing these tests are converted to fertiliser, according to the cooperative.

Together with other flatfish, the olive flounder is exported to the US, Japan, China, Taiwan, Singapore, Malaysia, UAE, Canada, Hong Kong and Vietnam. The Jeju Flounder Company is producing and marketing its Jeju Garlic Flounder where garlic is incorporated into the feed from early stages of culture to harvest. In 2011, the National Fisheries Research and Development Institute and Geoje Fish Aquaculture Association jointly developed live fish containers for transport and these are now used to export live fish to the US.

Baiksoo Han, TSP Korea (right) with Fang Jo Jeong, CEO of Jeju Developing Aquaculture Farm (centre) and Apirux Kimawanit, TRF feedmilll, Thailand. This 10-year-old farm cultures olive flounder, turbot and rainbow trout and is also a tourist destination.

Challenges

Biosecurity, fish health, welfare and sustainability are some of the challenges faced by industry in Korea, said Isidor Yu during the aquaforum session of the conference. To maximise use of limited land resources, farms incur high capital investments to achieve high outputs through high stocking densities. The Jeju National University initiated a farmer's group to move towards sustainable production practices following GlobalGap standards. It said that conventional olive flounder farming use methods which maximise short term productivity, profitability and high density culture without regard for animal welfare and the environment (www.globalgap.org). However, by 2015, only two farms have structured their systems and are GlobalGap certified.

According Myung (2015), productivity has been declining due to disease outbreaks. Since 2002, selective breeding has focussed on growth rates and growth is 30% faster with phenotypic selection. Selective breeding to develop disease resistant strains focused on *Edwardsiela tarda*, Viral haemorrhagic septicemia (VHS) and scutica. The development of immunity improved strains of the olive flounder is a target for 2015 by government institutions to reduce fish mortality.

Jeju producers need to have an international competitive edge. Myung said that focusing on growth is not the solution. Qualitative growth in terms of technical managerial advancements is required for more sustainable growth. The focus should be on production of high quality seedstock, a shift from the high usage of seawater and electricity to green technology such as recirculation aquaculture systems and biofloc technology, efficient feeds and automation to reduce the dependence on foreign labour.

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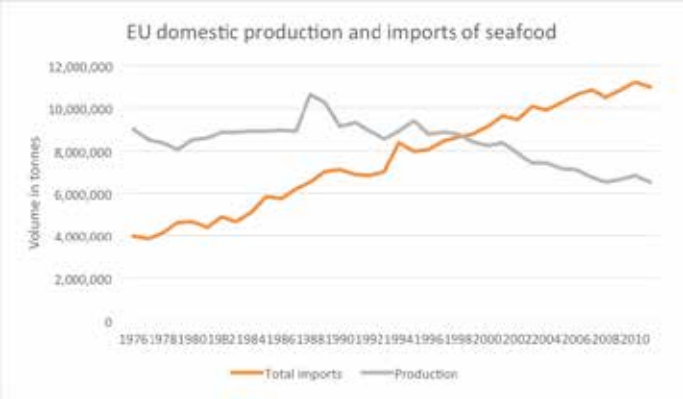
Marine cage culture in Europe – development and prospects

By Erik Hempel

Technological and biological solutions may facilitate further expansion and it will most probably be in the Mediterranean.

Europe is in a difficult position with regard to supplies of seafood. Demand is high and growing, but production is declining. Thus, every year, Europe depends more and more on imports of seafood from other countries. Capture fisheries are not able to produce more, so the only hope is aquaculture.

The European Union has seen declines in total seafood production since the late 1980s. Total production peaked in 1988 at 10.6 million tonnes. In 2011, production had declined to just 6.5 million tonnes. At the same time, demand is increasing, and this has to be met by increased imports. EU imports of seafood rose from 6.5 million tonnes in 1988 to 11 million tonnes in 2011.



Source: FAO FishStat

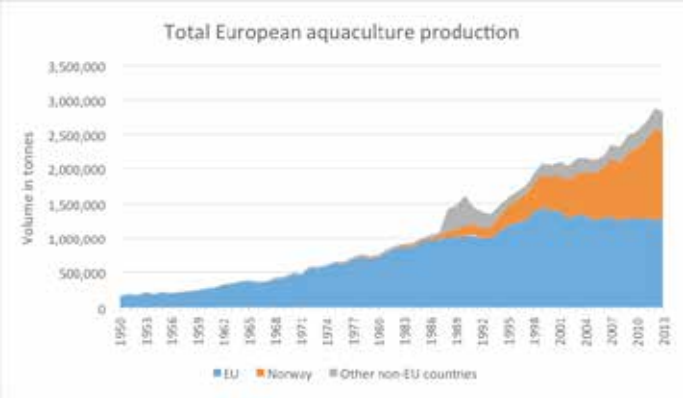
Over the past 40 years, marine aquaculture in Europe has grown dramatically. However, most of this growth has been due to the amazing success of salmon farming in Norway, which is characterised by floating cage operations. With the Norwegian success in mind, one may now ask: is it possible for the rest of Europe to copy this achievement through a dramatic expansion of floating cage marine aquaculture?

Present situation in Europe

Total European aquaculture production, (including freshwater, brackishwater and marine production, and including aquatic plants) amounted to just over 2.8 million tonnes in 2013, of which Norway alone accounted for over 1.25 million tonnes (44.2%).

European marine aquaculture production has grown more than ten-fold since 1960, from just over 208,000 tonnes to almost 2.4 million tonnes in 2013. Most of this production comprises salmon and troutwhich consists of 67% of the total production volume. The second largest species group is mussels, followed by miscellaneous coastal fishes and oysters.

However, if we look at the EU and exclude Norway, aquaculture production has actually declined over the past 15 years, after



Source: FAO FishStat

peaking at just over 1.4 million tonnes in 1999. In 2013 almost 75% of the production came from the marine sector.

Major farmed species

The nature of European aquaculture has changed dramatically over the past 50 years. In 1960, mussels and oysters were the dominating species, and finfish production was insignificant, except for the production of rainbow trout. In 2012 the picture was completely changed. Finfish had become dominant, with salmon, seabream, rainbow trout, seabass and turbot placing themselves among the top ten species grown. The production of mussels, comprising several species had also grown considerably.

In 1960, France was the leading aquaculture nation in Europe, accounting for 107,900 tonnes, almost 52% of the total production. In 2012, Norway was by far the largest producer nation, with 1,321,034 tonnes or 56% of Europe's total marine aquaculture production. Spain, which has a large production of mussels and oysters, came second, while France had slipped to fourth place.

EU strategies for aquaculture development

In 2002, the European Commission published the report *"A strategy for the sustainable development of European aquaculture"* (COM (2002) 511). The strategy specified a number of initiatives aimed at stimulating the development of the sector, but until now, these initiatives do not appear to have worked. Production has in fact been reduced rather than increased, and the Commission has therefore prepared new strategic guidelines for EU aquaculture based on long consultations with stakeholders. In 2013, the Commission issued a communication on *"Strategic guidelines for the sustainable development of EU aquaculture"* (COM (2013) 229), which sets out guidelines that are coordinated within the EU's New Fisheries Policy (NFP).

The *Strategic Guidelines* for the sustainable development of EU aquaculture recognises that there are a number of challenges facing the industry in the EU. The guidelines specify four such challenges:

- Administrative procedures
- Coordinated spatial planning
- Competitiveness
- Level playing field

The above challenges do not address the geographical, physical or biological problems that may have significant impacts on the culture system. The strategic guidelines are solely concerned with the bureaucratic infrastructure of the EU and member countries.

Administrative procedures

It is obvious that aquaculture cannot be left to develop freely in a country without a solid plan. There is a need for some administrative and environmental control. Many countries, especially within Europe, are burdened with administrative costs and lead time play an important role in the overall competitiveness and development of the sector.

The European Union is known for its huge bureaucracy that is often difficult to manoeuvre through. Obtaining authorisation to establish an aquaculture operation can take an inordinately long time. A recent study revealed that the process of obtaining such authorisation in the EU averaged between 2 to 3 years. In comparison, the highly efficient Norwegian aquaculture industry has a much improved situation. In Norway, the average time to obtain a licence for aquaculture farms has been reduced from 12 months to just 6 months, mainly by the introduction of 'a single contact point'.

If Europe, and more specifically the EU, is to succeed in expanding its production, the administrative procedures and lead times must be reduced significantly. The guidelines suggest that the administrative procedures in member countries should be studied in detail. However, it does not prescribe any initiatives to improve the situation.

Coordinated spatial planning

Marine aquaculture needs proper and good locations for optimal operation. Lack of suitable sites are often cited as an obstacle to the expansion of marine aquaculture. Norway alone has more suitable localities for aquaculture development than the rest of Europe put together, and it is therefore in Norway that the most aggressive expansion will probably take place.

The EU strategic guidelines specify that member nations will be solely responsible for the coordinated spatial planning, including maritime spatial planning for marine aquaculture development, However, once the coordinated spatial planning has been put in place, the guidelines suggest that the Commission will be responsible for monitoring the aquaculture development in the EU.

The EU today consists of 28 member nations, each with their unique bureaucracy. There is a need to improve coordination through better spatial planning and a more unified regulatory framework if a significant expansion of aquaculture production is to be achieved.

Competitiveness

The Commission is quite concerned with improving the competitiveness of EU aquaculture, but the measures proposed to enhance this competitiveness look disturbingly much like subsidies. In the strategic guidelines, the instruments defined under the Common Market Organization (CMO) and the new European Maritime and Fisheries Fund are proposed as instruments that should be used to improve the EU aquaculture industry's competitiveness. Subsidies do not create a profitable industry. In fact, subsidies tend to do exactly the opposite, because in order to demonstrate the need for continued subsidies, the industry needs to show that it is not profitable.

A level playing field

The strategic guidelines also mention that a level playing field is needed for the EU aquaculture industry to prosper and exploit its competitive advantages. Producers in developing countries will probably protest, because as seen from their perspective, the playing field is far from being level and against their advantage. In fact, over the years, the EU has put in place a number of non-tariff barriers such as hygiene standards, packaging and labelling requirements and bureaucratic procedures that make exporting to the EU very cumbersome. Many of these requirements do not apply to products produced within the EU, hence there is no level playing field.

Besides the above four challenges, we need to address the geographical, physical, biological or technological challenges that the industry faces. We could mention a few of these below:

- Feed: alternative sources of animal protein in order to produce enough feed.
- Disease: to develop new vaccines against diseases and also to improve farm management systems to prevent disease outbreaks .
- Parasites: to develop new ways to fight parasites (for example the sea lice).
- Technology: to develop truly ocean-going installations in order to bring marine aquaculture further out to sea.
- Pollution: to develop better management practices to deal with emission from the marine installations that may cause pollution.
- Public acceptance: to address public opposition to fish farming in general so that aquaculture becomes a widely accepted food production system.

Conclusion

So will it be possible to develop a modern, industrial cage culture in Europe? It has been done in Norway, Scotland, and a few other places. By 2050, the total European aquaculture production will probably be between 7 and 10 million tonnes. However, over 5 million tonnes will come from Norway alone, and Norway is not a member of the EU, and probably never will be.

There is probably room for expansion of marine aquaculture in certain areas of the EU, such as the Mediterranean. There will be technological and biological solutions that will make further expansion possible. In the EU, there are too many obstacles to make such a development likely. Most of these obstacles are man-made or bureaucratic in nature.

Prospects for an *EU* expansion in cage culture are somewhat bleak. The EU will have to continue relying on imports in order to satisfy demand in 2050 and beyond.

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Table 1. European marine aquaculture production: top 10 species. Volume in tonnes. Source: FAO FishStat

Species	1960	1970	1980	1990	2000	2010	2012
Atlantic salmon	...	294	5,010	201,015	622,442	1,160,622	1,492,757
Blue mussel	109,400	131,800	159,457	187,388	189,890	179,592	153,098
Sea mussels nei	4,800	150,000	192,000	173,336	248,101	188,158	204,342
Mediterranean mussel	4,590	9,954	29,244	61,554	79,871	99,375	112,374
Gilthead seabream	...	...	7	1,820	56,923	86,993	98,812
Pacific cupped oyster	65,900	41,551	104,449	143,726	140,134	104,462	91,585
Rainbow trout	1,900	430	4,675	16,490	61,240	71,188	89,241
European seabass	...	...	10	1,923	41,129	59,234	65,095
Brown seaweeds	...	...	...	5,388	3,008	3,614	6,584
Turbot	...	...	...	656	4 785	9,761	12,496
Other	21,820	21,600	8,014	17,686	30,023	52,388	34,567
Total	**208,410**	**355,629**	**502,866**	**810,982**	**1,477, 546**	**2,015,387**	**2,360,951**

Table 2. European marine aquaculture production by country. Volume in tonnes. Source: FAO FishStat

Country	1960	1970	1980	1990	2000	2010	2012
Norway	1,900	480	7,980	150,583	491,329	1,019,714	1,321,034
Spain	4,800	153,100	194,618	182,865	275,684	229,322	243,964
United Kingdom	...	344	714	36,126	142,287	188,370	191,761
France	107,900	95,904	182,159	209,942	212,562	183,240	166,625
Greece	...	...	23	5,286	91,168	117,063	134,120
Italy	250	6,000	23,474	43,102	59,906	71,953	85,428
Faroe Islands	...	...	222	13,076	34,823	47,575	76,564
Netherlands	77,600	86,000	76,972	99,747	68,892	60,205	42,559
Denmark	...	...	400	6,500	7,264	14,780	16,527
Ireland	2,100	3,701	5,107	25,968	50,130	45,758	35,451
Russian Federation	...	...	...	5,850	3,620	6,264	11,446
Others	13,860	10,100	11,197	31,937	39,881	31,143	35,472
Total	**208,410**	**355,629**	**502,866**	**810,982**	**1, 477, 546**	**2,015,387**	**2,360,951**

AQUACULTURE EUROPE 2015
October 20-23, 2015, Rotterdam, The Netherlands

The Aquaculture Europe 2015 event – 'Aquaculture, Nature and Society' will focus on the role and contribution of aquaculture to the management of natural resources and its importance in society through the provision of high quality, nutritious and healthy food. These are the thematic areas that will be addressed during the plenary sessions. AE15 will also feature an international trade exhibition, industry sessions focusing on RAS and Shellfish culture, student sessions and activities, satellite workshops of EU projects and initiatives and updates on EU research.

There will be three plenary speakers for the three-day conference program: Chris Ninnes, Aquaculture Stewardship Council will speak on 'Demonstrating our sustainability credentials'. Huw Thomas, Wm Morisson Supermarkets Plc will present on 'Adapting to consumer preferences' and Louise Fresco, Wageningen UR will present 'New approaches to production'.

Parallel sessions will cover a range of topics. The nutrition sessions will cover alternative feed ingredients, insect meals and advances in hatchery technologies. The disease sessions include disease description, mapping and epidemiology, fish welfare and spatial planning of aquaculture sites. Sessions will also cover climate change impacts on aquaculture, close containment technologies at sea, offshore production, eel reproduction, genomic tools and metabolomics in aquaculture. More information: www.easonline.org

A view on catfish farming in India

By B. Laxmappa, S. Vamshi and P. Sunitha

With the expansion in farming, more needs to be done to improve efficiency of feeds to bring down production cost.

The Government of India recently identified catfish farming as a national priority and emphasised of the need to diversify culture practices. At present, six catfish species are cultured in India (Table 1). Among these, only two species, pangasius and African catfish are cultured commercially.

Pangasius hypophthalmus: Commonly known as pangas or pangasius in India, this exotic catfish entered India through West Bengal in 1997. India has the second largest production of this fish in Asia after Vietnam. It is estimated that presently over 700,000 tonnes of the fish are produced in the country per annum. The fish is popular with farmers in Andhra Pradesh, West Bengal, Kerala, Orissa and Telangana and is favoured because of its hardiness and fast growth.

Clarias gariepinus: Commonly known as the African catfish or Thai magur, the culture of this species was banned in India under the Environment Protection Act. However, the fish was clandestinely introduced into West Bengal state possibly during 1994 from neighboring Bangladesh. Its farming quickly spread throughout the country but mostly in the states of West Bengal, Punjab, Tamil Nadu, Karnataka, Assam, Maharashtra, Western Ghats, Andhra Pradesh and Telangana. However, seed production is mainly carried out in West Bengal.

Table 1. Catfish species in India.

Common name	Scientific name
Magur	*Clarias batrachus*
African catfish or Thai magur	*Clarias gariepinus**
Singhi or stinging catfish	*Heteropneustes fossilis*
Butter catfish	*Ompok bimaculatus*
Pangas	*Pangasius pangasius*
Sutchi catfish	*Pangasius hypophthalmus**
*Exotic species	

Farming practices

Andhra Pradesh is the major producing state for pangasius particularly in Krishna and West Godavari districts. The pond water area for farming can be from 4 ha to 40 ha. Recently, the fish is an alternative to farming the Indian major carps, particularly in Andhra Pradesh. Shrimp farmers have shifted to farming this fish in their ponds because of diseases with shrimp. In general, the yields are 15 to 20 tonnes/ha/year which is higher than carp production (8-10 tonnes/ha/year).

Farmers culture the pangasius using improved management methods. Large farms use only commercially extruded pellets throughout the production cycle and smaller farms use a combination of pellets and farm made feeds. Pelleted and extruded grow- out feeds have 25 to 28% crude protein with feed conversion ratio (FCR) reported by farmers ranging from 1:1 to 1:3.

Pangasius fed floating pellets in cages

Some farmers use poultry wastes such as intestines and skin as in the case of African catfish farming to lower feed costs.

Changing grow-out methods

Since the last decade, there have been changes in grow-out methods in the culture of catfish. Culture is mainly in ponds which allows for better management of water quality and culture environment. With the availability of floating feeds, particularly in Andhra Pradesh, intensive culture of the pangasius has expanded. Pangasius culture in cages has started in some of the selected reservoirs particularly in West Bengal, Madhya Pradesh, Uttar Pradesh and Jharkhand states in India. The Telangana state government is also planning to initiate pangas culture in floating cages in the reservoirs.

A critical issue in catfish farming is low profit margins as ex-farm prices fluctuate regularly. In July, farm gate prices ranged from INR 50-60/kg (USD 1-1.2/kg). Feed costs (Table 2-3) are more than 60% of total production costs (except for African catfish, Table 4) which have been rising. Although production volumes have increased during recent years, there are doubts on its economic and environmental sustainability. Today, the extremely high stocking density and the feeding of animal wastes have led to risks with the environment.

Harvest of pangasius

Table 2. Farm made/mash feed (with locally available ingredients) for the pangasius in India

Average body weight(g)	Feeding %	No. of feeding/ day	Type of feed	Costs of feed per kg fish production
100-300	3-4	2-3	Boiled corn dough, cooked rice bran etc.	INR 35-40 (USD 0.7-0.8)
300-500	3-4	2-3		
500-800	2-3	1-2		
800-1000	2-3	1-2		
>1000	1-2	1-2		

Table 3. Generally recommended feeding table for high protein extruded floating feed (26% crude protein) for pangasius (Growel Feeds Private Limited)

Average body weight(g)	Feeding %	No. of feeding/ day	Costs of feed per kg fish production
0-50	3.3	2-3	INR 40-45 (USD 0.8-0.9)
50-100	4.8	2-3	
100-250	5.8	2-3	
250-500	8.4	2-3	
500-750	9.4	1-2	
750-1000	10.5	1-2	
1000-1500	11.0	1-2	
>1500	12.0	1-2	

Table 4. Common farm made feed given for African catfish, *Clarias gariepinus* in India

Average body weight(g)	Feeding %	No. of feeding/ day	Type of feed	Costs of feed per kg fish production
0-10	4-5	2-3	rice bran	INR 20-25 (USD 0.4-0.5)
10-25	3-4	2-3	spoiled and discarded cooked eggs	
>30	3-4	once in 3 days	chicken waste raw and boiled	

The current culture practices need to be improved in India and risks factors need to be identified to ensure sustainable development of catfish farming. Most farms exchange water regularly using untreated water and this practice is associated with disease outbreaks. Catfish farming also generates vast amounts of effluents including nutrient enriched waste waters and sediments. These are discharged into the natural ecosystem without treatment.

Another dire issue involves the use of poultry waste products which have adverse impacts on water quality. In the surrounding environment, we find unhygienic conditions where poultry wastes are strewn all around the ponds. In addition, catfish farmers heat up feeds using plastic and old or damaged vehicles tyres creating an environmental hazard with dark and toxic fumes.

Conditioning African catfish in hapas

Live transport of African catfish

Conclusion

The lack of information on the nutrition of the catfish requires more research. Further work in this area is required to bring down the cost of production. The use of floating pellets is desirable for better growth, meat quality and improved fish health. A nationwide campaign to improve the sanitation, environmental conditions and food safety in the farming of the catfish is required.

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Striking harmony in aquaculture

Taiwan moves to balance aquaculture with the environment and food safety.

Sashimi from tilapia farmed in marine ponds using FSE probiotics produced by Fortune Life Enterprises Co Ltd (article in issue July/ August 2015, p55)

The most prosperous period for Taiwanese aquaculture and fisheries was in the 1980s, when the country was a leading producer of the eel, tilapia and black tiger shrimp. However, the excessive number of farms drawing ground water resulted in environmental damage such as ground subsidence, water pollution and soil salination. Following this, from 1990 to 2000, the structure of Taiwan's aquaculture industry underwent adjustment, and the focus of the industry shifted from freshwater aquaculture to marine aquaculture (Ting, et al, 2015).

Fish and shrimp farming has a long history and for it to remain relevant, the new direction by the Fishery Agency, Council of Agriculture, is to balance production and the environment, and emphasise on food safety for aquaculture products to gain the confidence of consumers. The value of aquaculture is a 'harmony' between industrial development and the environment.

Aquaculture production in 2013 was almost 350,000 tonnes, according to official data. Despite these volumes, aquaculture still lags behind capture fisheries which produced almost 926,000 tonnes in 2013. Over five years, from 2009 to 2013, the major changes have been in the production of tilapia, milkfish, seabass and groupers (Table 1).

In 2013, the production of the tilapia reached 73,342 tonnes and for the milkfish, 65,692 tonnes, as these provide inexpensive high quality protein for the population. The latest trend is tilapia cultured in seawater. There is the brackish water red tilapia and king of tilapia (black tilapia) with high ex-farm prices (AAP, 2014). Saline tilapia has better meat texture, without the problem of 'off-flavour' common with tilapia farmed in freshwater ponds. However, growth is much slower with higher production costs. The Taiwan Fisheries Research Institute has been working on improving growth of salt water tolerant tilapia. This research outcome will be published soon.

Farmed seabass is mainly for the domestic market whilst the grouper is targeted for export. However, Taiwan based farms compete with farms in China, which have much lower costs of production and which are increasing output. The Fisheries Agency said that it has several strategies to secure markets and reduce costs. These include using energy efficient live fish carrier vessels. At the production level, it is encouraging efficient feeds for the grouper, development of vaccines to combat diseases and R&D. Breeding programs have already increased fertility by 10% and disease resistance by 15%.

Together industry, government and academics are working to overcome bottlenecks and aim to increase the value of farmed grouper production from NTD 3.8 billion (USD120 million) in 2007 to NTD 8.45 billion (268 million) in 2014.

Table 1. Trend in production of main aquaculture species from 2009 to 2013 in tonnes (source: Fisheries Agency, May 2015).

Species	2009	2010	2011	2012	2013
Tilapia	67,343	74,896	67,224	73,342	72,500
Clam	51,823	60,325	59,764	61,604	56,749
Milkfish	40,834	35,690	49,469	71,598	65,692
Oyster	27,395	36,056	34,643	26,923	27,793
Sea bass	9,547	22,764	24,153	19,394	31,802
Freshwater Clam	10,452	10,654	14,656	14,967	14,179
Grouper	13,480	11,297	13,894	22,356	25,749
White Shrimp	7,761	7,978	8,781	13,318	13,207
Giant Freshwater Prawn	7,470	6,318	6,459	6,759	6,774

Environmental improvement

In the past 5 years, the Fisheries Agency has invested NTD 2.5 billion (USD79 million) to construct and maintain sea water supply systems in 8 locations. This is part of the environmental improvement for aquaculture farms to discourage farms from extracting ground water. In addition, through the extension service, 1,000 farms have installed water recirculation facilities. The Fisheries Agency has formed a recirculation aquaculture

technical assistance team in 2000, to provide technical assistance and training to local governments and fish farmers in different counties. These cover the principles of water recirculation systems in fresh water and seawater ponds, basic research on indoor shrimp farming, management of water quality and operations such as use of mechanical and micro-particle filter systems, and super intensive automatic water recirculation systems in eel and shrimp farming.

Technology transfer

In the 1980s to 2000s, experts from Taiwan spread culture technology together with feed formulation and processing throughout South East Asia. Today, this has been institutionalised through the International Cooperation and Development Fund in the form of technical missions. Teams provide assistance in aquaculture in both Asia and Africa, including building of infrastructure and transfer of technology. The area of assistance covers consultation on special projects, training of personnel, guidance in upgrading and farm operations, assistance to partner countries in solving technical problems and creation of value added products.

Food safety

With improved living standards, consumer requirements for aquaculture products are no longer limited to sustenance, but also include health, safety and sanitation. In 2005, aquaculture products were added to the CAS (Certified Agricultural Standards) system. This means that Taiwan's agricultural and aquaculture products and processed goods recognized by CAS are of the highest quality. The government also actively promoted the ISO-9000 quality and hazard analysis critical control point (HACCP) systems to prevent imported aquaculture products from negatively affecting the environment and consumer safety in Taiwan. This is also to ensure that the quality of exported aquaculture products conform to international requirements (Ting et al, 2015).

Mechanisms are in place to safeguard consumer food safety. There is intra-agency co-operation to manage food safety from the production to processing and marketing levels. The Fisheries Agency is responsible for the random pre-market inspection of fishery products. When any product breaches food safety levels, the Fisheries Agency will request the local government to trace the source of the products. Once the fish farm is traced, the fisheries administrative and the inspection and quarantine agencies will follow up with re-examination and placing them for targeted guidance. When the violation is in the use of animal medication, there will be immediate sanctions. To ensure a stable aquaculture industry, the Agency conducts random inspection of aquaculture feeds including inspection of components of feeds, and residues of melamine, pesticides, clenbuterol, and other medications.

Reference:

Kuo-Huan Ting, Kun-Lung Lin, Hao-Tang Jhan, Teng-Jeng Huang, Chi-Ming Wang, Wen-Hong Liu, 2015. Application of a Sustainable Fisheries Development Indicator System forTaiwan's Aquaculture Industry. Aquaculture 437 (2015) 398–407.

2015 Taiwan Fisheries and Seafood Show

The inaugural trade show on aquaculture, fisheries and seafood will be held from November 19-21 at the newly completed Kaohsiung Exhibition Centre (KEC). In issue July/August 2015, AAP reported on some companies dealing with seafood processing, aquaculture and probiotics. This is continued in the following pages and features companies manufacturing equipment for seafood and aqua feed processing, pumps and cages as well as a feed miller and a multinational aquaculture company.

Strong and hardy cages

Cages made by Taiwan's **Toford Aquaculture** can be seen in all of Asia with 1,046 delivered since 1995. Toford made its initial foray into cages for aquaculture when as the Asian partner handling Norwegian polar cirkel cages, it was repairing damaged structures. After its experience with handling cages ravaged by typhoons off Taiwan, the company decided to embark on its own R&D.

Today the company has a range of cages for customers including walkway paths. Hoff F.C. Cheng, President and CEO, said, "Since 1991, cage structures were with HDPE piping. We then started our own R&D to develop cage structures, building from our knowledge and expertise with HDPE piping in homes under the Toford Plastic Co in Taiwan. We introduced the double stanchion cages made with high strength HDPE 100 materials. One of our latest products is the 3-collar extra wide stanchion to increase the separation between the predator net and the stock net.

"We have grown from supplying small cages in Taiwan to large international orders with 20m diameter cages. We now have a comprehensive range for cages with diameters of 100m with 630mm pipes. We also have a range of raft boats which we recently delivered to Papua New Guinea."

Toford has the signature orange handrails which are cooler to touch in comparison to the more common black handrails. "We stand out as we use butt fusion technology unlike many cage manufacturers in Asia. This resists strong typhoons such as the ones in Taiwan and in other regions. We have delivered 250 of our cages to the Philippines. In Japan, we work with net manufacturer, Nitto Seimo and together have delivered 420 cages. We also work with KikkoNet and together with net manufacturers, we have also developed the triple collar nets for some of these cages. Another innovation is the sinker tube which will help to keep the shape of cage nets."

On further expansion of the business, Cheng said, "The largest potential is the Japan market. Another market could be Indonesia where they are looking at farming young tuna. We will focus onAsia as if we were to market into Europe, that is, we will need to have technicians there to provide the technical service. Our cages have a long lifespan. For example, in Japan we installed some cages in 1998 and these are still in use."

Hoff F.C. Cheng (left) and Dave Cheng, Project Manager showing the large 2 and 3-collar stanchions

Food machines made in Taiwan

Anko Food Machine Co Ltd is well recognised as Taiwan's contribution to the processing of traditional foods. Established in 1978, Anko began by manufacturing electric-free automatic bean seed spouters for families and restaurants. Today, it produces machines for food preparations such as value added seafood (eg sharkfin and tilapia meat dumplings and shrimp dimsum or hare ko) to others such as the Arab preparation, kubba.

At the heart of the company is innovation, the role of the 21-man R&D team. CEO Robert Ouyoung said, "Every year we develop 5-10 new machines. Customers come to us after exhibitions or contact through the internet. In general, they are actually producing the food manually and together we work to develop a machine with as much automation as possible. One example is the machine producing 30,000 pieces of dumplings per hour. Some 80% of our market are machines for the frozen food sector.

Recent major markets are Russia, Poland and Ukraine. Vietnam also came to be a major market for us in 2014 and most of the requests were for value added products such as spring rolls produced at 2,400 pieces per hour. The machines are custom made."

In this sector, the main competitors are machine producers in Japan. Japanese customers usually source Japanese made machines which are 30-40% more expensive than the Taiwanese equivalent. "However, since 1990, we have sold machinery to Japan and we continue to have enquiries from Japanese food manufacturers. This indicates that our Taiwan made machines meet the stringent quality requirements of Japanese buyers. Usually small and medium food producers will seek our machines whereas the large producers will source from large multinational companies mainly located in the US and Europe. However, we do have some large customers buying our machines as they believe in our sales and technical services. Our machines can last more than 10 years if they are well maintained."

"Market demand from the frozen food sector for such machines is increasing. I believe it is bigger than the bakery business. Yearly we produce 800-900 machines of different types and sizes. We also supply turnkey projects where we combine mixers, choppers etc. All these are from manufacturers in Taiwan."

Anko has one factory in Taiwan and two in China which produce parts. Machine producers in China are also our competitors and for the Chinese market, we only supply simple machines. In future, we expect more competition from China as they are beginning to innovate too," said Ouyoung.

Robert Ouyoung. As a member of the Taiwan Turnkey Project Association (TTA), Anko also supplies turnkey projects using equipment from Taiwan manufacturers.

San Szu Chang (right) and son Evan Chang with the best selling BL1075C with an 8-inch pipe for a water flow of 7.5m3/min.

Veteran in vacuum packaging

Jaw Feng Machinery is a 30-year old manufacturer of vacuum sealing and packaging machines, vacuum massage tumblers and complete equipment. Located in Chia Yi County, the company services a range of industries from meat, poultry, seafood and dairy to the medical and pharmaceutical industries. Besides marketing its own brand, the company is also OEM for well known companies in the US, Europe and Japan.

The in-house R&D team work with customers on customisation and new innovations. In the past 6 years, they have developed advanced thermoforming packaging machines and automatic tray sealers for the food industry. The machines are exported to more than 130 countries.

"We have earned the trust of customers because of our emphasis on quality, equitable pricing as well as after sales service. Nowadays, our technology is very close to that of manufacturers in Japan, the market leader. The testimony is when Japanese customers buy our machines. Our highest selling machines are the fish fillet packing machines sold to Japan and Taiwan. In Taiwan, we have a 50% market share. Some 60% of our sales revenue is from sales in Europe, North America, Mexico and Canada. The other 30% is from the rest of the world and 10% from within Taiwan. There are 10 packaging machine companies in Taiwan and we are in the top 3," said Biao Kuo, General Manager.

On competition, Kuo said his machines are 25-40% cheaper than German made machines but more expensive that those manufactured in China. However, most of the machines made in China are sold mainly to smaller food producers within China.

On new trends, he said, "The future will see more demand for thermo packing especially for snack foods. I also believe that there will be a demand for more automation, especially in the seafood processing industry as less people will be interested to work in seafood plants. There will be demand for more customised machines such as for automatic filling jobs."

Biao Kuo, Jaw Feng Machinery

Energy saving aquaculture pumps

San Szu Chang founded **Sonho Pump Mfg** Co Ltd 20 years ago. With good sales track records particularly in Malaysia and other Asian countries, the company has recently moved to a larger facility. Sales have been growing annually at a rate of 10% and reached USD7 million in 2014. The best selling items are submersible pumps for aquaculture of 3,5, 7.5, 10 and 16HP. These were developed 20 years ago. Sonho also manufactures rotary aerators for waste water ponds.

Idah's James Chang

According to Chang, his strength is the high quality stainless steel manufactured in Taiwan. In pumps for seawater, stainless steel is used for the inside cavity. Copper and iron coatings give a life span of only 4 years. Sonho has been developing energy efficient pumps with reduction by 10-15%, for quite some time. However, with the new regulation in Taiwan to lower energy consumption, all new models will be energy efficient.

Chang added that in comparison with Japan made pumps, Sonho pumps use less energy such as only 7.5HP for an 8-inch pump. As the ones made in Japan are 5 times more expensive, his buyers will save both in the cost of the pump and operational costs.

Japan is a potential market and Sonho will work with a Japanese company on OEM production. This is an achievement as it shows that Sonho pumps are accepted as equal to Japanese pumps. Chang attributes this to technological advances and materials.

From feed to food grade SPC

With over 40 years manufacturing aqua feed processing equipment, **Idah Co Ltd** continues to provide new solutions to its customers. Founder and President James Chang described the new company focus with food grade soy protein concentrate (SPC). Idah demonstrates this to customers at its new food grade laboratory. It also supplies extruders and related equipment. With this development, Idah supplies equipment to three industries; feed, biofuel and food.

James Chang started Idah in 1974 when the aqua feed market was just growing. The company has several firsts and among them was the development of the first feed extrusion system in Taiwan in 1982. In 1986, it developed the first post conditioner for shrimp feed production. This become a standard in achieving water stability in shrimp feeds. Today, three-phase preconditioning is an industry standard in shrimp feed processing. Another first was the contra twin screws extruder for feed and food application in 2009. It re-engineered screw designs and rotation direction to accommodate future feed formulations such with high fibre plant proteins. A system was successfully set up in the Netherlands.

Idah is very proud that it has brought a change to the aquaculture industry via customer's feed production using its high quality equipment. It has branch offices in India, China and Vietnam. The company has secured a good reputation in shrimp feed processing with more than 200 feed mills using its equipment. These include almost all of the leading aqua feed millers in Asia. With recent expansion, its equipment are also in feed mills in the Middle East.

In the last two years, there has been an increase in processing equipment to India with 3-4 turnkey projects. Despite competition

Hsiu-Long Hu (centre) with his team. From right, son Che-Kai Hu, wife, Mei-Hui, Hsin, daughter in-law Ling-Yu Huang and Candy Lee.

from China's feed processing equipment manufacturers, Idah's advantage is its reputation with extruders, pellet mills and post conditioners, which are usually selected as the main equipment.

"As raw material prices are on the rise, we are working on replacing fish meal with soybean meal. Here we have removed the oil component through a 5-day fermentation process and developed a product with a high level of protein. We demonstrate to customers how to do this and then create a one-stop shop for the equipment. This will push up sales of our extrusion equipment.

"Although we continue to face competition from low cost processing equipment from China, our long-term business plans, without doubt, is to remain in Taiwan where we can use our knowhow to see to all the needs of our customers. We will work with clients to propose the best assemblage of equipment. We will guide them along at the installation and provide consultancy on their needs.

"Moving with times, we will also focus on the food aspect (as with SPC) and since 2015 we are transforming from turnkey to end solution provider. At the technical centre we have education classes on aqua feed and upgraded designs with 3D modelling," said Chang.

Quality and efficacy in aqua feeds

To Hsiu-Long Hu, President of **Everlasting A-One**, the goal is to research and develop knowhow in aqua feed processing to reach the optimum in quality, efficiency and food safety. Founded in 1994, Everlasting A-One produces a variety of aqua and pet feeds. It is also involved in seafood processing. For the aquaculture industry, the company produces and markets grow-out feeds for seabass, eel, groupers, threadfin, milkfish, tilapia, ayu, shrimp and sturgeon as well as ornamental fish.

"The philosophy of the management team is on food safety, credibility and good customer relationship," said Hu who started in marketing feeds as well manufacturing OEM feeds. In 2007, he established his own feed mill. The first feeds were for the eel farming industry. Back in those days, eel farming was one of the leading aquaculture activities in Taiwan.

"Since 2008, my sales revenue has been increasing from NTD 200 million to NTD460 million in 2010 and to NTD 550 million in 2014. I have also decided to obtain Halal certification for my feed factory to supply Chinese Muslim farmers in Taiwan producing the grouper, seabass and tilapia.

"We have the largest market share for floating seabass feeds and this is almost 50%. The key point is using best ingredients and ascertaining the quality of raw materials such as fish meal from Chile or Peru. It is also giving attention to food safety when sourcing ingredients. Our seabass feeds are efficient and do not have any feed additives. We keep updating our formulation and keep up with trends in the industry. However, with better quality ingredients, the feed price is much higher."

Automation at the factory with a robotic bag stacker

The factory has two pellet lines and two extrusion lines for the production of sinking and floating pellets. Eel feeds is powder. The Chiun-Long brand (群龍牌) of fish feeds have feed sizes ranging from the smallest 1.2 mm for fish fry to up to 23 mm for grouper finisher. The production is 1,500 tonnes per month (tpm) of grouper feeds and 2,800 tpm of eel and milkfish feeds. The production of pelleted feeds is 3,000 tpm. The feeds are sold all over Taiwan; the north for ayu feeds, west coast for the grouper feeds, and south east coast for milkfish, eel and seabass feeds.

Hu explains how he succeeds in this highly competitive feed market, "Our sales and technicians have a close relationship with clients. They help to solve problems at the farm level. As we are a small company, we can quickly mobilise our sales or technical team. We have 30-40 staff doing this.

"Our main exports are our seabass and eel feeds. Our aim is increase exports for the food fish production in South East and introduce our koi feeds to the markets in South Africa and Europe. We look forward to meeting new customers at the Taiwan Fisheries and Seafood show."

More than just a feed producer

Taoyuan City based **Grobest Group** is now a vertically integrated aquaculture group. Grobest started as an aqua feed miller in 1974. Feed production remains its main business activity but the group is fully integrated with hatchery, farming, feed production and processing in several conutries. Besides Taiwan, it is present in China, Vietnam, Thailand, India, Philippines, Indonesia and Malaysia and employs 6,000 people. The range of products include aqua feeds, feed additives, post larvae, tilapia and shrimp products. The Grobest group is the 138th largest company in Taiwan with sales revenue of USD850 million in 2014.

Grobest prides itself on its traceability control system. Batch management assures traceability at each stage, from raw material stage to processing and good farming practices. Third party validation assures safe and sustainable seafood production. Processing plants are close to farming areas to reduce transport time.

The company is recognised as an innovator in the aqua feed market in Asia with advanced formulation and precision manufacturing. In-house R&D teams develop functional feed additives and probiotics. In Taiwan, it is a market leader taking up 17% of the 600,000 tonnes per year feed market that is being supplied by 59 feed mills. Taiwan's growth potential in aquaculture production is limited but CEO Chi-Kang Ko believes that it is still possible for Taiwan to increase aquaculture output.

"We will find ways to improve aquaculture in Taiwan to help farmers produce quality seafood and increase supplies to local markets. In feeds, we innovate to find the best performing feeds to give higher returns to the farmer. The monodon shrimp farming was devastated by white spot syndrome virus (WSSV) in the 1990s. However, any animal can have its niche, now that we have found a way to control WSSV."

On the future plans of the company, Ko announced, "There are plans for both feed and seafood production. Soon we will have a total of 16 feedmills with new plants in the Philippines, India, Indonesia and Malaysia. We will also look at the potential market in Myanmar. In processing, we already have three processing plants in China and one in Thailand. The plan is to set up a new plant each in India and Indonesia."

"There is a need to be more than a feed group and today there are three synergistic focus groups ie animal-farm-consumer. In animal health R&D, it is balancing the immune system and stress. The farmer requires a healthy animal while the consumer requires healthy and safe seafood. Both are needed for a sustainable industry."

In the control of early mortality syndrome (EMS) in shrimp, Grobest has been successful with its newly formulated feed called 'Super Shield,' which helps the shrimp to recover from EMS. This was launched in Taiwan, China, Thailand and Vietnam. Jennifer Kuo, General Manager Animal Health said, "In Malaysia, farmers are beginning to harvest marketable size crops with this new feed. In China, harvesting of larger than 100g shrimp is possible when the farmers pay attention to post larvae, feed, environment and management."

The Grobest team at the media meeting, CEO Ko (centre, left) with Berry Huang (centre right), Jennifer Kuo (left), and Vincent Lin.

"EMS is a complicated disease. We have however put in more than 10 years looking at the Vibrio bacteria. There is the associated problem with pond management, which needs improvement. With Super Shield feed, we propose a healthy environmental control.

"Today, shrimp farming faces diseases such as EMS and WSSV. We have been trying to get the farmers and the entire industry to change. We think that there will be opportunities for Grobest to do this. Our feed is expensive but do not look at the price, look at the value of the feed," said Berry Huang, General Manager-Feed.

In the tilapia business, Vincent Lin, General Manager-Food explained that flesh yields are exceptionally high at 30-32% for deep-skinned tilapia fillet when fed on its feed. The company produces 1,000 containers annually or 16,000 tonnes of tilapia fillet.

WA 2015 JEJU
World Aquaculture 2015 Jeju

The World Aquaculture 2015 conference and trade show, organised by the World Aquaculture Society (WAS) and its Asia Pacific and Korean chapters was held from 27 to 30 May. It was attended by 2,416 participants from 66 countries. There were 57 sessions with 510 oral and 280 poster presentations. The trade show had 134 booths. WA 2015 also introduced Aquaforum 2015, held on 26 May. The Aquaforum program comprised three sessions; biosecurity, nutrition and production technologies. A news update in issue July/August 2015 covered the session on biosecurity.

Korean aquaculture

Dr Isidor Yu, Managing Director of Isidor Sustainability Research Institute, Korea discussed some successes and challenges in Korean aquaculture. Yu said that modern and intensive aquaculture practices are common in Korea largely because of limited land and water resources. On the east of the peninsula, there are land based farms for the flounder and scallop. In the south, cage aquaculture is possible and in the west, tidal mudflats are suitable for crustaceans and shellfish. Recirculation aquaculture systems are common but these require high investments. Concurrently, yields have to be high with high stocking density. Thus, a major challenge is biosecurity, fish health and welfare.

Innovation in feeds

In the Aquaforum session on nutrition, **Dr Craig Browdy**, Zeigler Feeds, USA presented on innovation and technological advances in aqua feeds. “We need to improve feed formulation strategies based on nutrient availability and specific requirements of the animals we want to feed. We could think of a WikiNRC updated in real time as new information is published to improve real time information exchange. We also need to use technology to better evaluate ingredients on an ongoing basis NIR (near infrared), in vitro analysis and nutritional modelling. In shrimp, more research is needed on ingredient digestibility.”

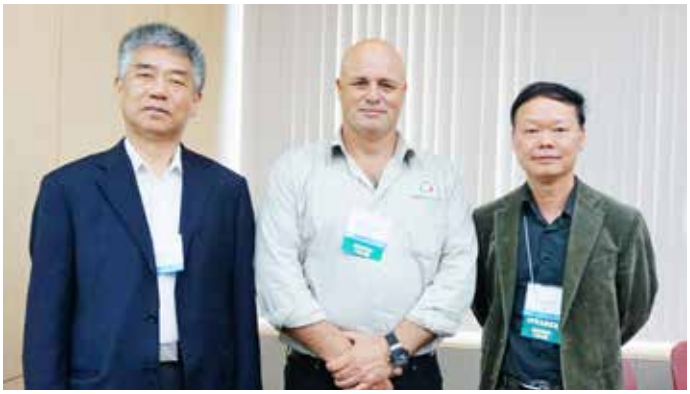
Craig Browdy (left) with Ramir E Lee, based in Ho Chi Minh at the Zeigler booth

On reducing costs of feeds, Browdy said that it will be difficult to bring down costs of ingredients while maintaining or improving performance. “Thus we need to have innovative ways to bring down production costs of feeds with energy efficient mills while improving digestibility of ingredients by optimizing the physical qualities of feed. Tremendous opportunities remain in the area of refining feeding programs so that investments in the best nutrient dense feeds result in improved performance and profitability.

"Fish meal replacement remains an important issue for aqua feeds. In some markets for species such as catfish, tilapia or carp, fish meal inclusion is near zero. “We are actually making improvements in fish meal replacement but still we need to pay attention to micronutrients. In the future, fish oil will be limiting. Future feeds will require innovations such as partitioning oils and developing blends of oils from different sources to meet precise requirements for each species”.

Browdy suggested a relook at how research conclusions are used to formulate feeds. “We use information based on research using small animals over a short period to develop feeds for large animals over a longer periods and based on simple weight gains and survival. Surely, we should be looking deeper into metabolomics and genomic responses. We need to be aware of changes in gut health and gut microbial communities. Should the required nutrient levels be more than the minimum amount obtained though these experiments? More advanced research techniques will allow us to move beyond short term growth trials that can oversimplify efforts to better understand ingredient substitutions.

Stephane Ralite, Lallemand, France (centre) and Dhanunjaya Goud, Lallemand, India (left) with participants from Avanti Feeds, India; K.V. Raju, Natarajan, Sambasiva, Mohanty, Mahesh Shinde, Dr. Srinivasa Rao and Ranga Babu. Ralite presented on developing preventive feeding strategies to mitigate penaeid shrimp sensitivity to vibriosis at the session on Shrimp-general topics.



Professor Kangsen Mai (right) with Professor Qingyin Wang, Yellow Sea Fisheries Research Institute, Qingdao, China (left) and Rodney Missen, Radaqua, Australia at the session on aquaculture in China.

At the AAP booth. Philippe Tacon, Phileo Lesaffre, France (left) with shrimp producers in Indonesia, brothers, Catur Widi and Tri Widi Darwiyono, Sui Trisno and Ronny Henur. Tri Widi has a shrimp farm in Situbondo, Sui Trisno, a shrimp farm in Bima, West Nusa Tenggara Province and Ronny, a shrimp farm in Madura.

China produced more than 18.6 million tonnes of aqua feeds in 2012, almost 25 times of production in 1991 at 750,000 tonnes. **Professor Kangsen Mai**, Ocean University of China, Qingdao said that the challenges with aquafeed include protein sources. China uses 51 million tonnes of soybean meal and 1.1 million tonnes of fish meal. In aquaculture, China needs to develop technologies to use efficiently limited resources of land, water and feed proteins. He suggested using non-traditional protein sources such as silkworm and duck weed. Depending on the processing technology, the protein composition of duck weed can be 44-48% protein on a dry weight basis. The advantage is that there are no anti-nutritional factors (ANF) and the amino acid composition is similar to soybean meal. The industry panel discussed possibilities with genetically modified plants and strains where ANFs have been removed.

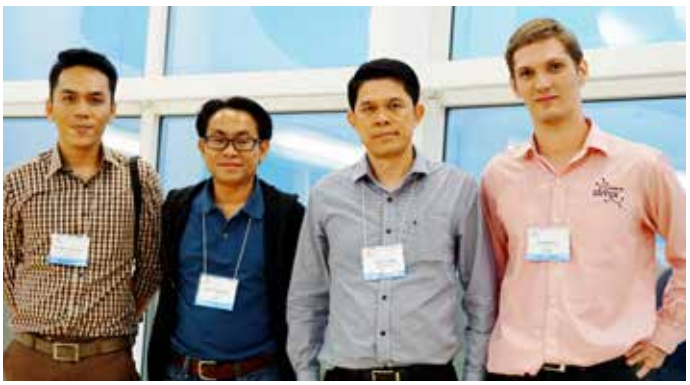
Microbial management

In the session on aquaculture production systems, **Dr Patrick Sorgeloos**, Ghent University, Belgium focused on the need for innovation. "We need to move from an empirical to a science based approach. Seed production is a big business, but we still need to make it more predictable and cost effective with high quality production. I still consider larviculture the key to success.

"If we look at the seabass/seabream fry production industry in Europe valued at €150 million, average survival is only 20% by day 60 and there are successful and failed runs. This industry is not predictable enough. Many farmers believe that microbial interference might be the problem. To manage diseases, industry requires good diagnostics and understanding of the disease, but not enough focus is placed on preventing the disease."

Sorgeloos, using examples with fish and shrimp said, "We do not pay enough attention on ecological aspects including what regulates the microbial community. By disinfecting water and then providing more nutrients through live or formulated feeds, we are actually favouring opportunistic bacteria. We need to revisit microbial management not only in water but also in the gut of the animal."

"In some hatcheries where post larvae are produced using concentrated seawater (120 g/L brine to make up the seawater) or recirculation is the only production option, the post larvae produced fetch a higher market value. We can now explain this by the fact that there is more stability with microbes in the water and gut of the animal." Sorgeloos detailed results on work with modern tools to look into microbial management.



Conference participants, from left, Narongkorn Kongsuwan, Charoen Pokphand (CP), Thailand, Chakrit Ridmontri, Olmix, Thailand, Manoo Sukrachakit, CP Vietnam Corporation and Jean Peignon, Olmix, Vietnam.

Final joint venture agreement for feed mill in China

The BioMar Group and Tongwei Co have signed the final joint venture agreement for the establishment a joint fish feed company in China in August. The new company will supply high performance feed to the growing production of high value fish species in China.

”After the signing of the Memorandum of Understanding this spring we have elaborated on the agreement, and with the final contract signed, we can now proceed to the next phase and start the actual construction of the first BioMar-Tongwei feed plant in China”, said BioMar CEO Carlos Diaz. The first feed plant will be located in eastern China and will have a capacity of around 100,000 tonnes per year.

”Our target is to become operative and start production next year taking advantage of the joint experiences of BioMar and Tongwei in plant design and construction. In the meantime we will through the joint venture start offering imported BioMar diets to the Chinese market”, said Diaz.

Entering the Chinese market and establishing a joint venture with one of the largest fish feed companies in the world is a major step forward for BioMar and according to Diaz an important move towards delivering on the objectives set out in it’s global strategy 'Beyond the limits'.

”We are happy that BioMar will soon be able to serve customers in one of the most important aquaculture markets in the world with high performance diets. I am sure this step will lead to further expansion in Southeast Asia”.

Diaz emphasized the importance of bringing BioMar’s know-how to the fast growing segment for high value fish species in China: ”We have a long tradition for creating diets which secure fish farmers the best total economic performance in their farming operations and at the same time are environmental friendly.”

BioMar has its roots in Denmark with the toughest environmental legislation in the world and with very elaborate standards for food safety. Danish farmers measure feed performance very precisely. ”This and our solid platform in the salmon market have provided us with unique capabilities to serve the high end market. We believe these capabilities will be of great value in China in the coming years.”

The objective for BioMar-Tongwei is to use the experience from this first joint project and expand with several production units across China in the coming years. Founded in Denmark in 1962, the BioMar Group A/S is a leading supplier of feed to the aquaculture industry and has 11 production facilities, producing feed for more than 30 different species including among others salmon, trout, sea bass, sea bream, eel, sturgeon, turbot, tilapia, and shrimp.

A new factory in Turkey is expected to start operations in early in 2016. In 2014, BioMar sold close to 1,000,000 tonnes of aqua feeds with a turnover around Euro 1.1 billion. BioMar is fully owned by Danish Schouw & Co listed at the Nasdaq Copenhagen stock exchange.

Part of the Tongwei Group, Tongwei Co. Ltd has a leading position in the Chinese aqua feed industry for the past 22 years. It is listed on the Shanghai Stock Exchange. Tongwei Co operates nationwide in China as well as in Southeast Asia with over 100 branches and subsidiary companies. In 2014 Tongwei produced around 2,500,000 tonnes of aqua feeds. More information: Henrik Aarestrup, Global Marketing Director, BioMar Group, haa@biomar.com)

Vice President Asia market region

Niels Alsted

Following the above announcement, the BioMar Group has announced that **Dr Niels Alsted** will become the first Vice President for BioMar’s new Asian market region. Alsted will relocate to China before the end of the year, but is already intensely engaged in setting up the new business unit.

“Alsted will be responsible for building up the new Chinese Joint-Venture together with Tongwei, ensuring that we within a short time frame will be able to supply the Chinese market with high quality feed to the growing production of high value species,” said Carlos Diaz, BioMar CEO. “I am sure Niels Alsted will be a very strong asset for our expansion in Asia. Under his leadership we can build a very strong team in China with a combination of our experience staff and local Chinese capabilities.

Part of the top management of the BioMar Group, Alsted assumed a broad range of responsibilities in different positions within R&D, and business development. He joined the company in 1987. Most recently he held the title of Vice President Sourcing and Business Relations. He has a masters in Fishery Science and a PhD in Fish Nutrition. He is also a member of the board of the IFFO RS and in the steering committee of the Aquaculture Stewardship Council and through various other organisational bodies he is deeply involved in the dialogue between the aquaculture industry, authorities, and NGOs.

“Alsted has during the last three decades been one of the most important persons in the process of continuously driving the development of BioMar’s feed program towards new and higher standards, both in terms of feed performance and environmental sustainability. This tremendous knowledge base Niels will now bring to our Chinese joint venture,” said Carlos Diaz.

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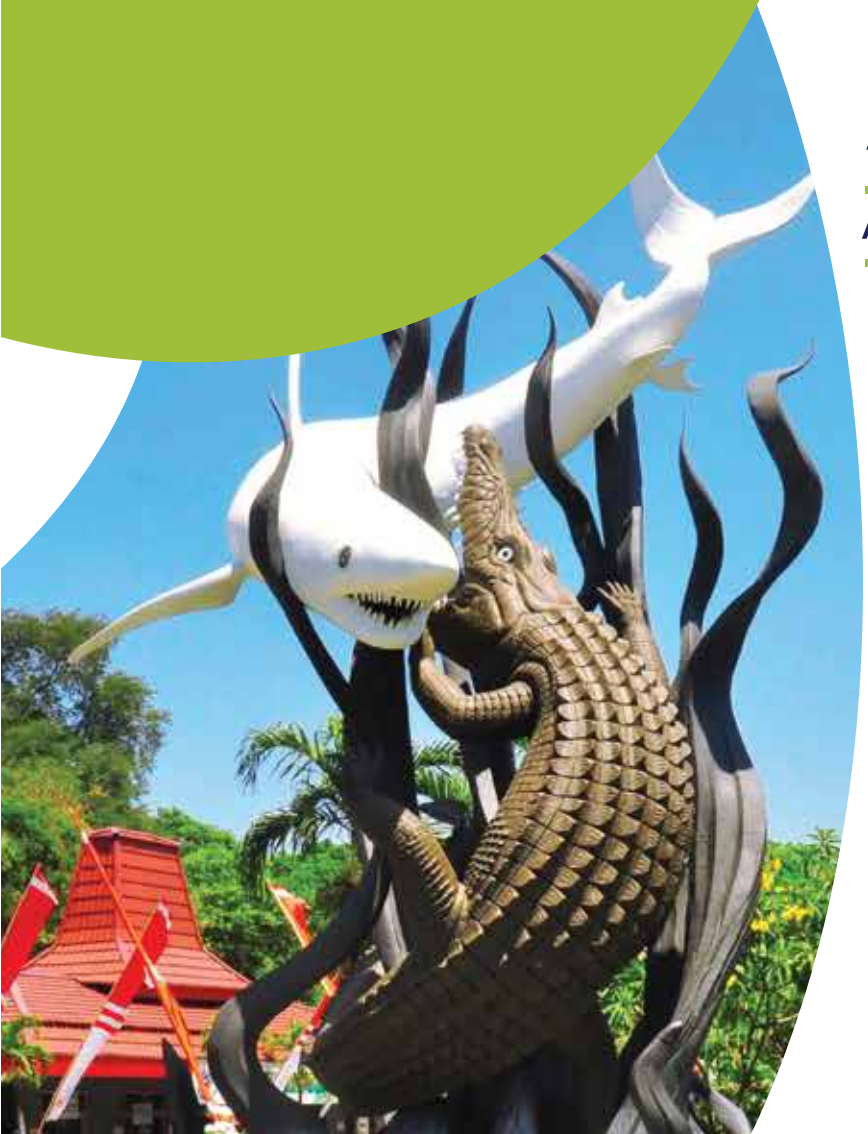

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Micro feeds for shrimp

Taiwan Hung Kuo Industrial Co Ltd was at the WA 2015 trade show to promote its Lucky Star range of micro feeds for shrimp to the international crowd of aquaculturists and farmers. The company started in 1984 in Taiwan and today, it has a subsidiary company in Xiamen, China. This plant in China produces grow-out feed for the Chinese market. It has 5 feed lines for an annual production capacity of 60,000 tonnes per year. The marketing at the show was mainly of larval feeds and brood stock for shrimp, weaning and juvenile diet for the marine fishes such as groupers, Japanese and other flounders, turbot, seabass and seabream. At its booth, Ken Hung, Export Manager and Director said,

"Our best selling product is the Micro Elite and Larval Plus for shrimp larvae for premium post larvae production of *Penaeus japonicus*, *P. vannamei* and *P. monodon*. The feed is based on a formulation for *P. japonicus* shrimp larval rearing comprising high levels of marine based protein, vitamins etc. It is also cleverly designed to give the healthy pigmentation of shrimp larvae. This feed is available in different sizes fo complete larval rearing, even up to raceway systems. Although the feed targets to completely replace traditional shrimp flakes for better water quality control, flakes can still be supplemented if it is the preferred protocol."

Micro Elite and Larval Plus are both processed by micro coating technology to extend stability and improve feed suspension in water column. These 50 µm to 200 µm feed remains buoyant under aeration to induce feeding. Larger granules of 200 µm to 500 µm are used as Artemia replacers or supplementary diet for the freshwater prawn *Macrobrachium rosenbergii*.

Ken Hung and Tie Teck Lok (left), General Manager who oversees marketing in China, at the Lucky Star Aquaculture booth.

Hung also described the characteristics of products for marine fish. "Initial, a micro coated granule feed for marine fish has particle sizes from 100 µm to 1.0mm. Prince Wean, ranging from <400 µm to 1.6 mm, is developed for salmon and trout as a weaning diet or can be a post weaning feed for marine fish. The feed is also used by customers in outdoor larval rearing. Prince Wean is also available in a different version for freshwater fishes. AbSoft fish feed is completely land animal free (LAP) formula and the high attraction is especially suitable for feeding fish during low water temperatures. AbSoft absorbs any liquid based additives without leaching. The softened pellets can easily increase feeding rate leading to accelerated growth and make top coating a much easier job for fish farmers."

Pond liners for biosecurity, productivity and cost control

Solmax is a world leading manufacturer of HDPE geomembranes and has been in the industry for more than 30 years. However, HDPE in shrimp farms is a more recent application of its geomembranes. Solmax started to support the aquaculture industry in year 2005 when it supplied 600,000 m^2 of 1.0mm HDPE liners to Belize Aquaculture Ltd (BAL), at that time one of the largest intensive shrimp farms in the Americas. Since building its brand new manufacturing plant in Malaysia, the company has been supplying liners of various thicknesses for shrimp farms in Asia. This is the first time that Solmax is exhibiting at an aquaculture trade show, and the team was pleased with the numbers of queries and interest on its aquaculture solutions.

"In recent years, we have seen increasing interest and increasing use of HDPE liners in shrimp ponds. In South East Asia, thickness of liners varies with the farm scale and ground conditions from 0.5mm to 0.75mm. The thicker liners of 0.75 -1.0mm are preferred in farms in Central America," said Daniel Tan, Senior Technical Manager.

"To date, we have farms all over Asia using our liners. Malaysia leads with our liners covering a total surface area of 3.4 million m^2. The Central American farms in Belize, Nicaragua and Guatemala cover over 1.7 million m^2.

"Solmax sees aquaculture as a potential market and we are looking at working closer with the industry to find the best solutions. We know that our geomembranes are definitely good choices for the shrimp industry. By providing a barrier between the soil and water, it reduces the risk of disease, easy control of water pH and salinity. In pond operations, liners ease harvesting and fasten turnaround time. Our clients in Indonesia advised that the black background of the liners improves the red colouration of shrimp when cooked," added David Cao, Vice President Asia Pacific Sales.

At the World Aquaculture, 2015 (WA 2015) trade show, the Solmax team, from left, Daniel Tan, Kevin Hor, David Cao and Jason Zhou.

The 4-member team at the trade show concurred that for liners to be environmentally safe solutions for the future of shrimp farming, they will need to work closer with farmers and research into how liners can add value. In other industries such as in water treatment systems, liners also perform functions such as encapsulating bactericides.

Solmax has its headquarters in Quebec, Canada. (www.solmax.com)

Fish CRO focusing on aquatic animal health

Cedric Komar

Ictyopharma, a European based CRO (Contract Research Organization) based in France, proposes services focused on aquatic animal health (AAH). It offers consultancy and has a state-of-the-art aquatic research facility to carry out standardized challenge trials for commercial warm-water food fish such as tilapia. Its location far from any aquaculture activity, allows for full sanitary control and full confidentiality for clients.

Less than 2 years old, Ictyopharma has been extremely successful with the facility fully booked months in advance since the start of its operations. At its booth during World Aquaculture 2015 (WA 2015) in Jeju, Korea, Cedric Komar, CEO and co-founder shared his views on the success to date.

"We attribute our key success factors to several advantages. There is our cutting edge expertise in the field of aquatic animal health product development. Co-founder, Lauke Labrie, fish veterinarian and Ictyopharma scientific director, was previously laboratory head at MSD aquaculture R&D laboratory in Singapore. She has the rare know-how and experience of A to Z biological AAH product development. Then, there is our industry network. Our clients are large pharmaceutical, nutritional and aquaculture companies."

Komar has more than 12 years' experience in sales and business development in the field of aquatic animal health in Asia and Latin America. Through this, he has developed relationships of trust with many decision makers of pharmaceutical and fish feed companies.

"There is also a growing demand from key players of the industry for independent, reliable and unbiased research trials run by people they trust," added Komar.

"Next is our extraordinary capacity for a quick response. Being a small-size CRO, we are able to adapt fast to the needs and changes of our customers and they appreciate this. In addition, we give full emphasis on providing high quality research, transparent results, ensuring the repeatability of our experiments. Equally important for clients is accreditation and ongoing is certification for Good Laboratory Practices (GLP)."

Ictyopharma is a fully equipped and brand new research facility with over 300 m^2 of wet lab facilities. There are above 90 holding tanks with a capacity ranging from 80L to 450L.

Komar said that currently their work is mainly focused on freshwater fish such as tilapia for which they have developed several immersion, cohabitation and intra-peritoneal challenge models using different *S. agalactiae* biotypes and serotypes as well as for *Streptococcus iniae* and *Francisella spp*. There are plans to start working with marine fish species as well as shrimp. (www. ictyopharma.com)

Algae-based omega-3 fatty acids for animal nutrition

DSM Nutritional Products Ltd. and Evonik Nutrition & Care GmbH announced in July that they have entered into a joint development agreement for algae-based omega-3 fatty acid products for animal nutrition, in particular in aquaculture and pet food applications. The aim is to meet the increasing demand for omega-3 fatty acids by harnessing naturally occurring marine algae using sustainable, biotechnological processes based on natural, non-marine resources.

Under the agreement, the companies will jointly work on the development of products and explore opportunities for commercialisation. The competencies that DSM and Evonik bring to the development partnership complement each other: DSM has expertise in the cultivation of marine organisms and long established biotechnology capabilities, whilst Evonik's focus for decades has been on industrial amino acid biotechnology executing large-volume fermentation processes.

The envisioned algae-based omega-3 fatty acid products will be high value, natural and sustainable alternatives to fish oil, whose supply is finite. This will help the animal nutrition industry keep up with increasing demand without endangering fish stocks and will contribute to healthy and sustainable animal nutrition. Until now, these fatty acids have been added to aquaculture feed almost exclusively from marine sources such as fish oil and fishmeal. By using algae, DSM and Evonik are looking to contribute to a more sustainable aquaculture industry.

DSM and Evonik expect that in Q4 2015 they will be able to report the first results of the algae-based omega-3 fatty acid product development.

Evonik, Germany, is one of the world leaders in specialty chemicals, operating in the Nutrition & Care, Resource Efficiency and Performance Materials segments. Evonik Nutrition & Care GmbH contributes to fulfilling basic human needs. That includes applications for everyday consumer goods as well as animal nutrition and health care. This segment employs about 7,000 employees, and generated sales of around €4.2 billion in 2014.

Royal DSM is a global science-based company active in health, nutrition and materials. By connecting its unique competences in Life Sciences and Materials Sciences DSM is driving economic prosperity, environmental progress and social advances to create sustainable value for all stakeholders simultaneously. DSM and its associated companies deliver annual net sales of about €10 billion with approximately 25,000 employees. The company is listed on Euronext Amsterdam.

More information: www.evonik.com; www.dsm.com.

Uniquely extruded feeds for the olive flounder and eel

Byoung Tak Kim (left) with Jung-Kuk Oh, Sales Manager, in charge of mainland Korea market at the World Aquaculture 2015 (WA 2015) trade show.

The Daebong Group of Korea is led by Daebong LS, listed on the Korea stock exchange (KOSDAQ). The group has companies involved in feed production as well as farming. The other activities are medical and cosmetics. **Daebong LF (Live Feed)** manufactures only extruded pellets for the farming of olive flounder and eel. In Korea, it is regarded as a small feed producer since it is dedicated to aqua feed production and has an annual production capacity of 30,000 tonnes per year. In terms of market share, it is third after Cargill and Dong One A.

"The actual production is only 8,000 tonnes per year as we concentrate on the production of feeds for the flounder and eel. We have plans to launch feeds for the abalone, seabream and rainbow trout for the Korean market. We will start the research into the formulation in 2018. We will collaborate with academia to do a good feed," said Byoung Tak Kim, Sales and Purchasing Manager charge of the overseas trade team at his booth.

"Today, our feed market is within Korea only and the largest market is in Jeju island where the feed plant is located. Out of 300 farms here, 160 are our customers. We sell to less than 50 farms on the Korean mainland. The plan is to expand into China's feed market but a licence to export is required, according to Korean regulations and this may take us two years."

The Eureka EP (extruded pellet) feeds took 50 researchers in the subsidiaries of Daebong to develop. This EP feed is an improvement over the Eureka SEP which equals a moist pellet (MP). EP feed can be stored at room temperature as the moisture content is only 7-9%. In contrast the MP feed requires storage at 4-5°C and at -20°C for longer storage of 5 days or more. MP feeds are the most common feeds in marine fish farming in Korea, popular among farmers because of high digestibility and good growth performance. It is the benchmark for any marine fish feed.

The Eureka EP feeds for olive flounder larvae have more than 58% crude protein from three animal protein sources; prime fish meal, krill meal and hydrolysates. Crude protein is reduced to 54% in grow-out feed, mainly from prime fish meal. No soybean meal is used so that the feed does not contain any allergen. Unlike salmon feeds which use wheat flour as binders, the EP feed uses pure tapioca starch.

"The EP feed for the eel uses hydrolysed fish meal as well as high quality fish meal with pepsin for a digestibility of more than 95%. The carbohydrate is reduced to 11% in contrast to dough feed which can have 22-25% carbohydrates. Pellets have micropores to increase the absorption of digestive fluid and reduce digestion time. Aside from DHA, EPA and linolenic acid, eels require linoleic acid and thus Eureka EP feed has the proper mix of this fatty acid. Water quality is critical in eel farming and so highly digestible feed ingredients are crucial.

"The merits of Eureka EP feed lies with the digestion process of the olive flounder and eel. In the case of the olive flounder, we have developed a formulation where the feed dissolves in the stomach within 4 hours, comparable to MP feed. In the case of EP feed for the eel, the feeds become porridge shape within 2-4 hours. We compared this to other extruded feed for eels in Europe where the feeds stay in the stomach for 8-16 hours after feeding," said Kim.

"These extruded pellets (EP) are for eel grow-out, from the small elvers at 5g to 300g market size eels. The general feed efficiency is 0.8 to 0.9 with these 53-55% crude protein feeds. One important advantage with feeding pellets rather than dough feeds is that it is possible to supply 2-3 pellet sizes such that all the eels in the tank can be fed and the size gap reduced."

In Korea, the most popular species is *Anguilla japonicus* but *A. bicolor* and *A. anguilla* are also popular. The high cost of feeds is because of the need for high quality fish meal. Many producers use white fish meal which costs USD3,000/tonne but in the case of the Eureka brand, Daebong uses fish meal from anchovy and sardine from Peru and Chile. Some feed producers also use mackerel fish meal for binding feed.

Kim also discussed some recent changes in the feed market in Korea. He said that the soft (or moist) pellet has the largest market share at 8-10 times that of extruded pellets. However, there are environmental issues with using these pellets and the Korean government will be releasing new regulations to replace soft pellets with extruded pellets in fish farming in 2016. (www.daebongls.co.kr)

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Aqua nutrition and aquafeed training

Progressus and Kasetsart University have launched two training programs in Asian aquaculture. Branded as AgriSchools, these 5-day training conducted by industry and university experts will be at the Kamphaeng Saen Campus, Kasetsart University, Thailand.

"AgriSchools fill a much needed service across the feed mill, livestock and aquaculture Industries. We are excited by the support and high ratings given by industry. This encourages us to continue our efforts, ensure that AgriSchools can be further developed and expanded not only across industry functions but also geographically," said Yiannis Christodoulou, Managing Director, Progressus.

The Aqua Feed Milling training will be from September 28 to October 2. Topics covered are material, systems and feed management including extrusion, quality and operational management, design and feed mill tours. The Aqua Nutrition training from November 23-27 will cover industry trends and challenges, standards and certification, aquaculture nutrition, feed formulation, production systems and their impact on feed quality and performance and feed formulation case studies. More information: agrischools@progressus.asia).

New Asia-Pacific marketing manager

Adchana Chaiteerapinyo

Alltech has announce the appointment of **Adchana Chaiteerapinyo** to the role of marketing manager, Asia-Pacific, based in Bangkok. Chaiteerapinyo has taken over the role from Alisa Anantvoranich, who moved to the U.K. to pursue a MBA following nearly seven years of service with Alltech.

Matthew Smith, Alltech vice-president, commented, "We are delighted to welcome Adchana to our team. She will bring a new skill set and energy to the position."

Chaiteerapinyo holds a professional certification in marketing and finance from the University of California, Los Angeles, as well as a master's in communications, marketing and advertising from California State University and a bachelor's degree in communications and advertising from Chulalongkorn University, Thailand. Chaiteerapinyo worked in California for six years before returning to Thailand. Before joining Alltech, she spent five years with the Michelin Tyre company as customer experience and digital marketing manager.

"I am very happy to join Alltech and I look forward to working with our team and customers across the Asia-Pacific region," said Chaiteerapinyo.

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

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

Volume 12 2016						
Number	1 – **January/ February**	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 & Nutrition	Hatchery & Nursery Technology	R&D & Genetics in Fish/Shrimp	Industrialisation & Automation	Biosecurity & Disease Management	Probiotics
Industry Review *Trends and outlook, demand & supply*	Marine Shrimp	Tilapia	Aqua Feed Production	Catfish	Marine fish	Freshwater Fish/ Prawn
Feeds & Processing Technology *Technical contributions from feed industry*	Functional Feeds/ Fish meal & Fish Oil Replacements	Micro Feeds/Lipid and Fatty acids	Additives/ Probiotics	Extrusion & Processing Technology	Feed Safety/Feed Enzymes	Nutrition & Formulation
Production Technology *Technical information and ideas*	Harvesting & Post Harvest Technologies	Cage Culture	Recirculation Aquaculture Systems	Sustainable & Responsible Aquaculture	Biofloc & Biotechnology	Aeration Technology
Aqua business Feature articles	Experiences from industry and opinion article covering role models, benchmarking, health management, SOPs, social investments, CSR, ancillary services etc					
Markets	Developments in markets (live fish, product development, market access, certifications, branding, food safety etc)					
Company/Product news	News from industry including local and regional trade shows					
Deadlines for Technical articles	**November 15, 2015**	**January 15**	**March 15**	**May 15**	**July 15**	**September 15**
Deadlines Advert bookings	**November 22, 2015**	**January 22**	**March 22**	**May 22**	**July 22**	**September 22**
Show Issue & Distribution at these events as well as local and regional meetings ****Show preview***	**AquaIndia 2016** January 29-30 Visakhapatnam, India **Aquaculture 2016** February 22-26 Las Vegas, USA	***Victam Asia 2016** March 29-31 Bangkok, Thailand **Asia Pacific Aquaculture 2016** April 26-29 Surabaya, Indonesia		**11th Asian Fisheries & Aquaculture Forum** August 3-7, Bangkok, Thailand **The Aquaculture RoundTable Series, (TARS 2016)** August 17-18, TBA **Vietfish 2016,** (TBA) Ho Chi Minh City, Vietnam	**China Seafood & Fisheries Exposition 2016** November China (TBA)	

Fish & Aquaculture – Equipment – Shipyards – Refrigeration – Processing

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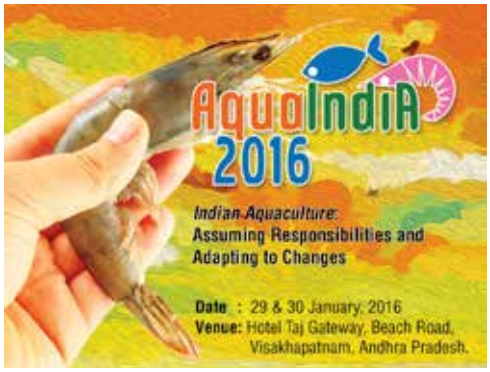
Aqua India 2016

January 29-30, Visakhapatnam, India



The Society of Aquaculture Professionals (SAP) has announced its 8th aquaculture event AQUA INDIA 2016. It will be held on January 29-30 at The Taj Gateway Hotel, Visakhapatnam, Andhra Pradesh, India.

The theme of the two day conference will be "Indian Aquaculture: Assuming Responsibilities & Adapting To Changes".

Registration is limited and the early bird registration ends on October 31, 2015.

More information:
Email: contact@aquaprofessional.org
Web: www.aquaprofessional.org

2015 - 2016

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

September 20 – 25
22nd Annual Practical Short Course on Aquaculture Feed Extrusion, Nutrition and Feed Management, Texas A&M, USA
Email: mnriaz@tamu.edu;
Web: http://foodprotein.tamu.edu/extrusion

September 28-October 2
Aqua Feed Milling AgriSchool
Bangkok, Thailand
Email: agrischools@progressus.asia

October 6-8
International Conference of Aquaculture Indonesia (ICAI) 2015
Jakarta, Indonesia
Email:icai.aquaculture@gmail.com
Web: icai.aquaculture-mai.org

October 8-9
Inaugural Institution of Aquaculture Singapore (IAS) Conference 2015
Singapore
Email: secretariat@aquaculturesg.org
Web: http://iasaqua2015.wix.com/aquaconference2015

October 14-16
Aqua Fisheries Myanmar 2015
Yangon, Myanmar
Web: www.myanmar-aquafisheries.com

October 20-23
Aquaculture Europe
Rotterdam, Netherlands
Web: www.easonline.org

October 22-24
The 7th Regional Aquafeed Forum
Can Tho University, Vietnam
Email:
Dr. Hua Thai Nhan (htnhan@ctu.edu.vn)
Dr. Tran Minh Phu (tmphu@ctu.edu.vn)
Web: http://conference.ctu.edu.vn/introduction.php?conf_id=AF

October 22-26
10th Symposium of World's Chinese Scientists on Nutrition and Feeding of Finfish and Shellfish, Wuhan, China
Email: SWCSNFFS2015@ihb.ac.cn

November 4-6
China Fisheries and Seafood Show 2015
Qingdao
Email: info@seafarechina.com/jennie8888@seafare.com
Web: chinaseafoodexpo.com

November 5-7
Expo Pesca & AcuiPeru
Fisheries, Aquaculture, Refrigeration & Processing
Lima, Peru
Email: thais@amauta.rcp.net.pe
Web: www.thaiscorp.com

November 11-13
10th National Philippines Shrimp Congress
General Santos City. Mindanao
Email: r.usero@yahoo.com
(Roselyn Usero)

November 16-19
South American and Caribbean Aquaculture 2015
Fortaleza, Brazil
Email: worldaqua@aol.com
Web: www.was.org

November 19-21
Taiwan International Fisheries and Seafood Show
Email: sonya_chaw@myexhibition.com.tw
Web: www.taiwanfishery.com

November 23-27
Aqua Nutrition AgriSchool
Bangkok, Thailand
Email: agrischools@progressus.asia

November 23-25
Shrimp 2015 India
Chennai
Web: www.infofish.org
Email: info@infofish.org

December 7-9
International Symposium on Aquatic Product Processing: Cleaner Production Chain for Healthier Food
Can Tho City, Vietnam
Email: Dr. Le Thi Minh Thuy (ltmthuy@ctu.edu.vn)
Web: http://conference.ctu.edu.vn/introduction.php?conf_id=APP

2016

January 29-30
Aqua India 2016
Visakhapatnam, India
Email: contact@aquaprofessional.org
Web: www.aquaprofessional.org

February 22-26
Aquaculture 2016
Las Vegas, USA
Email: worldaqua@aol.com
Web: www.was.org

March 29 – 31
FIAAP Asia, VICTAM Asia, GRAPAS Asia 2016
Bangkok, Thailand
Web: www.victam.com

March 29
Aquafeed Horizons Asia 2016
Bangkok, Thailand
Web: www.feedconferences.com

April 26-29
Asia Pacific Aquaculture 2016
Surabaya, Indonesia
Email: worldaqua@aol.com
Web: www.was.org

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Director
Wild Oceans Pty. Ltd.

November 4-6, 2015

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For more information contact Jennie Fu
jennie8888@seafare.com

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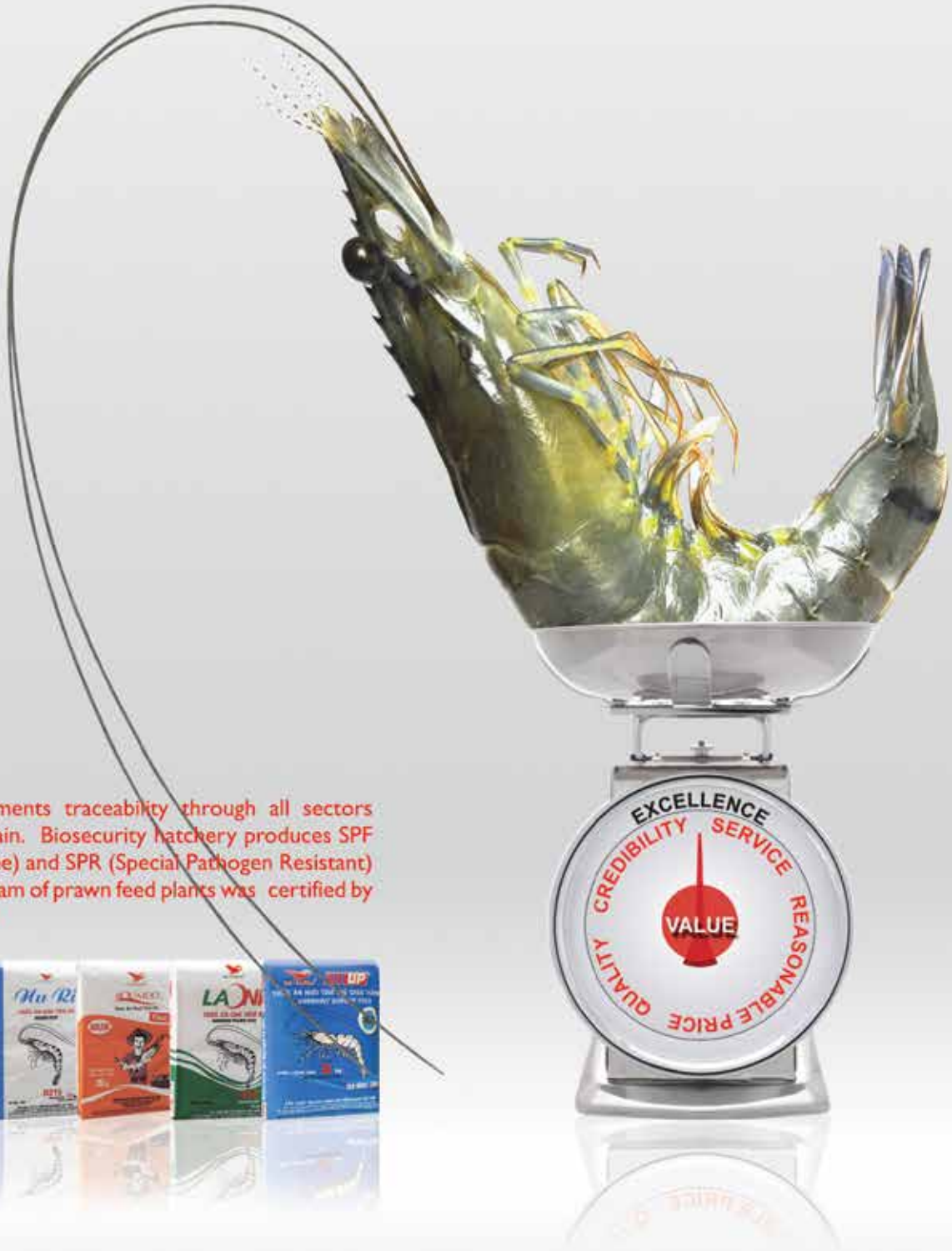

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