

# AQUA CULTURE

A s i a P a c i f i c

**S**elf Regulation against  
EMS in Thailand

**S**hrimp in Semi-Biofloc  
in Indonesia

**R**epositioning Tilapia in Asia

**H**erbal Remedies for  
Fish Health

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Harvest of tilapia in Indonesia. Picture courtesy of PT Aquafarm, Indonesia

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# From the editor

## EMS – Growing pains in shrimp farming

The past five years have seen an effort by vannamei shrimp farmers to shift from a backyard operation to an industrialised one. In agriculture, this is a natural progression following the pig and poultry industry where a holistic approach to farming, from genetics and feeds is tailored to meet the increase in productivity. However, in aquatic systems, the evolution pits science against art as the industry tests the limits of carrying capacity of the pond system and matches stocking density.

A consequence of this evolution is the growing pains faced by the industry and none is more evident today than early mortality syndrome (EMS) or more specifically acute hepatopancreas necrosis syndrome (AHPNS). It is still labelled as a syndrome because the causative pathogen(s) has yet to be identified. This is no different from the other growing pains, white spot syndrome virus and infectious myonecrosis virus, in the case of shrimp producers in Indonesia. Therapeutic solutions are still a long way away and in all three cases, the term 'living with them' seems to be the byword. We see how much industrialisation in aquaculture pits against nature in comparison with poultry farming.

Nevertheless, 2013 will likely see supply from the major producing countries in Asia decrease while demand continues to increase. This is likely to add pressure on prices to escalate. Many would agree that the COGSI petition where US wants to impose countervailing duties (CVD) on imports from 7 exporting countries (six in Asia and Ecuador) has come at a bad time as US consumers will have to pay a lot more for shrimp in the future due to CVD taxes and supply shortages. But at the same time, our producers will have higher costs defending their positions!

It is now well accepted that EMS could be viewed as a consequence of various factors. First and foremost is genetic selection for growth which is an opposing trait to disease resistance. Growth improvements have seen average weight gain from under 1g per week to over 2 g per week. Another factor is increased stocking densities in the hatchery and shorter growth cycles to reach post larvae (PL10). Apparently, the normal cycle of 21days can now be reduced to 18 days. This may develop weaker and immature PLs which are unable to withstand 'natural' pond conditions after coming out from sterile SPF conditions in the hatchery. In our bid to increase productivity, we have been trying to stock at higher densities with numbers such as 250PL/m<sup>2</sup> attempted in several countries. This will test the carrying capacity of ponds akin to pushing a speedboat to the limits before the bow breaks.

Although EMS was first reported in South China in 2009, the industry has not taken a coordinated approach to tackle the problem. The incidences reported in Thailand in 2012 may change things. This was very evident in the Suratthani meeting of the Thai shrimp industry over February 23 & 24 recently. Stakeholders from the industry came together to decide on a way forward. Instead of looking for scapegoats, the industry shared information and leadership was seen from the public, private and academic sectors ranging from the Thai DOF, respected disease experts such as Drs Chalor Limsuwan and Tim Flegel to major feedmill and feed additive suppliers. The industry has taken up the gauntlet to be self-regulating and has recommended a holistic approach to proper farm management which includes: Limit stocking density to less than 100 PL/m<sup>2</sup>; hatcheries to dry-out for 30 days before this production cycle. This is to be done in a staggered basis depending on zones; stock older post larvae such as PL12 and finally increase aeration and paddlewheels in the pond normally measured by horsepower per ha.

The quick and concerted action by the Thai industry is commendable and other countries would be encouraged to take a page from Thailand's remediation book.

Zuridah Merican

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- We strive to be the beacon for the regional aquaculture industry.
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- We strive to be the forum for the development of self-regulation in the Industry.



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The third of the Aquaculture Roundtable Series (TARS2013) will be held in Singapore from 21-22 August. TARS 2013 will focus on **Finfish Aquaculture-Industrialisation and Sustainability**. For more information and updates on this all important meeting, visit [www.tarsaquaculture.com](http://www.tarsaquaculture.com)



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# Self-regulation against EMS in Suratthani

The Thai shrimp industry works together to ensure that EMS will not bring them down. Industry leaders gave guidelines for hatcheries to revamp current practices and lead with improved PL quality.

Thailand's industry is often commended on its continued success in maintaining high volumes of production despite adversities caused by diseases such as white spot syndrome virus (WSSV), white faeces syndrome (WFS) and most recently early mortality syndrome (EMS). Shrimp production went down 15% in 2012 to an estimated 500,000 tonnes. Shrimp is the third largest export commodity and is well supported by the public sector.

Each shrimp farming province has a shrimp club and the largest, Chanthaburi and Suratthani Shrimp Farmers clubs organise annual conferences and trade shows which attract farmers and stakeholders from all over the country. Farmers network and keep up with developments during these events. The pride of the industry is the cohesiveness, the sharing of ideas and information and the respect for industry leaders and researchers who frequently visit shrimp farming areas conducting seminars and solving problems.

This year's gathering in Suratthani, held from 23-24 February had 1,800 participants. "We have been doing this for the last 23 years but this is the largest gathering so far. We do expect problems with EMS in 2013 and at this meeting we discussed how to work together and overcome these problems quickly. In late 2012, we have confirmed reports that farms in Chanthaburi suffered from EMS. This is the second largest producing area after Suratthani. We estimated production of only 20,000 tonnes in 2013 from 60,000 tonnes in 2012. Farmers and stakeholders are here to find out how to overcome this together", said **Dr Suraphol Pratuangtun**, co-founder of the Suratthani Shrimp Farmers Club and President of the Thai Marine Shrimp Farmers Association. Dentist by training, Pratuangtun has been farming shrimp for the past 30 years.

## Messages on overcoming mass mortalities

Outbreaks of EMS or acute hepatopancreatic necrosis syndrome (AHPNS) was first reported in Hainan China in late 2009 and subsequently in Vietnam since 2010, Malaysia since 2011 and in late 2012, in Chanthaburi in eastern Thailand. There are also sporadic reports in some southwest provinces but as these are unconfirmed as EMS, industry leaders such as **Dr Surasak Dilokkeart**, Network of Thai Shrimp and Thai Citizen, have described these mortalities as due to PMAD or poor management associated diseases.

In Thailand, several teams are working on the etiology of EMS as well as on likely situations which could bring about massive mortalities within the 30 days of culture. In his presentation, **Dr Chalor Limsuwan**, Aquaculture Business Research Center, Faculty of Fisheries, Kasetsart University reiterated that cause of mortality is designated as EMS when it occurs within 7-35 days of culture to exclude WSSV and WFS. The field diagnosis should match that described by Dr Tim Flegel, Centex Shrimp. Whether it is EMS or PMAD, the sentiment of industry at the gathering was just to learn how to prevent crop losses.

## PL quality

Recently, **Dr Tidaporn Chaweepak**, Department of Fisheries (DOF), Thailand has been screening post larvae (usually PL10) sent by farmers prior to stocking into ponds. She has been privy to numerous samples and her analysis has shown the following: the frequency of *Vibrio* has been increasing in the past few years and in addition, there is a significant presence of unidentified yellow spots in the



An autofeeder, bird scare lines and enhanced aeration at a farm in Krabi

hepatopancreas. These were also reported to be present in the brood stock. On culturing these shrimp, she observed that in older post larvae (PL24) the spots developed into gregarine-like organisms. Further research will be conducted. However, her message was, "These yellow spots are detectable with a low resolution microscope and farmers should be able to make simple observations with their PL. In comparison with the quality of PL of many years ago, current PL carry with them not only *Vibrio* but also fungal organisms."

**Dr Niti Chuchird**, Aquaculture Business Research Center, Faculty of Fisheries, Kasetsart University said abundant lipid vacuoles or droplets are an indication of health status. In his work on the scoring of healthy post larvae, he looked at the lipid droplets in the hepatopancreas. Unfortunately, based on the standard today, only 14% of samples passed the test. PL with low levels of lipid droplets, would not survive in the ponds. In checks for *Vibrio* populations, he said that none had passed his criteria and in such cases, shrimp will inevitably die in the ponds.

**Soraphat Panakorn**, Novozymes Biologicals and Dilokkeart said that there has always been a large presence of pathogenic organisms and parasites cohabiting in shrimp without any adverse effects at the hatchery. Conditions are stable in the hatchery in terms of pH, oxygen, temperature and alkalinity. However, PL are exposed to fluctuating conditions in the pond and if shrimp are stressed, they will die slowly. Panakorn explained that observations in the industry have indicated that with increasing demand, hatcheries have increased tank stocking density and have reduced water pH to hasten nauplii growth to PL. These PL with hastened growth possess gills that are not well developed. It is most likely that such PL will succumb to early mortality when stocked in the pond. Then there is also the case with *Vibrio* populations. These now exceed  $10^3$  or  $10^4$  CFU/mL.

## Brood stock

Industry leaders concur that there has been a decline in the quality of brood stock, although some stakeholders disagree. Limsuwan said that in recent years, imports of SPF brood stocks have declined. Locally bred brood stocks are preferred as they are perceived to be better adapted to local conditions. The lower quality of brood stock is indicated by the low



Dr Chalar Limsuwan (left) and Dr Suraphol Pratuangtun



Dr Surasak Dilokkeart (left) and Soraphat Panakorn

usage rate of 1-2 months after ablation instead of more than 4 months previously. In addition, it is most likely that pond bred brood stock carry parasites such as gregarines which can attach to PL. In the case of clean PL, fouling will take weeks to develop in the pond environment.

Prior to the meeting, the DOF requested hatcheries to observe a dry out period on a staggered basis depending on areas. Leaders suspect that hatcheries are cutting costs and urged them to reconsider their practices and use more enrichment diets. In a special session, chairman **Dr Puth Songseangjinda**, director Shrimp Institute, DOF discussed guidelines on best practices. Self-regulation in the industry is critical during this period. Farmers, on their part, were urged to check on the quality of PL and reject those that do not meet quality checks such as age, muscle to gut ratio, stress and formalin tests.

**Grow out conditions**

According to Panakorn, “Weak PL succumb easily to fluctuating or poorer pond conditions and depending on the ‘start- off’ condition of PL, how each farmer manages his pond will determine whether shrimp will succumb to EMS or PMAD. Our industry has skilled managers who should be able to modify their culture practices with changing pond conditions. We do not have specific guidelines but nowadays farmers check for dissolved oxygen and maintain stocking density at a level that they are comfortable with. Most farms have increased the rate of aeration to combat EMS.”

Limsuwan gave some advice such as on the feed amounts during the first few days which should be only 0.5 kg per 100,000 shrimp instead of the amounts recommended by feed companies ranging from 1 to 4 kg. Feed accumulated over 30 days must be 200-250kg only. In the case of dead shrimp suspected of succumbing to EMS, he asked farmers to stop feeding until there are no new dead shrimp, monitor the condition of live shrimp and resume feeding only after 7 days. He said some cases of suspected EMS are related to heavy pollution in the pond. He clarified that shrimp with red swimming legs are weak shrimp staying in the sludge area or an indication that the sludge is all over the pond. To avoid EMS, he recommended that farmers observe closely requirements related to pH, alkalinity and minerals, and it is important to provide optimal culture conditions.

During the meeting, it was apparent that the industry is ready for the next cycle which usually begins in March. A cautious strategy is to stock half of the ponds and if all is well stock the rest. The advantage of the industry in Thailand is that skilled farm managers are able to adapt to the changing situation.

“We are very optimistic that we will be able to overcome EMS and keep up production. The first report occurred three months ago, we have had time to develop the guidelines for hatcheries, advise farmers to keep checks on PL quality and work with DOF on controlling quality of brood stock. We are together in this business and now we ask hatcheries to do their part and lead by fortifying their PL,” said Pratuangtun.



Participants from Songkhla. They manage 100 ponds in a 1,000 rai farm.



Dr Robins McIntosh (left) and Dr Mati Nitibhon, Charoen Pokphand Foods presented ‘Making shrimp farming sustainable’

# News in Brief

## Market launch of first ASC pangasius

The Aquaculture Stewardship Council (ASC) celebrated the market launch of pangasius with its global, independent trademark for responsibly farmed seafood into Germany in February. This logo guarantees consumers that the fish they are purchasing has responsibly been farmed with regard to the environment and social aspects. The first pangasius to bear the ASC label comes from 13 of ASC certified farms in the Mekong Delta in Vietnam. Together they are now responsible for 10% of the total production. ASC certified pangasius will be available in several supermarkets throughout Germany. Brands and companies as TopSea, Frosta, Femeg, Queens, and Profish are all supplying pangasius products carrying the aquamarine ASC logo. More pangasius farms in Vietnam have all formally announced that they will be audited; and following a positive outcome, the supply of certified ASC products will substantially increase.

## EU to allow PAP in aqua feeds

From 1 June 2013, the European Commission will allow the use of non-ruminant processed animal proteins (PAP) for use for fish feeding according to Commission Regulation (EU) No 56/2013. This allows for the use of poultry and pig proteins for aquaculture. In a report, the European Feed Manufacturers' Federation (FEFAC) said that the European Food Safety Authority (EFSA) has provided clear scientific evidence that non-ruminant PAPs produced in accordance with the high EU processing standards are safe. They can help in reducing the EU dependency on fishmeal imports thus contributing to the Common

Fisheries Policy reform goals of pairing sustainable wild fisheries with the sustainable development of aquaculture.

## Breeding the humphead wrasse

Researchers at the Borneo Marine Research Institute (BMRI), University Malaysia Sabah, Malaysia will start a breeding program to increase the population of the endangered humphead wrasse (*Cheilinus undulatus*) or popularly known as ikan maming. The fish has a high retail value of up MYR250/kg (USD 80/kg). The fish is in danger of extinction but despite a ban on its trade, the fish is caught and exported mainly to Hong Kong. BMRI will also have a release program in an effort to increase its wild population. The breeding stock is now 2 years old and fish will mature at 7 years old.

## WSSV in the Philippines

The Bureau of Fisheries and Aquatic Resources (BFAR) regional office in Dagupan City has reported the emergence of the white spot syndrome virus (WSSV) in some shrimp farms in the Visayas and Mindanao and particularly in Sarangani. In the Philippine News Agency report, Director Nestor Domenden said that there is minimal encroachment of WSSV in Western Pangasinan but warned shrimp farm operators to implement necessary precautionary measures such as to continuously maintain hygiene and sanitation in their ponds as their first line of defence. Farmers in the Visayas and Mindanao reported unregistered shrimp hatcheries in Pangasinan or those in Zambales as the source of their supply of post larvae. These are not under government supervision.

## Certification for sustainable barramundi farming in Vietnam

Australis Aquaculture, the world's largest producer of barramundi, has received the GLOBALGAP Certification for its Vietnam farm operations. This is the Massachusetts-based company's first major certification to an existing global standard for its Vietnam aquaculture facility. "Achieving GlobalGAP certification means that our entire Vietnam production chain has been thoughtfully considered and recognised for its best practices for sustainable aquaculture," said Josh Goldman, CEO of Australis. Since receiving its license from the Vietnamese government in 2008, Australis has embarked on a steady growth plan that has resulted in production doubling each year. The award-winning company currently employs 100 people in Vietnam and is targeting a harvest of 2,700 tonnes in 2014.

## FDA has new office in India and website

The US Food and Drug Administration (FDA) maintains two offices in India (New Delhi and Mumbai), the only country besides China to have more than one FDA post. FDAImports.com now has an office in Chennai. "FDA is paying attention to India like never before," said Rick Quinn, principal at FDAImports.com and head of the Chennai, India office. "FDA's enforcement activity will undoubtedly increase as the regulations implementing the Food Safety Modernization Act take effect. A key offering for the new India office will be to continue to assist Indian companies with expediting FDA clearance of imported goods and also obtaining removal from FDA's Detention Without Physical Examination ("Import Alert") regime. Having an India-based

office with local native speakers who are also qualified experts will assist our clients exponentially." FDA also announced a new website: <http://www.usdapermits.com>

## Aquaculture insurance in China

China is expected to announce the framework for co-funding of insurance cover for the country's aquaculture farms. In seafoodsource.com, Jason Scott, aquaculture specialist at London-based FP Marine said that he expects that this announcement of reinsurance terms will be significant as it is expected to have an effect similar to that when China's agricultural ministry five years ago announced a reinsurance program for livestock. "Within five years China had become the world's second largest reinsurance market," said Scott. He believes the government is keen to push ahead with aquaculture insurance in order to protect the country's aquaculture industry while also ensuring the country's food security. Coastal aquaculture in China is also prone to storm damage from typhoons as well as outbreaks of WSSV. Another challenge to insurers is the onset of red tides and algal blooms in the country's heavily industrialised coastal belts. The nature the aquaculture industry with millions of small-scale players means that the government has to be a co-funder. Major global players in aquaculture insurance are keen to get a foothold in China, including FP Marine Risks, an accredited Lloyd's broker with offices in Beijing and Hong Kong. London-based, Longline Environment Ltd UK supports aquaculture insurers in Asia with risk assessment services and insurance surveys.



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# Successful production in semi-biofloc in Indonesia

By Agus Saiful Huda, Junaedi Ispinanto, Fauzan Bahri, Olivier Decamp

The Aquaculture Experience Farm in Java operated a hybrid system, based on a careful balance between autotrophic and heterotrophic organisms which gave average outputs of 20 tonnes/ha in early 2013.

High water exchange is standard practice to maintain suitable water quality in intensive shrimp production systems. However, environmental and biosecurity issues led farmers to develop methods relying on reduced or zero water exchange. A method that is commonly found in Thailand relies on recirculation systems where incoming water is treated in a reservoir before being pumped into rearing ponds, and where the pond effluent is directed towards a settling pond and treated before being either discharged to the environment or re-used for the next pond stocking.

Another example is the Biofloc Technology (BFT) system that was developed to reduce the risk of pathogen entry, minimise effluent discharge and protect the surrounding environment. For further information on BFT, please refer to publications in trade magazines and scientific journals, including those of Dr Yoram Avnimelech and Dr Ngan Taw.

The concept was applied in Indonesia, first at PT Central Pertiwi Bahari, then at other farms in Medan, Java and Bali. The success of these systems relies on high stocking density, adequate aeration, as well as the right amount and form of carbon/nitrogen ratio fed to the system. The understanding of the basic concept, the right tools to monitor the system and the right infrastructure will explain the success or failure of the technology under commercial conditions.

Despite the interest of many Indonesian shrimp farmers in the technology, the failure of various projects due to unsuitable facilities (no back-up in the case of power failure and limited monitoring), or incorrect number and position of the paddlewheel aerators, led farmers to move away from BFT. Many Indonesian farms (around 50%, personal communication Cindomas) switched to the semi-biofloc system (i.e. the hybrid system), using a rearing protocol adapted to local characteristics, facilities and infrastructure. The purpose of this article is to describe the semi-biofloc or hybrid system, as applied in farms in East Java.

## The hybrid system

The hybrid system, as operated in many Indonesian farms, is based on

a careful balance between autotrophic and heterotrophic organisms. These organisms create what we call bio-microfloc which is a smooth and compact aggregate matter made of green algae (mostly *Chlorella*) and bacteria (mostly *Bacillus* supplied via commercial probiotic), as well as detritus, organic particles and protozoa. The organisms from the bio-microfloc control water quality by converting uneaten feed, dead plankton and shrimp faeces into compounds that are non-toxic.

This action of the biofloc organisms not only detoxifies the system but also improves the stability of the rearing environment. As a consequence, the bio-microfloc can be called 'bio-conditioner'. The bio-microflocs are also a natural source of food for shrimp. For further information on the composition of the biofloc, and also the impact of probiotics on the nutritional value of the biofloc, we refer to publications, among others, from The Oceanic Institute (USA), Texas A&M (USA), Waddell Mariculture Center (USA), and the Fundação Universidade Federal do Rio Grande (Brazil).

Contrary to the full BFT, the balance between phytoplankton and bacteria is of the order of 30-40% autotrophs and 60-70% heterotrophs. With the development of the bio-microfloc, the pond water colour can be described as light brown or cream. The volume of bio-microfloc in the pond water has to be managed through the addition of chemicals (calcium carbonate, magnesium carbonate), organic matter, and microbial products (Sanolife PRO-W) or limited water exchange.

The shrimp pond is prepared for 20 days and stabilised (with algae and bacteria) before stocking the post larvae (PL10). Key parameters are water colour, pH, alkalinity, and the composition of plankton and bacteria. As with BFT, aeration is very important. Paddlewheels must be positioned correctly in order to maximize oxygenation (above 4 ppm, for shrimp and the organic degradation of organic matter), improve water circulation and mixing (to avoid stratification) while directing the sludge towards the central area of the pond. (Photo 1)

Problems with aerators can affect the suspension of biofloc, thus leading to the accumulation of biofloc biomass, the creation of anoxic zones and the dramatic reduction in dissolved oxygen. Power failures over an hour in duration can be critical. Back-up power generators

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Photo 1. View of pond with paddlewheel aerators.

must be available. Contrary to the zero-water exchange heterotrophic system, siphoning is routinely performed to control the organic matter (especially excess nitrogen), as well as the checking for the presence of dead shrimp. Water transparency is maintained at a Secchi disk reading of 25-30 cm. Limited water exchange is carried out if required.

### Example from a farm in Indonesia

The farm, Aquaculture Experience, is located in Kabupaten Lamongan, East Java. It includes 40 ponds, of an average size of 3,000 m<sup>2</sup>. Ponds are fully lined with HDPE. The total area of the farm is 27 ha.

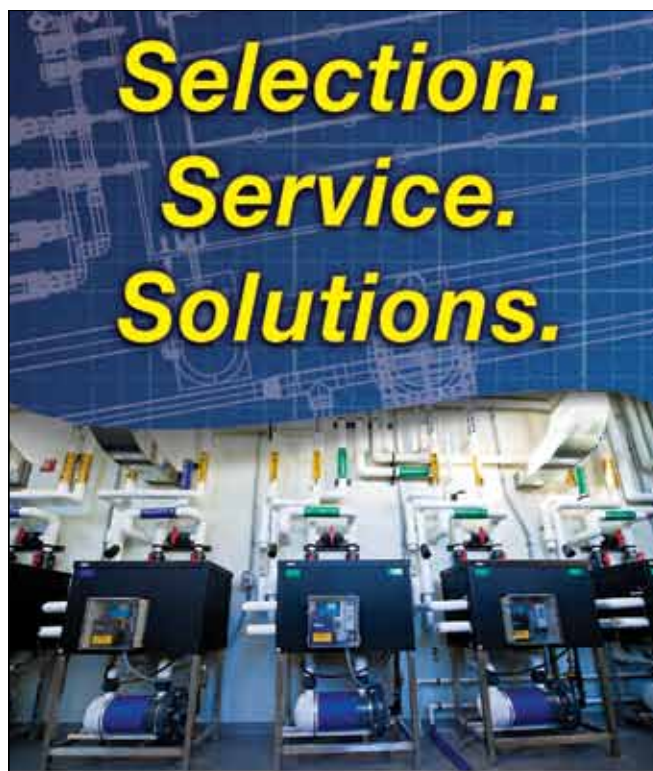
### Preparation for 20 days prior to stocking

After preparing the reservoir and pond, including setting up the biosecurity measures, i.e. crab protection and bird nets, the important phase of water preparation starts. This is the disinfection of the water using Sanocare PUR 1.2 ppm, followed by the initial enrichment of the rearing environment with the right nutrients. These include dolomite (10 ppm), a source of calcium carbonate and magnesium carbonate (Kaptan 3 ppm) and *Bacillus* mixture (Sanolife PRO-W 10 ppm). The small particles, together with the *Bacillus* mixture, are in fact a 'floc starter'. These products are applied on a regular basis over a period of 2 weeks or so until the pond water is stable with the right balance of microorganisms. This is followed by the 'directing phase' where a more stable environment is obtained (Figure 1).

### Culture operations

After stocking animals (PL10), the pond management consists of maintaining a stable environment through (1) strengthening the system and (2) controlling the system. The composition of the algal community is controlled through the manipulation of the N: P (nitrogen: phosphorus) ratio following Redfield stoichiometry, with targets of N: P ratio of 25: 1 (20-25 ppm nitrate and 0.5-1 ppm phosphate). Frequent addition of a source of nitrate (Sanolife Nutrilake 5 ppm) is required. In order to maintain the right equilibrium between algae and bacteria, the right mixture of *Bacillus* is frequently applied (Sanolife PRO-W 10 ppm). In order to compensate for mineral deficiencies, additives are mixed with the feed (protein content of 30-35%). Molasses is added 2 or 3 times per week at a dose of 10-15 kg/ha.

A combination of Sanolife PRO-W, dolomite and Kaptan 5 ppm is applied to establish and maintain aggregate (microfloc), with a target of 2-3 mL/L volume in Imhoff cones within 1.5-2 hours. This is different from the BFT system where the biofloc volume is generally higher, up to 15 mL/L. In order to maintain the stability of the system, water exchange is kept at a minimum. In addition to water quality management, feeding and shrimp health management, the mixed biofloc system also requires specific attention and management. This includes the use of a central drain and siphon to remove the excess



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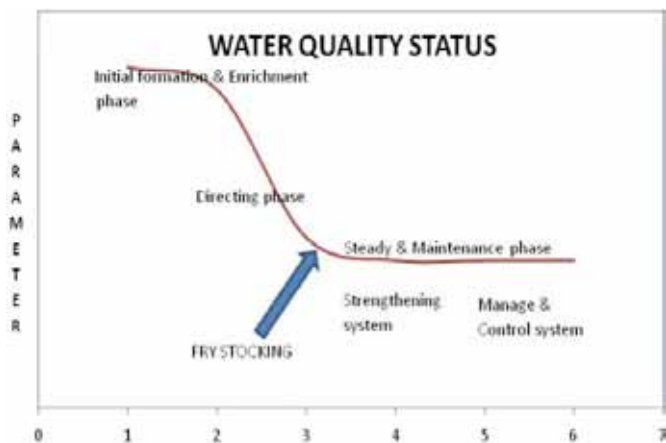
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Figure 1. Overview of the various phases in the hybrid system, as operated at the Aquaculture Experience farm.



organic matter that would accumulate in the central area of the pond (following the right positioning of the paddle wheel). An additional benefit of the frequent siphoning is the evaluation of the shrimp moult and the observation of dead shrimp that would have accumulated in the central area (Photo 2).

Two additional steps are taken. The immune system of the shrimp is optimised through the regular coating with a mixture of immunostimulants and nutraceuticals (Sano TOP-S). The feed conversion rate is improved through the coating of probiotics (Sanolife PRO-2).



Photo 2. After siphoning, workers check for dead shrimp or any indication of problems in the pond.

Performance of recent crops

Tables 1 and 2 give the results of the last two culture cycles in late 2012 and early 2013 respectively. The operation at the farm with the hybrid system has led to the stable production of shrimp. The stocking density is only an estimation as there is a tendency for hatcheries to supply a higher number of PLs to the farm. Fine-tuning of the protocol to the conditions prevailing in this part of East Java led to an improvement of the feed conversion ratio (FCR) with an increase in the productivity.

Table 1. Harvest data from Aquaculture Experience farm operated under semi-biofloc in autumn 2012.

Pond	Size (m <sup>2</sup> )	Density (PL10/m <sup>2</sup> )	Days of Culture	Size (pcs/kg)	Yield (kg)	FCR	Productivity (tonnes/ha)
A	2,800	80	88	48	4,110	1.32	14.7
B	2,900	65	86	52	3,979	1.21	13.77
C	2,900	72	87	50	3,935	1.28	13.6
D	2,800	72	86	51	3,741	1.26	13.4
E	2,300	78	87	48	3,172	1.32	13.8
Average	2,740	73	87	50	3,788	1.28	13.8
A	3,300	113	104	46	7,527	1.38	22.8
B	3,000	133	82	62	6,273	1.53	20.9
C	2,900	137	83	62	5,794	1.69	20.0
D	3,000	119	97	47	6,423	1.36	21.4
E	3,200	120	96	46	5,360	1.53	16.7
F	3,000	119	96	48	5,760	1.44	19.2
Average	3,067	124	93	52	6,188	1.49	20.2

Table 2. Harvest data from Aquaculture Experience, farm operated under semi-biofloc in January 2013.

Pond	Size (m <sup>2</sup> )	Density (PL10/m <sup>2</sup> )	Days of Culture	Size (pcs/kg)	Yield (kg)	FCR	Productivity (tonnes/ha)
A	2,800	107	96	45	6,011	1.30	21.5
B	2,900	105	94	53	5,783	1.28	20.0
C	2,800	107	89	51	5,504	1.33	20.0
Average	2,833	106	93	50	5,766	1.30	20.3

The phytoplankton was dominated by green algae with blue-green algae kept below 10% of the total community most of the time. Water transparency was reduced from 40-60 cm in the first weeks of the crop to 20-30 cm in the last 2 months of the crop (Figure 2).

Conclusions

As with other intensive shrimp rearing systems, it is important to have a well defined check list for each stage of cultivation, detailing the potential hazards at each stage, the precautionary measures, the parameters to be followed, and also the contingency plan. For each

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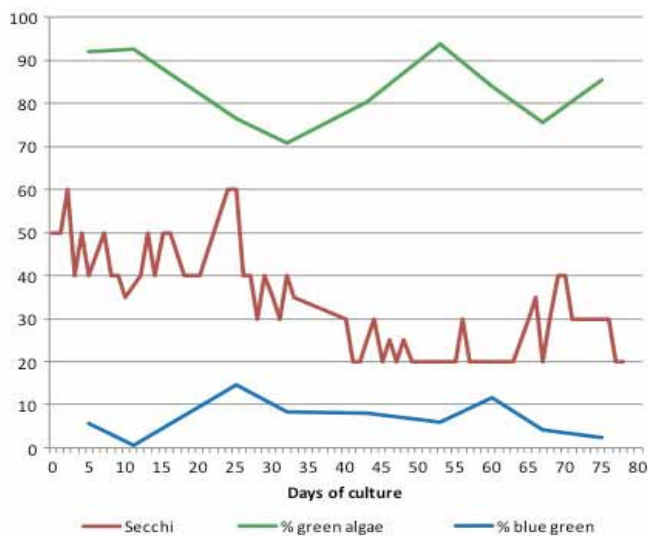


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Figure 2. Characteristics of the phytoplankton: water transparency (Secchi disc reading, cm), percentage of green algae and blue green algae in the total phytoplankton.



problem, an action plan (a solution) should be defined in advance. Looking at the 'Early Warning System', based on daily observation, we include parameters such as discolouration of the shrimp, changes in body shape and behaviour, extreme size variation, status of shrimp hepatopancreas and faeces, and slower growth rate.

The important points to consider are

- Production must be biologically feasible, but also technically and economically viable.
- Production should be right from the first time. Avoid the mistake at

the beginning.

- Prevention and control of disease through:
  - a. Reduction and control of stressful factors. System must be as stable as possible.
  - b. Stimulation and activation of the immune system continuously. This is achieved through the coating of a mixture of immunostimulants and nutraceuticals.
  - c. Control of pathogens, such as *Vibrio*, virus and fungi.
  - d. Identification of appropriate treatment in case of disease.
  - e. Containment of disease.
  - f. Optimization of the feed digestibility and absorption. This is achieved through the coating of *Bacillus* probiotics.



Agus Saiful Huda



Junaedi Ispianto



Fauzan Bahri



Olivier Decamp

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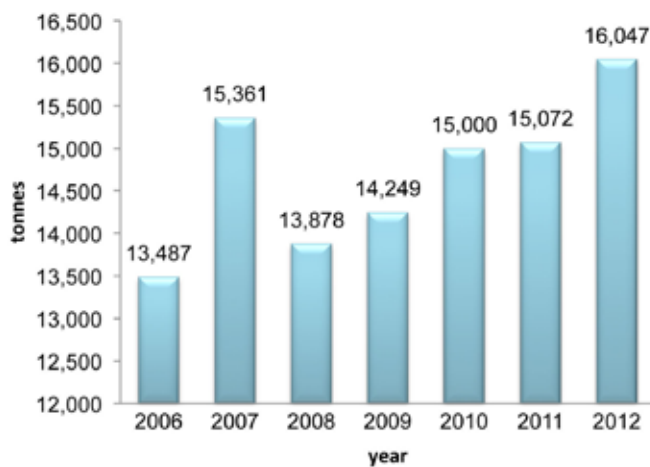
# Out of season shrimp

The cold season in North Vietnam does limit vannamei shrimp farming, but this is not always the case.  
By Zuridah Merican

Marine shrimp farms in North Vietnam usually have two crops, the first from March to June and the second, from July to September. The winter season is from November to April. However, some farms continue to stock in end September or early October for a third crop, particularly when ex-farm prices are high. In late October 2012, a storm destroyed some late season crops, although these coastal farms are protected from severe floods from high sea waves by an elevated cement dyke.

Coastal shrimp farming in the Red River Delta provinces of North Vietnam is centred around Haiphong City, some 88 km from Hanoi. In 2011, the production of farmed shrimp was 15,072 tonnes (MARD, 2011) from the coastal provinces of Quang Ninh, Hai Phong, Thai Binh, Nam Dinh and Ninh Binh. In Haiphong district, farms are usually small with 6-7 ponds. There is only one large farm with 75 ponds in an area of 122 ha, belonging to the Son Truong Co Ltd. Uni President Vietnam (UPV) provides feeds for many of the small farms. Feed is from its feed mill in the central province of Quang Nam, near Da Nang. Other feed suppliers are Grobest and Charoen Pokphand Vietnam with factories in south of the country.

Figure 1. Shrimp production in coastal provinces in the Red River Delta, North Vietnam (GSO, Vietnam, 2012 and MARD for 2011 and 2012 production).



Duc Bui Linh started farming 4 years ago at his 2ha farm with 6 ponds ranging in size, from 2,800 to 3,000 m<sup>2</sup>. After one crop of black tiger shrimp *Penaeus monodon*, he quickly changed to farming the more profitable *P. vannamei*. In Vietnam, farmers regard vannamei shrimp farming as an 'efficient use of land' in comparison to that of the black tiger shrimp (Hoang Thanh, 2011). Today, his stocking density is 100-120 post larvae (PL10)/m<sup>2</sup> for the 1.2 to 1.3 m deep ponds. Post larvae are from Uni President's hatchery in Ninh Thuan Province, central Vietnam. In Haiphong, a common practice is to line the sides and pond bottoms with a blue and white loose mesh polyethylene material. This type of pond liner is also common in the shrimp farms in the central provinces.

According to Linh, the liners usually last for one or two crops. At his farm, he uses this 'blue and white' material to line the sides and a thicker black HDPE liner for the pond bottoms. He added that whether a farmer will opt to use a relatively thicker and durable liner will depend on his financial resources.



Shrimp in feeding trays at the farm of Nguyen Van Dang. At low temperatures, shrimp reach size 68/kg (15g) after 92 DOC.



Pond preparation in between crops

## Winter crop

December is a cold month for the vannamei shrimp but there is still shrimp in one pond ready for harvesting in the new farm managed by Nguyen Van Dang. This farm comprises 10 ponds of 3,000 m<sup>2</sup> and larger. This is a relatively new farm which began operations in 2012. The stocking density is 110 PL10/m<sup>2</sup>. The farm practises zero water exchange in its ponds. Incoming water is treated with chlorine in the reservoir. Salinity of water in the ponds averages 18 ppt. Close to harvesting and with night air temperatures of 16°C, Dang has to be careful that the crop is not lost to the cold weather.

"He needs to run two types of aerators; paddlewheel and spindle aerators," said Linh, who also distributes feeds for this farm. "Throughout the culture cycle, in each pond, usually four long arm spindle aerators are used to oxygenate the ponds and when shrimp are larger, paddlewheel aerators are added, usually located at the four corners of the pond. At times like this when the air temperatures are low, such as today at 21°C, the farm manager will also operate 2-3 paddlewheel aerators. The purpose is to have a good mix of the top and lower layers of water. This is the standard procedure.

"This particular pond was stocked at the end of August. The shrimp is now at 68 pcs/kg after 92 days of culture (DOC). At higher temperatures, we expect this size shrimp after 60 DOC and the highest achieved was a summer crop of size 50/kg weighing 20 g at 86-90 DOC. Usually shrimp is sold live to restaurants in Hanoi, through brokers. Harvesting is usually partial but during the cold months, there will only be a one time harvest for each pond. In December, the expected price for the shrimp was VND 138,000 for size 70/kg (USD 6.6/kg). Prices are higher by VND 5,000-10,000/kg for live shrimp."

The average yield at the farm is 4.5 tonnes/pond/crop of 15 g shrimp (size 70/kg). The cost of production in the north during the cold season averages VND 70,000/kg (USD3.4/kg) whereas it would be only VND 55,000 to 60,000/kg (USD 2.6/kg to USD2.9/kg) in the south's warm season, said Cheng Yen-Hung, assistant vice-president of Uni-President Vietnam. "The farm uses 5 tonnes of feeds for the production of 4 to 4.5 tonnes of shrimp. We supply 7 types of feeds to the farm. We also supply post larvae from our hatchery in the central province for farms in the north. It is common to see that farmers in the central and southern regions feeding vannamei shrimp with vannamei shrimp feed during the early culture period and then shift to black tiger shrimp feed such as our UniPro for the later stages. This is common when they stock at low density (<math><150\text{PL}/\text{m}^2</math>) and wish to hasten harvest when prices are high. In this way, they achieve better feed conversion ratio (FCR) ranging from 1.1 to 1.2 to harvest. However, in the north, farmers use vannamei shrimp feed throughout the cycle and achieve FCR of 1.4-1.5 when the density is more than 150PL/m<sup>2</sup>."

During the second crop in 2012, shrimp died at 45 DOC in two ponds and when mortality continued at 50 DOC, Dang decided to abandon the crop. He has attributed mortalities to the 'HP (hepatopancreas) disease', presumably to the early mortality syndrome or acute hepatopancreatic necrosis syndrome (AHPNS) which has affected many farms in Vietnam.

"In 2013, we will still maintain the stocking density of 100 PL/m<sup>2</sup> and maybe will increase to 120 PL/m<sup>2</sup>. In March, we will restock the ponds initially with 2-3 ponds followed by the rest of the ponds. I expect the new ponds now under construction to be ready for stocking in May 2013."

## References

General Office of Statistics, Vietnam (<http://www.gso.gov.vn>)  
Hoang Thanh, 2011. Vietfish International, pp 57-59, March/April 2011)



Spindle and paddle wheel aerators in operation



Nguyen Van Dang (centre, left) and Bui Duc Linh (centre, right) with the UPV team, from left, Cheng-Yen Hung, Van Duc Long (sales representative), Vo Thuy To Quyen (deputy manager of Aquatic R&D division), Chau Tot Thuc (sales assistant) and Nguyen Xuan Hanh (sales manager).



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# An effective nutritional way to reduce skin parasites in amberjack and yellowtail

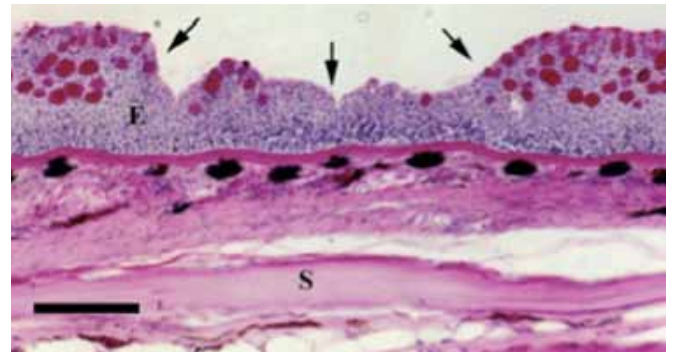
By Serge Corneillie, Kei Nakayama and Midori Funaki

The aquaculture industry in Japan faces problems with skin and gill parasites that restrict its development and profitability. The parasites graze on the epidermis of the fish, causing irritation and a lot of stress especially when high numbers of parasites are present. Furthermore the parasites cause skin wounds which acts as an entrance points for pathogenic bacteria such as *Nocardia*.

The primary defense mechanism of a fish can be considered to be the physical barrier (skin, gills and gastrointestinal tract) and their protection mechanisms, at the point of interaction of the environment and the physiology of the fish. Both externally and internally, the mucosal barrier and tissue cellular membrane integrity play a vital role in this process. Parasites graze the epidermis of the fish and cause bleeding wounds. Many bacteria (for example *Nocardia*) and viruses enter the fish through these skin wounds. When large amounts of parasites are present, they graze off large areas of epidermis, which include the mucus cells, and therefore the fish cannot produce mucus anymore. The first defense system, mucus, disappears.

## A thick mucus layer prevents the attachment of the parasite larvae

In Japan, the flatworm parasite *Benedenia seriolae* is seen as one of the biggest problem in the industry. The life cycle of the parasite was studied by I. Ernst, C. Talbot and S. Corneillie in 2001. The free swimming larvae



Skin of yellowtail: the upper layer (epidermis) has been eaten by the parasite. The red dots are mucus cells (Ingo Ernst, 2002).

of the parasite attach to the fish and grow to an adult parasite in about 20-30 days, depending on the water temperature. The parasite feed on the epidermis of the fish. The adult parasite produces up to 60 eggs per



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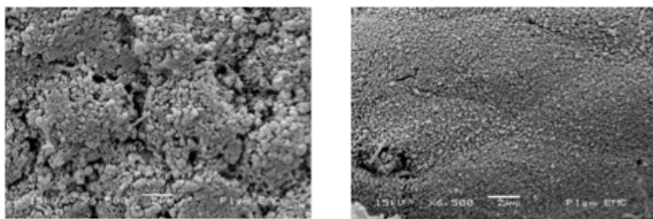
hour in summer. The eggs have a long tail which attach to the fouling on the nets. When the larvae hatch, after 5-7 days, the larvae need to attach within 24 hours to a new fish or otherwise dies.

Recent trials in which amberjacks were fed a feed additive (Aquate PP (mc), Alltech, USA) for 2 months show an increase of mucus production in the epidermis which contributed to the reduction of up to 90 % skin parasite after 2-3 months. Similar results with Aquate SPMP were obtained in salmon in Norway and Scotland. The mucus layer is the first physical barrier that the parasite larvae must overcome.

## Reducing parasites

### Tests with the salmon

In 2008-2010 the Marine Harvest group in Norway, Chile and Scotland established many tests with Aquate SPMP in salmon to reduce parasites. Marine Harvest in Scotland found that the salmon fed extruded feed containing the feed additive had a nearly double thick mucus layer. It was assumed that this makes it very difficult for the parasite larvae to attach to the fish. Indeed, as a result the salmon fed the feed additive had over a 3-4 months period nearly zero attachment of parasite larvae (Wallace et al., 2008). Some of the biggest salmon groups in the world are now using the product on their total production to reduce parasites. One of the other main benefits of the product is that some nutritional elements in the product stimulate strongly the development of the microvilli in the intestine. Farmers using the product observed a better growth and a lower feed conversion ratio (FCR). This better performance could be due to at one hand a result of the lower parasite stress but on the other hand a result of the fact that the nutrient absorption area (microvilli surface area) is strongly increased which leads to a better uptake of nutrient but also of medicines (Wallace et al 2009).

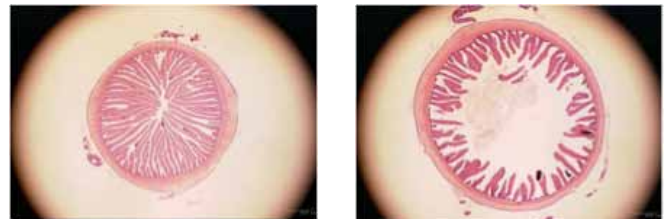


Electron microscopy of the salmon gut microvilli in control versus the much denser structure in the Aquate SPMP group on the right

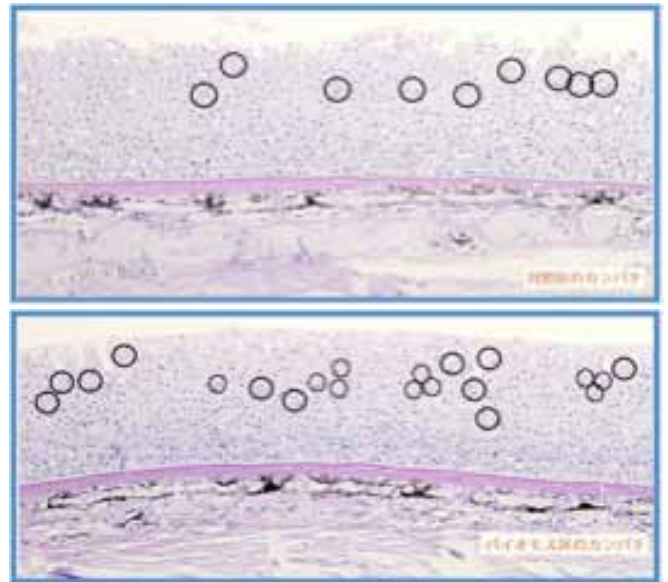
### Amberjack in Japan

During the summer of 2011 and 2012, many amberjack, yellowtail, red sea bream and blowfish farmers used Aquate PP (mc) and Aquate PP in different areas in Kyushu and Shikoku in Japan. Results in many tests showed a strong reduction of parasite numbers. Results in one amberjack farm in 2011 showed that the parasite numbers were strongly reduced in 6 test cages using the first feed additive ( versus 74 control cages) and during the period September-November only 2 peroxide baths were needed for the test cages versus 5 peroxide bath treatments in the control cages. The same company put all first year amberjack on the second feed additive in 2012 and peroxide baths on average was only 2 against 8-9 in normal years (every 2 weeks) in the period September-December. Cost of the product for one cage is about the same as the cost of one peroxide bath. In another test, the parasite numbers were reduced by 75 % (around 80 parasites per fish versus 20 parasites per fish in the test cages).

Histology of the skin and the intestine showed that more mucus cells were observed in the outer skin and also that we could see a much stronger microvilli development in the intestinal tract. Similar observations were made in sole, catfish, seabass, trout and many more fish species.



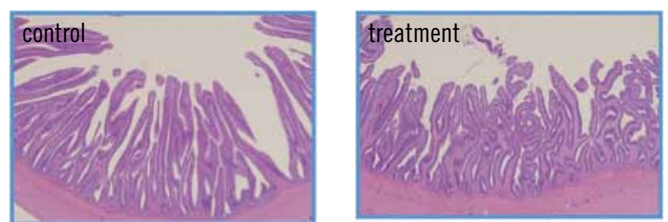
Microvilli development in yellowtail fed Aquate PP (mc) versus control on the right, (Corneillie et al. 2010)



Outer skin of Amberjack (upper pic: control versus Aquate PP (mc) (lower pic) much more mucus cells are observed in the test group (2011 Kagoshima)

## Conclusion

Amberjack and yellowtail fed with the products for over 2 months develop a thicker mucus layer which hinders strongly the attachment of the parasite larvae. As a direct result the lifecycle of the parasite is cut and the numbers of skin and gill parasites is strongly reduced. It is also important that a much better development of the intestinal microvilli is observed and many farmers claimed good growth or lower FCR.



Microvilli development of amberjack fed without (control) or with Aquate PP (mc)



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# Extrusion of fresh water fish feeds

By Joe Kearns

This starts with species specific formulations to changing process variables and ending with dryers for exacting final product specifications.

In 2011, the Food and Agriculture Organisation reported that Asia led the world in 2009 with 66.67 million tonnes of fish production or 91.3% of global production. Eighty percent of this total is freshwater fish production with various carps, tilapia, and pangasius catfish dominating cultivated fish in Asia. Production is spread over many countries, all with various formulations based on local available ingredients for production of floating fish feeds. Nine out of the top 10 aquaculture producers are in Asia with China, Indonesia and India leading the way.

Extrusion cooking is a key tool in production of the majority of aquatic feeds and specifically for freshwater fish. Floating fish feeds are a major management tool in reduction of feed conversion ratios by allowing the consumption to be monitored and thus feeding volumes to be changed accordingly.

## Species specific formulations

Production of floating aquatic feeds start with the species specific formulations. These ingredients are ground to a homogenous mix with a fine particle size. Typically the general statement is no particles larger than 1/3 the die hole size as a minimum. Actually the finer the grind on the raw materials, the better as fine grinding yields a very nice pellet appearance and also allows for greater capacity in the extruder as it is easier to precondition and cook. The general requirement for



Pond side harvesting of pangasius catfish in Andhra Pradesh, India, February 2013.

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—Steve Jobs



*Newly farmed aquatic species, changing raw material availabilities, and even controversial ecological issues have created serious needs for advancements in aquafeed processing. As a long-time leader in extrusion, Wenger is addressing these and other challenges with ground-breaking approaches. Consider these recent Wenger innovations: Oblique Tube Die and Diverging Cone Screw result in small diameter feeds at rates three to five times those of previous technology; Thermal Twin Screw Extruder permits high percentages of fish slurry, oil and high moisture ingredients; HIP preconditioner, with adjustable mixing intensity, addresses recipe challenges - especially those with varying content of starch, fiber and oils. And the list goes on.*

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Typical floating feeds of various sizes for carp, tilapia and catfish

floating feeds is that 20% starch is present in the formula to achieve the water buoyancy characteristic required.

### Critical areas in extrusion

Reviewing the stages of extrusion cooking allow for some discussion on the critical areas in the process. It begins with the formula being delivered to the holding bin directly attached to the extruder. This bin needs to be free flowing in design and evenly deliver the material through a rate controlling screw conveyor into the preconditioner. Uneven flow can result in non-uniform pellets at the discharge of the extruder barrel. Preconditioners come in various styles and types.

### Preconditioning

The objective is to premoisten and partially cook the material prior to the extruder barrel. The advanced designs will yield a free flowing powder at the discharge directly above the extruder barrel. The material is preferred to be non sticky so blockage and buildup in the transition is avoided. Preconditioner designs allow for inclusion of steam, water and possibly other liquid ingredients. Retention time is the key in total absorption of the moisture into the feed particles. Typical retention times are in the 2.5 to 4 minute duration. This allows for non sticky free flowing powder delivery to the extruder barrel. Any variation of mass flows such as dry feed rates, steam, water or others, to the preconditioner can momentarily cause stickiness or at least uneven pellet size at the extruder final die.

### Final control

The extruder barrel is a specialized part of the machine which gives the final control on the product characteristics. There are single screws, traditional twin screw and non parallel completely tapered twin screw barrel designs. Each has a place in the industry for advantages they offer.

The single screw extruders are the work horses of the industry with the majority of floating feed being made on these style machines. Capacities can vary from a few hundred kilograms per hour up to 20 tonnes per hour or more. Generally, they are of a simpler design and have a rugged durability with day in and day out performance. With industry trends moving towards quality of feeds there are moments when these machines do leave the operator with selected challenges.

Uneven flow cause non uniform pellets. This can be caused by a number of factors, even mass flows is the first to be confirmed. Component wear or the gap between the rotating screws and matching head or the extrusion tube allow for back flow causing product 'surging'. Surging is the art of continuous making feeds of various sizes which is normally not desired. Die design and cutting techniques also play a major role in the final product appearance.

An additional point is the use of pneumatic conveying between the extruder and dryer. Many plants do not use this technology with a preferred simple dropping of the pellets from the extruder through the floor down into the dryer inlet. This works perfect if all is in order. In many cases not all is just right and the result is what is referred to as 'clumping and or chaining' of the pellets. All the pellets stuck together in a lump or a string of pellets all attached to one another.

Pneumatic systems greatly reduce this effect if not completely eliminate it. The act of passing air over the die cools the die, sucks away each pellet individually and cools the outside surface of the pellet avoiding the stickiness associated with hot extruded product directly out of the die. This system would cost more initially but is justified against the sifting out of the lumps and reworking them over the life of the plant. In addition, the lumped together pellets if dried and then broken apart could allow formation of wet spots resulting in possible mold growth in the bags.

### Twin screw technology

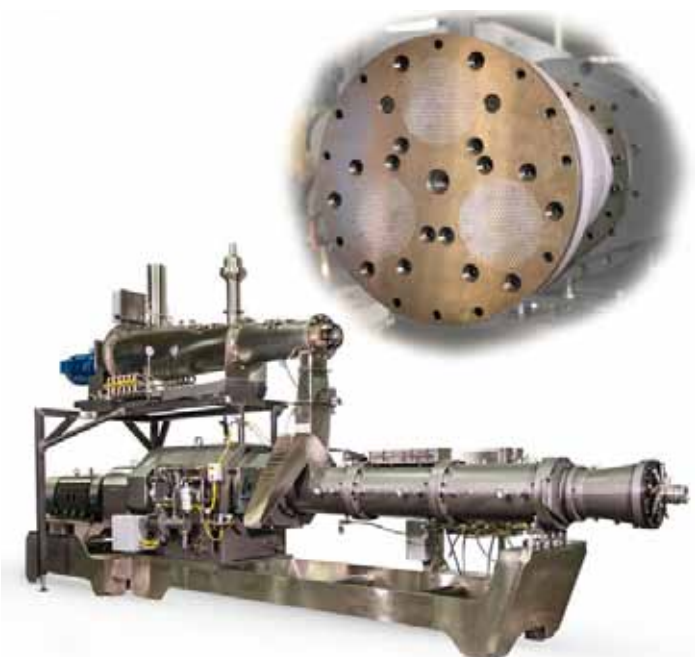
The use of twin screw technology for floating feeds is gaining popularity due to the positive pumping action of the double screw design. This effect allows for higher production of smaller diameter feeds. The aquatic feed industry has begun to recognize the benefits of the twin screw extrusion process over single screws. This is especially true in the micro aquatic feed production. The advantages of the twin screw are particularly notable on floating micro aquatic in which there has to be high die pressure to achieve expansion. High die pressure is hard to control on a single screw in a production mode as there is too much uncontrolled back flow.

Pictured below is a large capacity twin screw extruder, up to 12 tonnes per hour, utilising the patented OTD die concept. It lends itself to substantially higher capacity on micro aquatic pellets because it allows for tremendously increased die area than possible on existing face dies. It also produces much more uniform pellets than is possible on standard dies.

The nontraditional twin screw extruder C<sup>2</sup>TX, conical co-rotating twin screw extruder allows generation of material compression continuously throughout the barrel. The intermeshing co-rotating conical screws have a unique profile that kneads the dough mass as it is forced through the barrel. The process is referred to as profile kneading and is unique to the industry's only conical co-rotating twin screw extruder.

From the low density preconditioned recipe at the extruder inlet to the dense dough mass at the discharge into the die, the unique profile of the conical intermeshing co-rotating screws assure uniform and constant compression and kneading in the full length of the barrel. With less material in the short C<sup>2</sup>TX extruder barrel than in the barrel of a conventional single or twin screw extruder, the C<sup>2</sup>TX extruder is extremely responsive to process variables such as screw speed, recipe moisture, recipe, temperature, cook in the preconditioner, and the effect of the barrel back-pressure valve.

C<sup>2</sup>TX screw speed may be adjusted during operation from 500 to 1200 rpm as required for the product and recipe being processed.



TX-3000 traditional twin screw extruder with oblique tube die (patented) for high capacity floating and sinking feeds.

Changing any of these several process variables will result in immediate and controllable changes in finished product density, cell structure; surface texture and color without changing the extruder die or screw components. This design coupled with the patented oblique die technology has resulted in not only greatly improved sinking feed production such as shrimp feed but it has also shown the benefits as noted above for the traditional twin on floating feed production.

The C<sup>2</sup>TX design is better suited for the 5 to 6 tonnes per hour maximum rates.

### Dryers play a role

Floating aquatic feed production is not simply just extrusion cooking but the design of an appropriate dryer is also critical. Horizontal dryers lend themselves to computer control where the extruder and dryer can communicate together in unison for the exacting final product specifications. Floating fish feed production is a process where the variation of the input water and steam into the extruder is utilized for accuracy in the final product density. These variation changes actually change the moisture levels delivered to the dryer and thus communication between equipment in high technology computer controlled plant designs allow for the exacting moisture levels out of the system. Existing procedures of storage of feed in flat warehouses and the movement of these bags to the pond sites in the tropical high humidity climates justify close control to avoid development of molds and spoilage of the feeds.

Varieties of extruder designs exist for the many required feeds now needed in the aquatic industry. Some very versatile and others highly specialised. Volumes of special feeds needed in major aquaculture production areas are now justifying the need for plants to utilize different extruder designs to efficiently manufacturer these wide ranges of feeds. There are extruders available to fit all possibilities such as floating, slow sinking, sinking, micro feeds, semi-moist and all types of marine feeds at wide capacity ranges.



Conical co rotating twin screw design



**Joe Kearns** is Aquaculture Process Engineering manager at Wenger Manufacturing, Inc. Sabetha Kansas, USA. He has been with Wenger since 1974 and is recognised for several patents ranging from texturised sinking feed, sea urchin feed to those on increasing capacity of production from floating




and sinking feeds with single and twin screw extruders. Email: [jkearns@wenger.com](mailto:jkearns@wenger.com)

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# Formula optimisation

By Bruno Duranthon and Stéphane Ralite

**Formulation software with a new tool for a rapid analysis of an additive brings added value to the aqua feed industry as it seeks to optimise new ingredients and additives.**

The past fifteen years have seen a tremendous development in the aquaculture industry. As more and more new species are being farmed, especially in Asia, aqua feed manufacturers must deal with an increasing number of formulas. Since the availability of raw materials and price are major issues, there is a growing need for innovative solutions in terms of novel raw materials, precision in defining nutritional needs, formula optimisation and new additives.

In addition to being a critical tool for implementing these innovations, formulation software also brings an intrinsic added value, as we will see. In this article, we will look at three areas which are key in the aqua feed industry: the use of moist raw materials, the specific optimisation of feed containing additives which affect digestibility or diminish the effects of anti-nutritional factors, and the management of increasing numbers of constraints imposed by export markets. The A-SYSTEMS company has developed the Allix<sup>2</sup> formulation software with specific ways to meet these needs by providing a very simple to use yet sophisticated tool for users. In this way, users can concentrate on their nutritional expertise and not become overwhelmed by complex software.

## Optimal drying and feed concentration

The need to decrease fish meal content in aqua feed has led to a greater use of moist or liquid raw materials, such as fish solubles, liquid hydrolysates, moist fish or animal by-products and moist vegetable paste. It is not easy to properly optimise and calculate the benefits of using these raw materials with current software because optimisation is done on the final nutritional value, using the humidity content of the dry feed. Since the final humidity can limit the incorporation of moist raw material, the software should take into account the feed drying phase to calculate the optimum amount of moist raw material to be used.

A second problem is feed concentration. In nutritionally concentrated feed, the incorporation of liquid raw materials into the formula is limited by the 'space' occupied by water. Current software prefers concentrated raw materials, although they are much more expensive. Once again, the drying phase must be taken into account for formula optimisation to allow for a proper evaluation of moist content.

Allix<sup>2</sup> provides a very easy-to-use solution to this issue. The software optimises moisture extraction from the feed and calculates optimal diet density. These calculations enable major savings, since formula cost can be reduced by up to 2%.

## Optimisation of additives

Allix<sup>2</sup> also brings the benefit of special tools which have been developed to optimise the incorporation of specific additives to enhance the value of raw materials. Some additives (such as enzymes) affect digestibility, the energy level of feed and the inhibition of nutritional factors. These effects can vary with the raw material used and, of course, the species to be fed. But which nutritional value should be used for specific raw materials? Additives may change the availability of nutrients such as phosphorus or modify the energy value. How can this be taken into account during formulation? Allix<sup>2</sup> includes a new tool which makes a simple, rapid analysis of the relevance of an additive for a particular formula. With this tool, the formulator can study the specific effect of an additive on the evaluation of a raw material, as well as on the nutritional constraints of the formula. A specific modeling feature automatically tests which additive is most beneficial. If a dose effect is shown, it will be noted in the optimisation report. In this way, the nutritionist can quickly and easily compare different additives: Should I use this enzyme or another one? Does the effect described by the supplier give us a competitive advantage in terms of cost and nutrition? This type of study is very difficult to make with other optimisation software, even with software which seems to be extremely sophisticated.

## Meeting the specifications of different clients

A third area concerns the management of an increased number of client specifications. Since most aquaculture products are exported to major markets, clients are obliged to develop certification with restrictions on the use of raw materials, nutritional values, etc. Some will require

## Feedback from the field



Romain Troussset

As the Feed Division Manager at Ultralloy in South Africa, Romain Troussset had twelve years of experience as a formulator for international feed and premix companies. He currently sells nutritional products and services to the feed industry.

"In addition to perfect formulation and optimisation functionalities, what I like most about Allix software is its ergonomic approach and specific management tools. I use these tools for jobs such as studying the overall consumption of raw materials or to compare. It is also very easy to exchange information between Allix and Microsoft Office, which helps a lot in my daily work. I especially appreciate the software when I must make a nutritional study for one of my clients. The Allix management tools let me provide an answer very quickly. Since they are compatible with Office, I can adapt a specific presentation to a specific client. The A-System team is also very reactive, and I am always surprised at how much they know about the work and needs of formulators and feed manufacturers. Today, as a distributor, I am very much reassured by the long-term vision."

Optimization

File Edit Display Tools Options Go to...

Optimization Min % Cardinality Swing

Product: 101 DEMO

Plant: 01 Planta 1 / Plant 1 Number of RM's: 28

Price list: 2012/10 Oct 2012 Number of nutrients: 20

Price \* Tonn: 100000 Cost diff\* Tonn: 15045 Tonnage: 750 Totals: 100.0000 'Production': 32.29 100.00

Price: 251.84 Cost diff.: 20.06 Rounding: 188.9 Optim No: 9124 'Production': 8645 37 19/09/2012 SR

Product Optimization Rounding Automatic rounding Note Prod

Composition Nutrient RM rejected Constraints

Code	Raw material	Value	Diff.	Min.	Max.	Status	Price	Cost	From	To	Lower price	Higher price	Min %	Production
001	OAT	3.5495	3.55		30.000	✓	350.00				171.78	356.10	1.00	
012	CORN (HIGH FAT LEVEL)	30.0000	17.80		30.000	✓	274.38	-0.25	25.73	30.00		299.81	1.00	
016	TAPIOCA 62.5	15.0000			15.000	✓	163.20	-4.21	11.10	16.78		584.45	1.00	
021	MIXED FAT	5.0000		1.00		✓	104.00					130.76	0.50	2.60
073	SOYA MEAL 47	27.9470	2.93			✓	253.98				39.93	259.01	1.00	
107	RICE BY PRODUCT	0.8124	-9.19		10.000	✓	153.58				150.70	273.46	1.00	25.70
108	DDGS	7.0000	6.72		7.000	✓	193.80	-0.58	4.87	8.38		252.02	1.00	
112	CORN GLUTEN 60%	5.0000			5.000	✓	287.58	-7.61	3.62	6.09		1048.35	1.00	
140	CALCIUM BICARBONATE	2.1358	-0.94			✓	50.00					72.71	0.10	3.48
150	PHOSPHATE	2.6706	2.02			✓	650.00				639.03	754.04	0.05	0.10
154	SALT	0.3577	-0.02			✓	80.00					3489.57	0.10	0.33
159	DL-METIONINA LIQUID	0.0270	0.03			✓	3300.00				1228.69	4805.34	0.01	
999	PREMIX	0.5000		0.50		✓	1530.00	2.86		1.39	1244.18		0.01	

Optimisation screen

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the absence of genetically modified organisms (GMOs), others will not allow the use of animal products or palm oil or will have constraints on organic raw materials. In addition, certain manufacturing plants may have specific constraints, for example in terms of the maximum level of liquid or oil. These constraints increase formulation cost. At the same time, it is not easy for formulators to know the origin of constraints: Are they from the nutritionist? Client specifications? Which client? Are they from the manufacturing plant? If the answers to these questions are not clear, you might keep a costly constraint in the formula even if the client's specifications have changed. Or you might forget to change a constraint.

Allix<sup>2</sup> can help you handle this data very easily by including the constraints from different specifications to build into the formula. Once the specifications have been established, you can be certain that the product calculated will meet these specifications, thus simplifying and securing your work. When a client specification changes, just update all the formula with a click. You are certain to meet all specifications and not forget any which might lead to a costly error.

Specific tools are available for aqua feed formulation and there are many others to provide quick answers to questions ranging from: What will we gain from using this raw material? If I can buy limited quantities only, where should I use them to maximize profit? In which formula? At which plant? Depending on quality control results or market price variation, when should I reformulate? Which formula should I change? Since my company is able to trade in raw materials, will it be better to sell or use our raw materials?

Formulation software is an invaluable time-saver in situations like these and enables both formulator and nutritionist to carry out more thorough and cost-effective studies and optimisation.



Bruno Duranthon

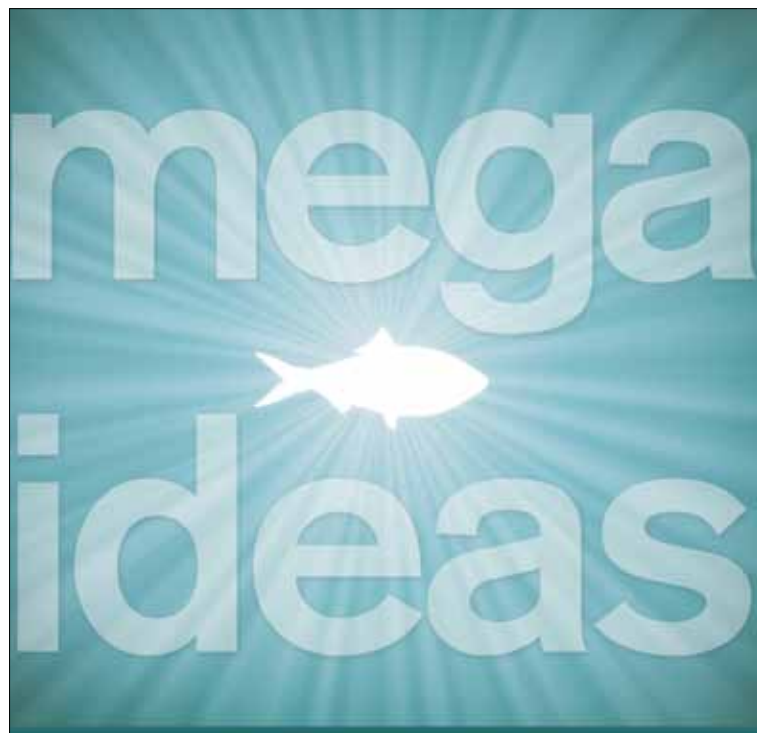


Stephane Ralite

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Stephane Ralite is feed and nutrition consultant at A.M.N. (Aquaculture Market and Nutrition), France. Email: [amn@ralite.com](mailto:amn@ralite.com)

A-SYSTEMS was founded by a team of nutritionists and mathematicians and is a leading expert in both feed formulation software and quality control software. More than 1,000 companies use A-Systems solutions around the world. Web : [www.a-systems.fr](http://www.a-systems.fr)



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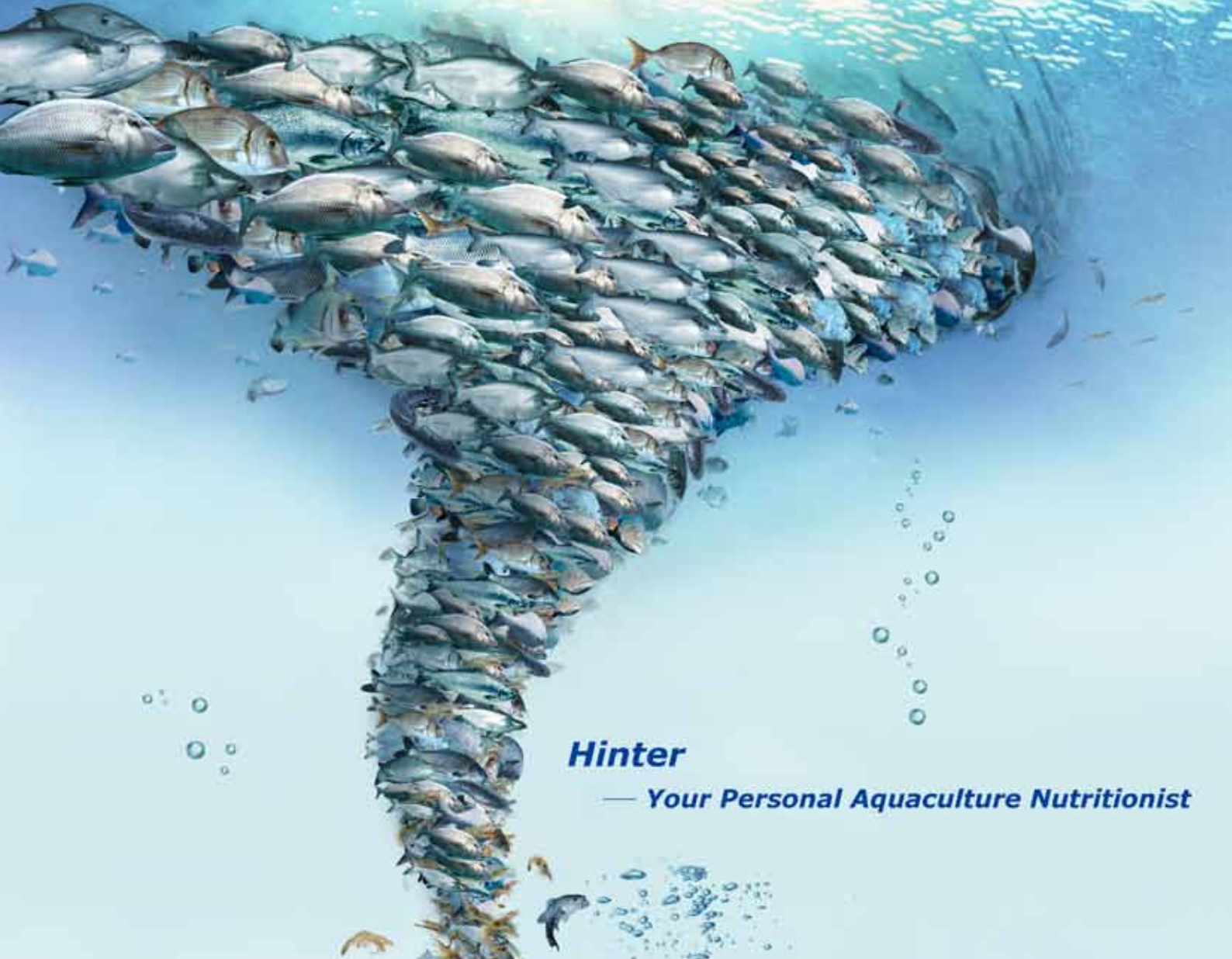
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# 2013 Global Feed Survey

Survey says that global feed production increased to 954 million tonnes and Asian production grew by 13% within a year.

In January, Aidan Connolly, vice president of Alltech announced the results of Alltech's 2013 Global Feed Survey. The annual survey, now in its second year, is unprecedented in terms of the size and scope of its assessment of global feed tonnage and trends. Carried out in December 2012, the survey covers all major types of feed in 134 countries.

The 2013 Global Feed Tonnage Survey released showed that the world is producing 954.4 million tonnes of feed, 9% more than in 2011. Globally, the survey identified 26,240 feed mills. China was reaffirmed as the top producer of feed at 198.3 million tonnes and an estimated 10,000 feed mills. The latter is down from 50,000 feed mills a few years ago. Consistent with late 2011 assessments, the US and Brazil followed with 168.5 million tonnes produced by 5,251 feed mills and 66 million tonnes produced by 1,237 feed mills respectively. Overall, a 36.7 million tonnes increase was observed in BRIC countries (Brazil, Russia, India and China) year to date. Some 60% of feed produced globally is pelleted, with percentages particularly high in Europe

In the executive summary, Connolly who is also Alltech's director of annual Global Feed Tonnage Survey said that where possible, information was obtained in partnership with local feed associations and, when not possible, it was done utilising information gathered by the more than 520 members of Alltech's global sales force, who visit more than 26,000 feed mills on an annual basis. When reviewing the data, there are two considerations to bear in mind. First, numbers for less developed countries may be less accurate, but given their size, this will have little numerical influence on the overall dataset. Second, the definition of feed, feed mill and species varies from country to country.

"The 2013 publication of the annual year-end assessment by Alltech is being released as an industry outlook resource for the new calendar year and will hopefully allow governments, non-governmental organisations and the greater public to appreciate the value that the feed industry is generating globally," said Connolly.

"In terms of technology, the survey showed that although technology is improving, it has not moved fast enough. There have been little advances in processing technology. Companies have not embraced more regulations such as with PCBs and mycotoxin controls. There is also a global move to stop the use of antibiotics. The enzyme market will continue to grow at 7-8%. The use of enzymes such as phytase and for wheat is increasing and with DDGS, the types of enzymes will increase."

Asia continues to be the world's number one producing region at 356 million tonnes from 12,149 feedmills. This is a 13% increase in

production compared to 2011. However, Africa exceeded Asia in percent growth over 2011 results, increasing its tonnage nearly 19% from 47 million tonnes in 2011 to 56 million tonnes in 2012. The Middle East was estimated to have the largest feed mills, with an average of more than 63,000 tonnes produced per mill which is significantly higher compared to the Asian figures of 29,347 tonnes.

## Aquafeeds

This is the fastest growing species sector by tonnage with growth greater than 16% since 2011. The 2012 estimate was 34.4 million tonnes, increasing from last year's estimate of 29 million tonnes. Asian aquafeed production was 25.6 million tonnes or 58% of the global aquafeed production. China led in aquafeed production with 13.3 million tonnes followed by India, 3.5 million tonnes, Vietnam at 2.92 million tonnes, Thailand, 1.6 million tonnes, Norway, 1.5 million tonnes, Indonesia 1.3 million tonnes and Poland, 1.15 million tonnes.

The consumption of fish meal did not reflect the growth in aquafeed production which Connolly explained, "Most companies have addressed the need to eliminate fish meal completely from aquafeeds. Formulations now have only 10-15% inclusion rates of fish meal. The future will see more substitution with land based protein meals such as algae and yeast proteins as fish meal becomes more expensive."

As for 2013, Connolly said. "I believe that we will see a large increase in aquafeed production as aquaculture grows to replace fisheries. The game changer will be that aquafeed will surpass the 50 million tonnes level of petfoods.

"The other game changer is the move to use lots of different ingredients rather than just corn and wheat. There will also be upstream consolidation in the industry in most countries and we will see more restrictions imposed by governments and consumers on how we feed and what types of feeds."

Global feed production has traditionally been difficult to quantify because many countries lack a national feed association. For this reason, Alltech began in late 2011 to leverage its global presence to obtain a finer estimate of the world's feed tonnage. The results of the annual year-end assessment are announced in January as an industry outlook resource for the new calendar year. A summary of the 2013 Alltech Global Feed Survey findings, including graphs, may be downloaded at <http://www.alltech.com/sites/default/files/2013-feed-tonnage-report.pdf>

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# Tilapia in Asia: more production in 2012

**Product repositioning is required despite rising volumes for the tilapia as it morphs from being a food crop for the masses to that tailored for retail markets.**

The popularity of the tilapia continues to grow globally. It is now second to the carp as a farmed food fish. Dr Kevin Fitzsimmons, University of Arizona in a presentation at the Ninth International Tilapia Industry Development Forum (NITID9) in Hainan, China in November 2012 says that he expects the fish will one day surpass that of the carp as it is amenable to farming in saline and freshwater environments. More tilapia farms are being set up. Tilapia aquaculture is one of the greenest forms of aquaculture where effluents from tilapia farms can be used to grow crops. It is environmentally sustainable with no fish meal required in the diet and no need for antibiotics in its culture. Tilapia aquaculture has become a model for other finfish species.

“The uniqueness of the fish is that it is farmed by small scale farmers to supplement family incomes to large scale industrial farms” said Fitzsimmons. Tilapia farming has few constraints in comparison to other species such as the pangasius catfish. Global tilapia production was 3.66 million tonnes in 2011 and should exceed 3.8 million tonnes in 2012. China continued to hold its position as the single largest producer (1.4 million tonnes) in 2011 and production is forecasted to rise to 1.5 million tonnes in 2012 (USDA, 2012). It exported 286,125 tonnes in the first ten months in 2012. Indonesia produced 461,717 tonnes in 2011 (DJPB, 2012). It is the biggest exporter from Southeast Asia. Philippines produced 275,000 tonnes and Thailand 250,000 tonnes.

## India a new player

Tilapia is farmed widely in the whole of Asia with the exception of India. This will soon change as the authorities have allowed its farming but with specific guidelines. Farms have to obtain a permit/license from the Government to carry out the farming. Farming is allowed only with monosex male fish of Nile tilapia or its hybrids. Minimum stocking sizes are 10 g for pond rearing and 50 g for cage culture. The maximum stocking density in ponds is 5 pcs/m<sup>2</sup> and each farm should not be more than 4 ha in size. Cage culture is permitted in reservoirs where there is an established stock of tilapia. In cages, use of floating feeds with minimum protein content of 25% is encouraged. In recirculation aquaculture systems, the stocking should be limited to 150 pcs/m<sup>2</sup>. The guidelines also specify biosecurity measures to prevent escapees. In the case of hatcheries and nurseries, permits are also required and they may only use brood stock from approved foreign and Indian companies. Fishing Chimes (January, 2012) reported that farmer Ramesh Raju has started to farm all male black and red Nile tilapia in monoculture or polyculture with the rohu, pangasius catfish and marine shrimp. He uses floating extruded feeds produced by a local company Growel Feeds Pvt. Ltd. Industry is also interested in saline tolerant tilapia for farming at 15-30 ppt salinity.

## Expansion in Asia

In 2012, authorities both in Indonesia and Malaysia announced programs for small farmers where the tilapia is featured as the main species. In South Sulawesi, Indonesia, the Australian Centre for International Agricultural Research (ACIAR) and Brackish Water Aquaculture Center (BBAP) conducted trials using strains of red tilapia namely, agile, gift, and nirvana (Trobos, January 2013). The semi-intensive farming using only 1.2 kg of 20-25% protein feeds to produce one kg of fish has garnered interest from milkfish and shrimp



*Tilapia in Indonesia. Picture courtesy of PT Matahari Sakti.*

farmers keen on polyculture with tilapia. Malaysia also wants to expand production with cage culture in four lakes under its agriculture transformation program. This is expected to add 96,000 tonnes of production by 2020.

In general the tilapia enjoys a high domestic demand. The Philippines consumes virtually all the tilapia grown in the country. Vietnam has a ten-year program to produce 200,000 tonnes of the tilapia as a key export commodity. Although tilapia culture expanded quickly particularly with the use of former pangasius catfish cages in the Mekong Delta, production only reached 100,000 tonnes in 2011 (Vietfish.org) which is sufficient for domestic consumption. According to the Sustainable Ethical Aquaculture Trade (SEAT) program Thailand exported only 10% of its tilapia production in 2009. However, Thailand's tilapia development strategy also includes exporting 60,000 tonnes of its planned target of 300,000 tonnes in 2014.

“The interest in tilapia production comes from the increasing demand from the main market, USA. US consumption of tilapia, both from domestic and imported supplies continue to increase and the estimated consumption was 613,406 tonnes of live weight equivalent in 2011. Consumption is expected to rise further, ahead of the pollack, unless pollack prices come down. Nevertheless the percentage of tilapia in grocery stalls has been growing. We see tilapia is almost all cruise ships and it is starting to appear on menus on airlines and in schools, hospitals and prisons. Even the fish fast food chain, Long John Silver has tilapia on its menu. Imagine if McDonalds and Burger King decide to use tilapia, we will need to double production,” said Fitzsimmons.

“The reason for the continued increase is due to better packaging and processing such as IQF fillets, new product forms such as smoked tilapia and sashimi grade tilapia. China remains the leader with tilapia by-products used for collagen production. Prices have remained relatively unchanged in the last 20 years and this can be expected to remain the same in the future. Only prices of fresh fillet have increased. Large tilapia integrators have also established traceability and environmental standards for their products.

## Product repositioning

Despite the continuous increase in production, constraints in its farming remain. Industry is asking for high quality fry and fingerlings. Fitzsimmons stressed the importance in genetic improvement and seed production as farmers need higher quality seed stock obtained through improved breeding programs. There are already excellent breeding programs such as the GIFT programs in Malaysia, Bangladesh and China, Genomar in Brazil and Norway, Chitralada and Tabtim in Thailand, GIFT Excel in the Philippines, Molobicus, a saline tilapia hybrid in the Philippines and YY supermale in the Philippines and Swansea, UK, Egypt and Indonesia. The next frontier in the genetic program is the tilapia genome project which has assembled the entire DNA sequence for the Nile tilapia *O. niloticus*.

Through a selective breeding program in Egypt spanning over 10 years, WorldFish has developed the Abbassa strain that grows 28% faster and heavier than the most commonly used commercial strain in the country, the Kafr El Shaikh strain. Similarly, in Ghana the Water Research Institute (WRI), in partnership with WorldFish, has developed the Akosombo strain, which grows 30% faster than non-improved tilapia. WorldFish has been working with partners on two breeding programs in Ghana and Egypt to develop the 'Abbassa' and 'Akosombo' strains of Nile Tilapia (*O. niloticus*), a variety of fish native to much of Africa ([www.worldfishcenter.org](http://www.worldfishcenter.org))

In China, a selection program using the GIFT strain was started in 1997. The work in three research stations had targets of increasing growth rates to 750 g in 5-6 months instead of 500 g and fillet ratio of 40% from 33%. In 9 generations over 9 years, the result is a new variety in 2005, which has a fillet ratio of 40% which is 5-8% higher than that for the common tilapia. In 2010, another new GIFT tilapia

grew to 750 g in 5-6 months. Farmers reported higher productivity at 1-2 tonnes/mu/crop (15-30 tonnes/ha/crop) and in the south, 2 crops are possible. The Jili fish, which is salt tolerant was produced. Following the production losses during the cold spell of winter of 2008 and streptococcus infections in 2009, attention focussed on cold tolerance and stress resistance (Yang Hong and Dong Zaijie, 2012).

Working with industry in China and Thailand, SEAT scoping surveys identified flavour quality of tilapia as one of the constraints in increasing tilapia exports and sustaining it. It added that European consumers mentioned in interviews that flavour of fish is important to them as the way they eat fish is different from Asians. Europeans will just add some salt, with not much sauce or curry, so the flesh has to be of good quality and with flavour. There is no room even for a small hint of off-flavour. Thus for action research, SEAT is looking at some ways of producing on-flavour tilapia to meet demand for exports (<http://seatglobal.eu>). In Hainan, Professor Liu Liping at Shanghai Ocean University said that considerable losses in the export of tilapia can be attributed to the low reputation on quality, largely due to off flavour mainly from small and medium scale producers (AAP, 2013).

## The US market

In the US, tilapia is a top five seafood item with a per capita consumption of 1.287 lb/capita in 2011, closely behind that of the pollack (1.30 lb/capita) and salmon (1.9 lb/capita). John Connelly, president of the National Fisheries Institute (NFI), a leading trade association said that the tilapia has already seen a 28% growth in consumption in the US in the first 8 months of 2012. The tilapia is a relatively low priced fish and has a position below the pollack. According to Urner Barry the average price of 3-5 oz. frozen tilapia fillets in September 2012 was reported

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Kevin Fitzsimmons

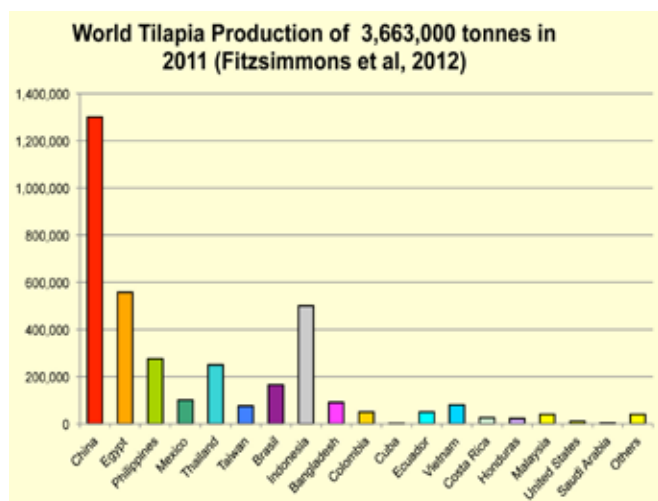


Molobricus brood stock (15 ppt saline tilapia hybrids) at the National Integrated Fisheries Technology Development Center (NIFTDC), Philippines

at USD1.90/lb, down 13% from the start of 2012. This is the lowest average price since July 2010 when prices also averaged USD1.90/lb.

The US will still remain a huge and major market and Connelly expects more demand with the future demographics showing the Hispanics population, more culturally accustomed to fish consumption, growing from 13% to 24%. Fish consumption is favoured as the American population gears towards food to meet health, wellness and nutritional expectations. In addition, science backs the importance of seafood in the diet. He added that although “opportunities for increased tilapia sales in the future are strong in the US, there are barriers (such as the negative perceptions on other aquatic imports) to growth in this market.”

“The import alert in June 2007 on farm raised catfish, shrimp, basa, eel and dace from China for non-approved pharmaceuticals was because the FDA perceived that Quality Supervision, Inspection and Quarantine (AQSIQ) and China Inspection and Quarantine (CIQ) were not acting to stop illegal antibiotic use. The continued use of antibiotics, in particular, harms the image of all Chinese seafood in the US market. This problem is to the point that some large retailers will not sell any Chinese seafood. The other barrier to future tilapia growth in the US is the practice of short weighing and improper use of carbon monoxide in processing tilapia. Short weighing is illegal in the US which requires the proper labelling of net weight of the product (without ice). NFI also understands that FDA is reviewing its position toward the use of carbon monoxide (CO) in tilapia and other fish.”



### Certification and Sustainability

Most of the large producers have certified their production facilities (hatchery, grow-out and processing plants) to one or more of tilapia standards available in the market. In Malaysia, Trapia Malaysia which produces tilapia in cages, was certified by GlobalGap in 2010, and Aquaculture Stewardship Council in January 2013. In the case of small and medium size producers, certification to local inspection schemes is common. However, international certified products are often a requirement by major importers. The Sustainable Fisheries Partnership (SFP) is building up sustainability at an industry level in tilapia through its program in Hainan, China (AAP, 2013).

In October 2012, the Aquaculture Stewardship Council formed an alliance with two partners in China, the China Aquatic Products Processing and Marketing Alliance (CAPPMA) and WWF China, to begin to tackle the problem of how to help China’s producers operate in a more environmentally sustainable way. With a grant from the European Union (EU) of €1 million, it will address the two major challenges facing tilapia aquaculture in China: the lack of transparency in the supply chain, and the weakness of the production system in some Chinese tilapia farms with unsustainable practices. Without access to sufficient information on issues such as traceability, hygienic regulation and environmental management, the confidence of consumers in the industry and its products will be lower than desirable. The EU is currently the third largest importer of Chinese tilapia, with a share of around 10% and is a growing market ([www.asc-aqua.org](http://www.asc-aqua.org)).

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# Tilapia in North Vietnam

While tilapia is being intensively farmed in cages formerly used for the pangasius catfish in the Mekong Delta, in the Red River Delta of North Vietnam, the main farming system is polyculture with carps.

In 2010, the northern provinces of Hai Duong, Bac Ninh, Bac Giang, Ha Noi and Hung Yen produced 27,780 tonnes of tilapia from 5,105ha of ponds. The Department of Agriculture and Rural Development in Hai Duong said that production of tilapia have increased significantly. In 2005, the pond area was only 10ha with average yields of 5.2 tonnes/ha. In 2009, this rose to 3,440 ha and 6 tonnes/ha, respectively.

Here the farming of the red and black tilapia in cages and ponds is a small scale farming activity, mainly to supply local markets. The market size for the red tilapia is 800g whereas that for the black variety is larger at 1.1kg. The culture season is limited to the months from March to October in ponds and from April to November in cages for the red tilapia. The growth period is 7 months to reach 800g, says Nguyen Thi Hang, who now farms tilapia in freshwater floating cages.

"I started farming tilapia in ponds together with the common carp and grass carp; three years ago, I began to culture both red and black tilapia in ponds and now I have moved to farm the fish in cages in a river. Whether we farm in ponds or cages, ex-farm prices are the same. Furthermore, we do not have complaints of off-flavour when we market the fish.

"We use the same fingerling size for farming in ponds or cages. These come from China. The price for size 400 pcs/kg fingerlings is around VND 600 each (USD 11.5/kg). Over the last 7 years, I have seen many changes in the culture trends of the tilapia. In cages in the river, the stocking density is 75pcs/m<sup>3</sup>. The production is 5 tonnes/cage of 108 m<sup>3</sup> (6X6X3m). The ex-farm price for the red tilapia is VND 50,000/kg (USD 2.4/kg) whereas it is VND 27,000-28,000/kg (USD1.3/kg) for the black variety."

Nguyen Van Dong who is a feed distributor said, "Farmers used to feed tilapia with farm made feeds, but today, the feed demand for commercial feeds is about 10 times higher. In the first 8 months of 2012, I sold 4,000 tonnes and I expect this to increase to 6,000 tonnes in 2013. Farmers do not follow any feeding program and seem to develop their own feeding regime based on their experiences".

Dong added that the feed market for tilapia in the north is divided amongst three producers, Uni President which has a 70% market share, Cargill at 20% and Charoen Pokphand Vietnam at less than 10%. In addition, there are more than 20 small Vietnamese feed companies. The crude protein content of feeds ranged from 35, 30 and 27% and the average price for grow-out feed is VND 14,000/kg (USD 0.67/kg) and feed conversion ratio is 1.4 for tilapia reared in ponds and 1.7 to 1.8 for tilapia in cages.

Almost 80% of the tilapia produced in the three northern provinces Hai Duong, Bac Giang and Hung Yen are farmed in ponds, in polyculture systems with common and grass carps.



Nguyen Van Dong (second right) with the Uni President team, from left, Cheng-Yen Hung, assistant vice president, Aquatic R&D Division, Vo Thuy To Quyen, deputy manager at the Aquatic R&D Division and Nguyen Xuan Hanh, sales manager

The stocking density is low at 4-5 fish/m<sup>2</sup>. Farmers offset the low ex-farm prices for the black tilapia with the high prices for grass carp which was VND 55,000/kg (USD 2.6/kg) in December 2012. The problem with polyculture is that feed amounts cannot be calculated, said Nguyen Van Can who has a 3,600m<sup>2</sup> pond in Thanh Mien, Hai Duong province. The market size for the common carp is 700 g whereas that for the grass carp is 2 kg.

"We know that the floating feeds are consumed by all the fish in the pond even though the common carp is a bottom feeder. The stocking ratio of common carp: tilapia: grass carp is 25: 50: 25. I buy fingerlings from a hatchery in a nearby province and sometimes get the tilapia fingerlings from Thailand."

He added that the prices for the locally bred fingerlings (2.5 cm or 85 fingerlings/kg) is VND 1,000 each (USD 4/kg) but pays VND 2,400/fingerling (USD115/1000 fingerlings) for imported fry from Thailand. Common carp fingerlings cost VND 50,000/kg of 30 fingerlings (USD2.4/kg).

In 2003, Vietnam's Ministry of Fisheries focussed on developing the tilapia as a key seafood export. The target production was 200,000 tonnes by 2010 but only 100,000 tonnes was produced. The reason for the shortfall was poor management of broodstock imported from Egypt, Thailand and Philippines. The Ministry has set a new target of 150,000 tonnes by 2020 at a growth rate of 7.9% and 43,000 tonnes of production will be from the Red River Delta provinces. To achieve this target, the ministry will have a program for the development of seed stock adapted to the weather and culture conditions in the north and implement VietGap in tilapia farming.



Nguyen Van Can



The pond belonging to Nguyen Van Can stocked with common and grass carp and tilapia

# Marketing the 'Taiwan tilapia'

By Peter Chiang

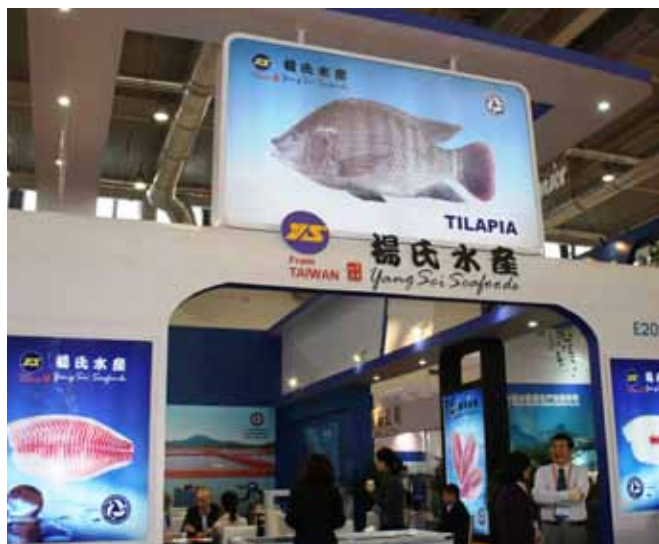
**Image building and branding for a fish treasured by industry.**

Taiwan's tilapia farming industry has 66 years of history. It started with the *Oreochromis mossambicus* which originated from Singapore in 1946. In the subsequent years, farming was with the *O. zilli* from South Africa and *O. niloticus* from Japan. In 1968 the Taiwan red tilapia which is a hybrid of *O. niloticus* and *O. mossambicus* was developed. Other species such as *O. aureus* from Israel, *O. hornorum* from Costa Rica were also imported for farming in Taiwan. Tilapia feed was developed in Taiwan in 1975.

In 2011, Taiwan produced 67,224 tonnes of tilapia from 5,308 ha of farms. It exported 30,566 tonnes of live weight. The value of production was TWD 48.52/kg (USD 1.63/kg) and the export value was TWD 60.05/kg (USD 2.0/kg). In comparison, the value of exports was TWD 37.61/kg (USD 1.26/kg) in 2001. In the early days, prior to the 1970's, the fish had a negative image generated from pig-tilapia integrated systems used in its farming. This as well as the consumer perception that tilapia is a poor man's fish had to be addressed. Then as the tilapia became the 'aquatic chicken', Taiwan's exports (with much higher production costs), faced stiff competition from those produced in China. The next move was to bring up the image of the fish with new strains and hygienic farming practices. Taiwan Tilapia Alliance (T<sup>2</sup>A) established in 2002 was entrusted with this role.

T<sup>2</sup>A used the 4Ps in marketing (product, price, position and place) in its image improvement program. The result is the brand 'Taiwan tilapia' to distinguish its tilapia from that produced in other countries. It worked on adding value with new tilapia strains, genetic selection and economics in production. Genetics and selective breeding produced fast growers that are tolerant to cold temperature and high salinity. They have better colour and are docile in behaviour. They also have high fecundity and are resistant to diseases. All male populations without hormonal treatments were developed for farming. Feeds were developed for better flesh quality and to reduce production costs with better feed conversion ratios and higher yields. Today, the brand 'Taiwan tilapia' is the pride of the country.

Tilapia is the leading export product, overtaking the milkfish. Today, it is the only fish fillet exported to the EU. By 2011, the acceptance of Taiwan tilapia reached sashimi grade at the export level. In Taiwan,



Marketing Taiwan tilapia at the China Fisheries and Seafood Expo in 2011



Neil Shih, a specialist in aquaculture production holds a 3.6kg Taiwan tilapia. Shih is one of Taiwan Aquaculture Corps (TAC) which is affiliated to HANAQUA. He is now involved in a tilapia project in Vietnam.

Globefish (2012) reported a 30-40% increase in demand with the scare on livestock feed tainted with the drug ractopamine.

The whole fish can be fully utilised and comprises 36.5% fillet, 4.0% skin, 3.0% scale, 4.0% trim, 7.0% chin, 5.0% belly, 15% head, 9.0% bone, 10.5% offal, 4.5% residues and 1.5% blood. The red tilapia was produced for the niche market and the black as a commodity. Quality is assured with live fish sent to the processing plant. Skinless fillet is cleaned in ozone. Scales are extracted for collagen production. Since 2011, industry has been successful with transformation of tilapia tailfins into a product very similar to processed shark fins and they are now a stand-in for the shark fins with the same appearance and texture (Chan, 2011).

The vision is now to move to low carbon footprint in tilapia farming in Taiwan and auditing for certification by Global Gap and Aquaculture Stewardship Council. The vision is to spread the farming of the 'Taiwan tilapia' strains to other places globally such as in many parts of Africa and Vietnam.

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The article is partly based on a presentation at the 9th International Tilapia Industry Development Forum, 12-13 November 2012, Haikou, Hainan.

# Herbal therapy in fish farming

The road to herbal therapy to solve disease and health problems in fish farming is long but certainly will lead to safer products and more sustainable aquaculture

Traditional farmers in many parts of Asia use plants or plant extracts for the prevention and treatment of diseases in fish and shrimp farming. Herbal therapies are seen as alternatives to antibiotics but more information on the relationships that exist between plants or plant extracts and health of fish/shrimp are required if it is to be integrated into farm health strategies. Research into the active components and modes of action will bring a scientific dimension to health and disease management using plants and plant extracts.

In December, the "First Workshop on Herbal Therapy in Fish Farming: From Ethnobotany to Sustainable Aquaculture" was held in Hanoi, Vietnam. It was jointly organised by IRD (French Institute for Research and Development), ISE-M (Institute Science of Evolution-Montpellier) and CIRAD (French Centre for Agricultural Research for Development). The workshop addressed measures taken by the Vietnamese authorities to manage chemical and drug usage in aquaculture and shared scientific information on the ethnobotanical approach in health management. It also looked at ways to foster research and development of pharmacopeia for sustainable aquaculture and food safety.

In her introduction to the workshop, **Dr Samira Sarter**, microbiologist at CIRAD, Hanoi said that industry concerns centred on the use or misuse of antibiotics in fish farming and how this creates a reservoir of resistant strains of bacteria in fish and pond sediments, and the subsequent risk these pose to both animal and human health. "Resistance of bacteria to antibiotics is a worldwide concern and in the region, the level of antibiotic resistance has been reported as 90% tetracycline, 76% ampicillin, 100% chloramphenicol, 65% nitrofurantoin and 89% trimethoprim-sulfamethoxazole in bacterial populations in fish, water or sediments. The frequency of chloramphenicol-resistant *Escherichia coli* was reported at 58.3% in Vietnam, 25% in Malaysia and 31.8% in Thailand. Reports showed also that multi resistance among fish bacteria in Mekong Delta could reach up to 90% of isolates."



From left, Domenico Caruso, Samira Sarter, Rafael Guerrero III and wife.



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Antibiotic residues in aquaculture products raise concerns of food safety but even if these are not detected, there are cumulative effects in the long term. These interactions mean that bacteria are disseminated through the food chain. It is not only antibiotic residues risks in the food chain but also the spread of resistant bacteria or resistant genes to other pathogens of diverse origins. The lack of contaminants screening at the earlier stage of culture (antibiotics and pesticides residues, heavy metals, pathogens) has been identified as factors affecting the quality of new processed products from aquaculture such as surimi from silver carp or tilapia.

Conversely, in intensive culture systems, the threat of disease and other fish and shrimp health problems leave the farmer with few options to secure the crop and improve efficiency in production. Unfortunately, a farmer's decision-making process is strongly influenced by the presence of numerous chemicals in the market and by biased sources of information. The presence of multi resistance bacteria in the pond environment decreases the performance of antibiotics and leads farmers to use multiple drugs.

### Managing diseases in Vietnam

In freshwater fish farming the main diseases are *Edwardsiella ictaluri* in the catfish and red spot *Aeromonas hydrophila* in carps. Since 2009, streptococcus in tilapia was reported in the northern provinces where the fish is fast developing as a major culture species. In marine shrimp farming, the main diseases are white spot syndrome virus (WSSV), taura syndrome and monodon baculovirus. Infectious myonecrosis virus (IMNV) was reported in 2009 in imported brood stock. In September 2012, early mortality syndrome in marine shrimp has resulted in 30-40% loss of production, mainly in the intensive farms in Bac Lieu, Soc Trang and Camau. The losses totalled USD190 million. Lobster aquaculture faces problems with milky lobster disease and in marine fish farming, viral nervous necrosis (VNN) affect groupers and the cobia suffers from vibriosis.

Since January 2008, the task of aquatic animal health management, including disease control, hygiene inspection and drugs and chemical control is with the Department of Animal Health, Ministry of Agriculture and Rural Development Vietnam (MARD). Collaborative work with farmers has managed to reduce the use of antibiotics in fish farming, said **Dr Le Van Khoa**, Head of the Division on Aquatic and Animal Health. Furthermore the selective pressure on antibiotics usage in fish farming may be reduced through hygienic practices and use of alternatives such as plant extracts.

A study showed that in freshwater aquaculture, at least 24 antibiotics belonging to 10 groups are used for disease prevention and treatment. Sulfonamids, tetracyclines, phenicols and fluoroquinolones

are the most common chemicals for fish and shrimp production. The use of chloramphenicol is illegal and quinolone is restricted. MARD has regulations on the sale of chemicals for aquaculture. It has also begun to regulate labelling, repacking and registration of manufacturers.

### Herbal therapy

According to co-organiser and fish pathologist at IRD-ISEM, Indonesia, **Dr Domenico Caruso**, herbal therapy has advanced in human health and in ruminant production but has seen limited application in aquaculture production. "However, the road from plants to safe products is still a long way. We need to foster research on how to use the products in aquaculture and this requires a multidisciplinary approach."

There are various products in the market which fit into the concept of ethnobotany and which have been used in aquaculture. Considerable information on the use of herbal medicines is already available in the scientific and grey literature.

### Plant remedies in Vietnam

According to **Dr Nguyen Van Tien**, Research Institute of Aquaculture 1 (RIA1), several species of plants (in their natural forms or extracts) are used to kill pathogens such as parasites and pathogenic bacteria, to enhance or stimulate the immune system and protect the fish/shrimp against pathogens. Currently, these herbal medicines/extracts against antibacterial disease are recommended for use 1-2 months before an epidemic season, especially during the summer months. These are also used as nutritional supplements.

Some examples are *Melia azedarach* used to treat lernaosis in fish. The dose is 0.4 kg/m<sup>3</sup> of water and water is exchanged 2 days after treatment. Farmers also use *Derris elliptica* to kill fish and parasites during pond preparation as it decomposes quickly. It is also effective against the parasitic crustacean *Argulus*. For the treatment of Helminthosis in catfish, the plant *Areca catechu* is mixed into feeds and fed to fish at a dose of 5 g/kg of fish. Another plant, *Leucaena glauca* is also mixed into feeds and fed at a dose of 2 g/kg of fish. A century old remedy is saponin or tea seed cake. It is used to clean up ponds by killing fish and other unwanted animals. Added at 14%, it also stimulates growth and moulting of shrimp.



*Leucaena lavandulaefolia*

RIA1 has produced a herbal medicine called KN04-12. This is for the prevention and treatment of bacterial infections. The product contains antibacterial compounds extracted from garlic (*Allium sativum*), wedelia (*Wedelia chinensis*), false daisy (*Eclipta alba*), *Euphorbia hirta*, chamber bitter (*Phyllanthus urinaria*) and mixed with vitamins and other micronutrients.

“So far, KN04-12 has been shown to be effective against bacterial infections such as red spot disease, gill rot, and enteritis in carps. It has positive effects in the prevention of some bacterial diseases in the Mekong catfish and is now widely used in several provinces. The recommended use is 4 g/kg fish/day for the fingerling stage and 2 g/kg fish/day for larger fish. The product is mixed in the feed and fed to fish for 3 consecutive days 30-45 days before the onset of the disease. In the case of treatment, the same dosage can be applied for 6-10 days,” said Tien.

RIA1 has also developed Becanor TD1 and Becanor TD3. These are a mixture of extracts from garlic and ginger, with added vitamins and yeast. Similar to the earlier product, this is effective in the prevention of bacterial diseases in freshwater fish. They also enhance the immune system of the fish.

Tien also reported on bacterial activity for some plants found in Vietnam, published by Satapron Direkbusarakom (2004). *Euphorbia hirta*, *Wedelia calendulacea*, *Lactuca indica* and *Portulaca oleracea* all have an inhibitory effect on *Aeromonas hydrophila* and is used to treat brown spot in the freshwater prawn *Macrobrachium rosenbergii* and red spot disease in grass carp.

*Euphorbia thymifolia* and *Portulaca urinaria* inhibit *Vibrio parahaemolyticus* and are used to treat vibriosis in *Penaeus monodon*. *Eclipta alba*, inhibits *A. hydrophila* and *Edwardsiella tarda* and is used to treat necrosis in the catfish. *Polygonum hydropiper* inhibits *A. hydrophila* and is used to treat bacterial diseases in the catfish.



From left, Le Van Khoa, Nguyen Van Tien and Dr Le Thanh Hung, Nong Lam University

“Some of these treatments are not unique to Vietnam. *Euphorbia* is also used in Indonesia. Currently, herbal medicines/extracts used to treat antibacterial disease are generally applied 1-2 months before an epidemic season, especially during summer. Although these have been used by farmers in the field, what are required are studies on their chemical composition and the variability of the active ingredient. We also need to conduct more tests on the optimal dosage for disease prevention and treatment, respectively,” said Tien.

### Essential oils in shrimp culture

In Madagascar, the team from CIRAD and the University of Antananarivo looked at the microbial properties of the essential oils of the endemic plant *Cinnamosma fragrans*. The antimicrobial activity of the essential oils from two regions and their major compounds, 1,8-cineole and



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Workshop participants. Dr Phonekampheng Ondom, Nalong Faculty of Agriculture, Laos (second right with the team from the Institute of Ecology and Biological Resources (IEBR), from left, Nguyen Phuong Thanh, Luu Dam Ngoc Anh, (Ethnological Department) and Nguyen Thi Phuong Trang.

linalool, were analysed *in vitro* on several bacterial species, including *Vibrio harveyi*, *V. fisheri*, *V. penaeicida*, *V. alginolyticus*, *V. anguillarum*, *Micrococcus luteus*, *Escherichia coli*, *Salmonella typhimurium*, *Staphylococcus aureus* and *Bacillus subtilis*. Preliminary trials were conducted in an organic shrimp *Penaeus monodon* farm in Madagascar (OSO Farming) to test their use in aquaculture and analyse their effects on shrimp larvae survival and microbial flora in the rearing tanks.

After the 18-day trial, the survival rate of *P. monodon* larvae in hatchery tanks with the essential oils showed similar survivals at 70-80% as larvae in tanks with a conventional antibiotic. In the control tank without any treatment, survival was 15%. Levels of *Vibrio* populations declined significantly in the tanks with the essential oils, such as with the antibiotic.

Sarter added that these results showed a negative correlation between bacterial concentration and larval survival when the antimicrobials (antibiotic or essential oils) are used. Further investigations are still needed to provide scientific data on the plant extracts use as antimicrobial in aquaculture.

## Seaweed for health management

Some seaweeds such the green algae, *Caulerpa*, brown algae *Sargassum* and red algae *Gracilaria* are cultured for the production of carrageenan (from red seaweeds) and agar (from *Gracilaria*) and alginic acids (from *Sargassum*). Dr Rafael Guerrero III, Aquatic Biosystems, Philippines said that studies have shown that carrageenan from seaweed have anti-viral and anti-fungal properties. Industrial phycocolloids from seaweeds have health related impacts because of its composition of minerals, vitamins, fatty acids and bioactive compounds.

"Published literature has demonstrated the efficacy of hot water extracts at a dose of 850 mg/kg diet of the red seaweed *Asparagopsis sp* and *Gelidium amansii*, administered orally in the shrimp to improve resistance for both *P. monodon* and *P. vannamei*. Crude extracts of the polysaccharides of the seaweed *Sargassum fusiforme* and green seaweed *Acrosiphonia orientalis* administered *in vivo* showed anti-viral activity against WSSV in these shrimp," said Dr Guerrero.

He added that there is a commercial product 'Green Laver powder' which claims to enhance fish growth and disease control. A recent study in the Philippines showed that extracts of *Sargassum polycystum* have anti-bacterial activity against *V. harveyi* and *Pseudomonas aeruginosa*. Guerrero cautioned that most claims are based on laboratory trials and that there is a need to study their efficacy, cost effectiveness in the field and effective application methods for these products.

## A long road to development

In Latin America a ten-year extensive survey has been conducted to investigate the role of traditional herbal remedies in traditional health care systems of local communities. In this context, an ethno-

pharmacological study was conducted in the French Guiana focussing on local febrifuge herbal remedies. A bioguided chemical fractionation of selected plant extracts, led to the discovery of Simalikalactone E, a new molecule isolated from *Quassia amara*, a Pan-Amazonian plant, widely used against fevers and malaria. Based on his experience in this project, Eric Deharo, IRD, said that the extensive and multi-disciplinary work involved ethnopharmacological surveys, botanical identification chemical extraction process, biological testing and determination and structural elucidation. This raised the question on the commercial value of such resources and the time consuming research needed for aquaculture use. In some cases the quantity of the active ingredient can be minute and require methods to increase the biomass of the plant to be processed to get a sufficient amount of the active compound. Sometimes the activity of the whole extract is higher than the isolated constituents. In that case, it was suggested that it may not be necessary to work on pure products but on extracts only. This methodology could be also profitable to aquaculture treatments.

## Consensus on plant based alternatives

On the outcome from the workshop, Sarter and Caruso said that there was a general consensus among participants that the use of plants or derivatives may be relevant in fish farming but it should be integrated into a larger health strategy in farms especially to prevent diseases. The participants highlighted the need to consider food safety requirements at the earlier stages of production and to manage both animal and human health from 'Farm to Fork' through a multidisciplinary approach to mitigate the risks associated with resistant bacteria to antibiotics.

A network on herbal therapy in aquaculture and food safety was proposed. The aim of this network will be to share information and to promote studies and knowledge of the use of plants or natural substances in aquaculture. According to interests of the participants, it may be possible to form working groups on several aspects such as: immunology, antimicrobials, extraction and galenic form of plants, as well as regulation, food safety, toxicity, etc., all of which highlight the need for a multidisciplinary approach. For each country, a lead project for the network will be identified on studies relevant in the country. This scientific network should involve government agencies such as MARD in Vietnam and non-governmental organisations.

The need for a database was expressed because the herbal pharmacopeia is poorly documented for aquaculture. Comprehensive work would be necessary to set an inventory of known plants used in aquaculture in Southeast Asia (botany, geography, uses, therapeutic indications). The use of plants and natural substances should be given more visibility into the frame of research related to fish or shrimp diseases. MARD would support a special session dedicated to herbal therapy at the next ASEAN Symposium of Aquatic Animal Diseases which will be held in Vietnam in 2014.

IRD has three different programs (co-funded by French Ministry of Foreign Office MAE) related to the valorisation of plant biodiversity in Southeast Asia. The purposes of these projects vary from new compounds for anti-malarial and anti-tumour drugs; natural active compounds against vectors of dengue and malaria to herbal therapy in aquaculture and food safety. Despite the different objectives, these three projects share methodologies and approaches that provide synergies. A collaborative dimension will be then sought in order to share the results and promote the search for alternative eco-friendly treatments.

Issues related to the overexploitation of natural resources have been emphasised and they should be considered before the application of plants or their derivatives in fish farming. Equitable sharing of benefits should be recognised in traditional knowledge (if any) and economic incentives should be planned for fish farmers who are using plants or their extracts for health management in their farms.

# Therapeutic alternatives in aquaculture: Phytotherapy, ethnobotany and fish pathology

By Domenico Caruso, Angela Maria Lusiastuti, Taukhid, Lili Sholisha, Jacques Slembrouck and Marc Legendre

Screening for antimicrobial components in plants valorises the widespread practice of herbal therapy in fish health management in Indonesia.

In West Java, there are almost 800,000 small scale farmers whose livelihoods are dependent on aquaculture. Several species of freshwater fish are farmed in various extensive to intensive culture systems. Fish farmers make extensive use of plants with proven histories in traditional medicine for human health to prevent or treat common diseases in fish. However, despite the interest generated by herbal therapy, knowledge of traditional medicine remains fragmented and its science largely unknown. In 2010-2011, surveys were conducted to draw up an inventory of plants used in aquaculture and to determine the ethnobotanical characteristics of the use of plants, variables that influence the use of plants and their specific uses. These surveys covered several districts of the province and around 600 questionnaires and interviews were collected from fish farmers from more than 170 different villages.

The results from this ethnobotanical survey showed that the use of plant or plant parts is a common practice and almost 50% of fish farmers use plants in their farms. The use of plants is mainly steered against diseases or to prevent them, but many plants are also used to improve water quality.

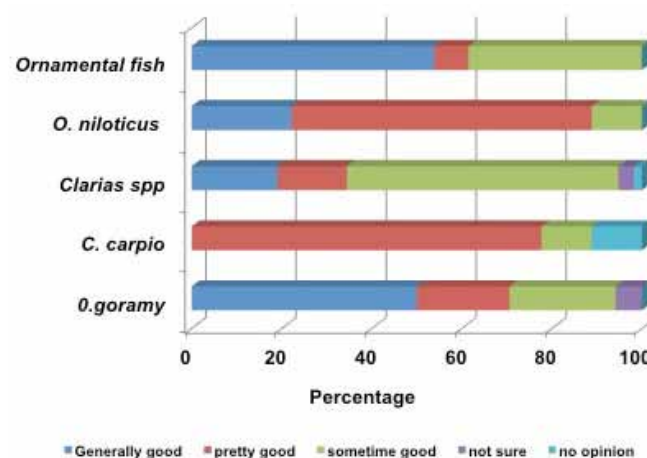
The use of herbal therapy is dependent on the experience of fish farmers, size of rearing facilities and stages in fish production. Plant extracts are used more often in small rearing facilities and for juveniles compared to grow-out farms. For example, more than 90% of hatcheries use plants whereas less than 40% of grow out farms use herbal therapy. The use of plants varies according to fish species but also cultural factors such as the ethnic origin of fish farmers may play a role in the use of plants. For example, Javanese farmers are more prone to use plants for water management relative to Sundanese fish farmers. Different plants are also specific to different ethnic groups. It should be noted that most users are relatively new and have reverted to using traditional plant remedies when authorities began to emphasise on the negative aspects of using antibiotics.

From the farmer's point of view, results have been generally good (Figure 1), although the use is rarely specific and the same plant may have

several therapeutic indications. The degree of satisfaction with the use of specific plants also depends on the species of plants and target fish.

With regard to fish species, herbal remedies are more common for the gourami, *Clarias* catfish and aquarium fish. In general, farmers reported better results in the farming of gourami, and ornamental fish. (Figure 2).

Figure 2. Use of plants and plant extracts by type and species of fish.



## Efficacious plants

Despite the extensive use of herbal therapy, the knowledge of plants appears scattered among fish-farmers. According to the ethnobotanical indicator (Use value) only 33% out of 79 species of plants identified during the study are commonly used by fish farmers. These plants defined as 'common plants in herbal therapy' are mainly used to prevent or treat diseases (Figure 3). In general farmers use plants or the extracts as a general spectrum antibiotic replacement and do not have an idea of the mode of action of any particular plant or extract. Moreover, no clear separation exists within the therapeutic indications and the same plant may have different indications according to the experience of the fish farmer. One such example is in the use of papaya (*Carica papaya*), the most popular plant which can be used by fish farmers both to improve water and also to prevent or treat diseases in fish.

Eighteen plants were randomly chosen within the common plants used in herbal therapy by fish farmers from West Java and tested for antibacterial activity *in vitro* on *Aeromonas hydrophilia* and/or *Streptococcus agalactiae*. Laboratory analyses indicated that 83% of the plants were relatively effective against these bacteria with an efficiency ratio comparison of between 22-69% compared to a reference antibiotic (chloramphenicol). The plant extracts also appeared to be more effective against gram negative bacteria and maceration in ethanol was more effective than aqueous maceration.

This high validation rate, higher than the rate observed in random screening for antimicrobial activity of plants, confirms the advantages linked to the ethnobotanical approach, which also identifies the limits of the empirical use of these plants. It also gives information on the holistic approach to health strategies carried out by fish farmers and highlights the value of the traditional knowledge that is at risk of being lost.

The huge reservoir of plant biodiversity should encourage the diversification of therapeutic approaches towards an ecofriendly

Figure 1. Farmers' opinions on the use of plants and plant extracts.

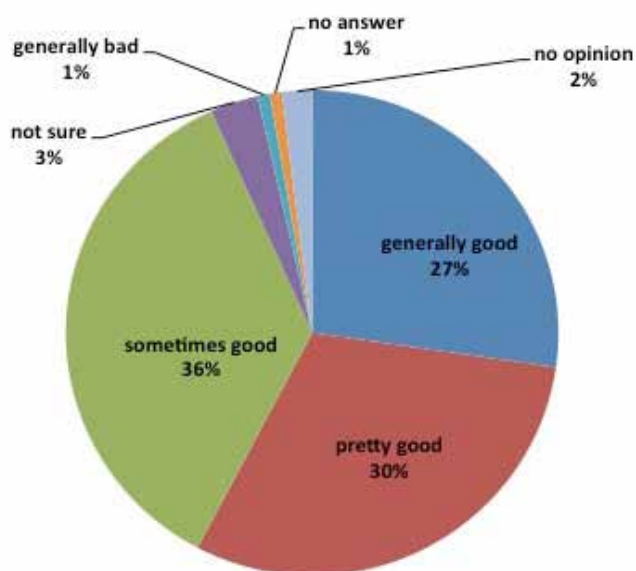
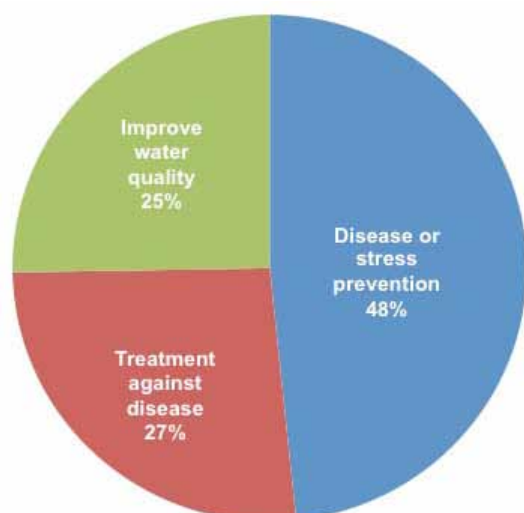


Figure 3. Primary use of the 79 species of plants identified during the study.



pharmacopeia in aquaculture. Ethnobotany, the screening of plants and the adaptation of use of plants to the field conditions may represent one pathway to increase the sustainability of tropical aquaculture.

### Acknowledgements

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# The Nemo Project: Four years on

Researchers in the NEMO project have been investigating the capabilities of  $\beta$ -1,3/1,6-glucan to balance the immune system and its application in aquaculture. As the project draws to a close, what has this project meant for BIORIGIN and the aquaculture industry?

For the last four years, Biorigin's leading  $\beta$ -glucan product MacroGard® has been the subject of a European Marie Curie ITN project known as NEMO. In 2007, Biorigin and 8 other European partners, both commercial and academic, were awarded a major research and development contract by the European Commission, under Marie Curie Initial Training Networks (ITN). Such contracts are extremely competitive due to their high remuneration value and prestige. That year, €240million in total was awarded to Marie Curie ITNs for research and training activities; only 65 of 905 applications were awarded funding. This contract was for €3million, issued under the European Union's Seventh Framework Programme (FP7) for a project known as 'NEMO'.

## NEMO

The full title of the 4-year project (2008-2012) was 'Training network on protective immune modulation in warm water fish by feeding glucans'. It was to investigate various aspects of  $\beta$ -glucan activity in fish. Across the partners, 16 researchers were employed. Table 1 summarises the partners and researchers of the project. Each partner had its own roles within the NEMO project. MacroGard®, the  $\beta$ -glucan product chosen for research due to its vast documentation and guarantee of bioactivity was provided by Biorigin. The company also co-ordinated technical information and support.

With a growing global demand for food protein and the immense growth of the aquaculture industry in the last few decades, there has been fresh impetus for the research and development of substances beneficial for fish health and that could help control the frequent disease outbreaks in aquaculture.  $\beta$ -glucans are a prime candidate for further research.

Those involved in the NEMO project have been investigating MacroGard®'s role and effect on, for example, gene expression, innate phase proteins, cell apoptosis, gut physiology, membranal composition, the inflammatory response, binding mechanisms, neutrophil extracellular traps (NETs) and wound healing. Four years on, as the NEMO project draws to a close, there have been many interesting and exciting new discoveries with regards to MacroGard®.

NEMO has been a very valuable project for Biorigin. Not only has it generated further documentation for MacroGard®, supporting it as the most documented  $\beta$ -glucan for use in animal feed, but it has highlighted new areas that could benefit from  $\beta$ -glucan application and kept Biorigin at the forefront of  $\beta$ -glucan research. The NEMO project enabled research on a large scale over a relatively short period of time and the dissemination of recent findings across European feed and aquaculture industries.

Biorigin and the NEMO group have attended and participated in many events over the last four years. Key events have included the 15th conference of the European Association of Fish Pathologists (EAFP) in September 2011 and a conference entitled 'Prebiotics and probiotics in medicine, veterinary sciences and aquaculture: the future' held at Keele University, September 2012. For both of these events, Biorigin and



*View of Biorigin (MacroGard) production and R&D facility in Lencois Paulista, Sao Paulo State, Brazil*

the NEMO group provided sponsorship, gave numerous oral and poster presentations, organised social events and distributed materials.

New relationships, both in the aquaculture business and academia, have been formed and there is the prospect of future research and collaborations. Both brand and company have been strengthened as a whole.

The NEMO group has already published several papers in highly acclaimed journals, and many more are expected in the near future. In a broader spectrum, as the knowledge of  $\beta$ -glucans grows, so does the acceptance of their immunomodulating capabilities and their potential as a natural, sustainable method for maintaining healthy livestock and increasing productivity. This could have significant impact in increasing turnover for related industries, enhancing cost-benefit for the end users (farmers) and contributing to meeting growing global food demands.

Biorigin develops feed ingredients for the animal feed industry. All their ingredients are based on derivatives of yeast (*Saccharomyces cerevisiae*); a natural substance, produced in an environmentally friendly and sustainable manner. Biorigin offer a range of products such as, autolysed yeast with excellent palatability and digestibility, organic selenium yeast and purified mannanoligosaccharides for intestinal health. Undoubtedly, their most specialised and studied product is  $\beta$ -1,3/1,6-glucan, purified yeast cell walls known commercially as MacroGard®. This enhances an organism's natural defences against common pathogens and stressors.

Pathogens frequently develop resistance to pharmaceutical treatments and so the pharmaceutical industries constantly struggle to produce new alternatives for the prevention of diseases. Yeast  $\beta$ -1,3/1,6-glucan is recognised as a natural substance that helps strengthen the immune system rather than targeting pathogens directly.  $\beta$ -glucan can act as a preventative measure (prophylaxis) to infection rather than a cure and provides an ecological, long-term alternative to feed antibiotics.

The availability and structure of different  $\beta$ -glucans should not be assumed identical between products, as there are large differences in bioactivity. MacroGard® is world renowned and is the most widely documented  $\beta$ -1,3/1,6-glucan for animal feed.

For more information: [www.biorigin.net](http://www.biorigin.net); Email: [ole.fretheim@biorigin.net](mailto:ole.fretheim@biorigin.net) (Ole Fretheim)

Table 1. Partners and researchers of the NEMO project.

Partner	Location	Employed Student origin	Position held
Biorigin	Belgium (Antwerp)	England	MPhil
Tetra	Germany (Melle)	England	MPhil
Biomar	Denmark (Brande)	Sweden	MPhil
University of Veterinary Medicine	Germany (Hannover)	Poland England	Post Doc PhD
Danish Technical University	Denmark (Copenhagen)	Columbia Poland	PhD PhD
Wageningen University	Netherlands (Wageningen)	Denmark Denmark Italy	Post Doc PhD PhD
Keele University	UK (Keele)	Germany France Spain	PhD PhD Post Doc
University of Plymouth	UK (Plymouth)	Germany	PhD
Institute of Ichthyobiology and Aquaculture	Poland (Golysz)	England Ukraine	PhD PhD



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  - (4) Fisheries & Asia Pacific Fish Watch
  - (5) Fisheries Policy, Economics, Marketing
  - (6) Fish for Human Nutrition & Health
  - (7) Environment Impact, Pollution & Ecotoxicology
  - (8) Biodiversity, Genetics, Biotechnology, Breeding & Conservation
  - (9) Fishing Gear & Technology
  - (10) Fisheries Assessment & Aquatic Resource Management
  - (11) Aquatic Animal Health & Management
  - (12) Shrimp & Other Crustacean Aquaculture
- Special1 : Higher Education of Fisheries Science  
Special2 : 4th Global Symposium on Gender in Aquaculture and Fisheries

### CAA4

- (1) Marine and Freshwater Cage Culture
- (2) Environment, Pollution and Ecotoxicology
- (3) Disease Prevention and Health Management
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# Korean Aquaculture

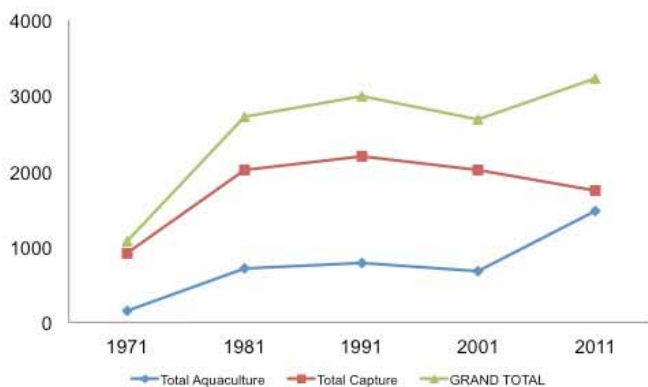
By Jeong-Yeol Lee

## Four decades of expansion, intensification and diversification.

Aquaculture is a very important and well-established sector in the Republic of Korea, providing food security, revenue and employment to the country. Aquaculture in Korea has expanded, intensified and rapidly diversified in the last four decades (Figure 1). In the 1960s and 1970s, aquaculture technology was developed to produce seedlings of laver, oysters and other species, while in the 1980s it was devoted to shellfish farming. In the 1990s and 2000s it was dedicated to promoting pen and cage systems for finfish, and now, the focus is on sustainable technology.

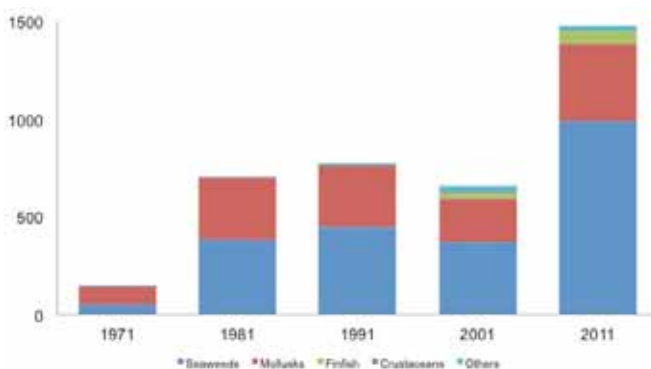
Through government support, and its continuous research, development and extension, thousands of Korean farmers have been given the opportunity to reap the success of Korean aquaculture in the last 50 years.

Figure 1. Trends in capture and aquaculture production (x1,000 tonnes).



Recently, the Korean government has nominated ten economically important aquaculture species as the national target species in 2011. These are the olive flounder, abalone, tuna, sea cucumber, grouper, shrimp, oyster, eel, ornamental fish and seaweeds including, laver and sea mustard). In 2011, mariculture was the highest contributor (1,448,000 tonnes) to total aquaculture production (1,478,000 tonnes), and it accounted for 98% of the total production (Figure 2).

Figure 2. Trends in marine aquaculture production (x1,000 tonnes).



It has been reported that marine finfish aquaculture in Korea is dominated by the olive flounder *Paralichthys olivaceus* (40,800 tonnes, 56.35%), Korean rockfish *Sebastes schlegelii* (17,300 tonnes, 23.89%), mullet *Mugil cephalus* (4,800 tonnes, 6.6%), red sea bream *Pagrus*

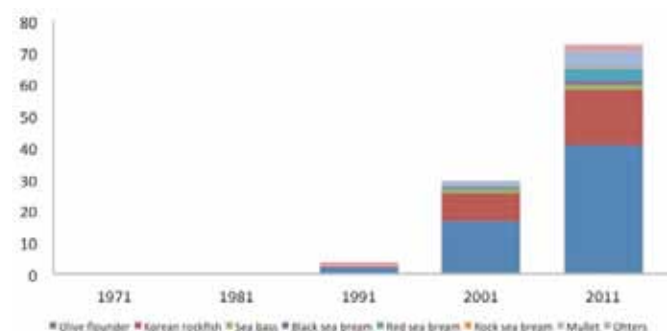


*major* (3,500 tonnes, 4.83%), sea bass *Lateolabrax japonicus* (1,800 tonnes, 2.48%), black sea bream *Acanthopagrus schlegelii* (1,200 tonnes, 1.65%), rock sea bream *Oplegnathus fasciatus* (700 tonnes, 0.96%), and a few other species such as brown croaker and puffer *Takifugu sp* which totalled 2,300 tonnes or 3.17% in 2011 (Figure 3).

## Marine finfish

Olive flounder is the most important marine finfish cultured followed by Korean rockfish). Korea is the leading producer of olive flounder in the world. The establishment of seed production systems and favourable government policies has motivated farmers to expand marine finfish aquaculture. Land-based tank culture systems are very important systems. Farms are usually located in the south, east and west coasts, especially around Jeju Island at the most southerly part of the country. At present approximately 532 licensed coastal farms covering 1,839 ha, 434 sea cages and pens occupying 1,168 ha, and 98 land based farms covering 672 ha (KNSO, 2011) are engaged in marine finfish aquaculture in Korea.

Figure 3. Trends in major marine finfish aquaculture production (x1,000 tonnes).



## Freshwater fish farming

The major freshwater finfish species cultured and production trend are presented in Figure 4. The bulk of the finfish production comprises



eel *Anguilla japonica* (7,250 tonnes, 27.33%), various carps (6,150 tonnes, 23.19%), Amur catfish *Silurus asotus* (4,940 tonnes, 18.62%), rainbow trout *Oncorhynchus mykiss* (3,010 tonnes, 11.34%), loach (560 tonnes, 2.11%), tilapia (220 tonnes, 0.82%) and a few other important species totalling 4,390 tonnes (16.55%). Contrary to the trend in mariculture, freshwater culture is dominated by finfish.

Freshwater aquaculture is dominated by eel production because of its export potential, especially to Japan. However, overall freshwater finfish production has not increased significantly but eel aquaculture has developed and has been growing since. However, with its policy to protect the water resources in 1997, the government directed the majority of inland farms to discontinue the culture of the eel. Eel aquaculture has been considered one of the most profitable industries in the world as well as in Korea due to the increasing demand and short supply from the wild. Due to the unavailability of wild seeds and lack of standard seed production technology, the aquaculture of eel has become one of the most challenging species to culture. There is also the urgent need to replace the practice of dough feeding to increase the overall efficiency of eel farming.

### Seaweed farming

The Korean Peninsula has been home to a variety of algal species and marine seaweed culture has been an integral part of aquaculture in the country since ancient times. Mariculture is dominated by seaweed

production, accounting for 67% of the total mariculture production in 2011. According to FAO, 2012 report, 99.6% of global cultivated algae production is exported by only eight countries including Korea.

Laver production has become more pronounced after the 1980s due to the artificial production of seedling, transplantation of new species and expansion of the culture grounds as well as the development and implementation of the float system of cultivation. Seaweed aquaculture as well as processing technology is developing rapidly in the country. Predominant species are wakame, *Undaria spp.* (394,000 tonnes, 39.71%), followed by laver, *Porphyra spp.* (316,000 tonnes, 31.85%), kelp, *Laminaria japonica* (247,000 tonnes, 24.89%), fusiforme, *Hizikia fusiformis* (23,000 tonnes, 2.31%) green laver (6,000 tonnes, 0.60%) and a few other important species (6,000 tonnes, 0.60%) of the total seaweed production in 2011 (Figure 5).

Improved culture technology in the last two decades has enabled the production of good quality laver and sea mustard for both domestic and export markets. Dried, roasted, salted and boiled laver manufactured by automated machines is in great demand in the preparation of several processed fast foods. However, the present decline in the area of seaweed beds and diseases pose serious threats to its further expansion in Korea. A large quantity of kelp is consumed by abalone cultured in Korea rather than for human food. A major challenge is keeping production of seaweed stable while demand is on the increase.

Figure 4. Trends in freshwater finfish aquaculture production (x1,000 tonnes).

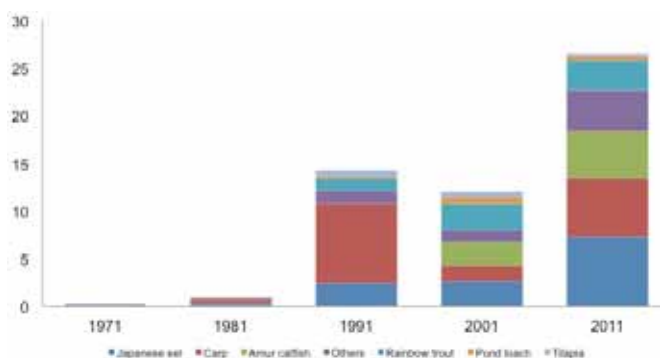
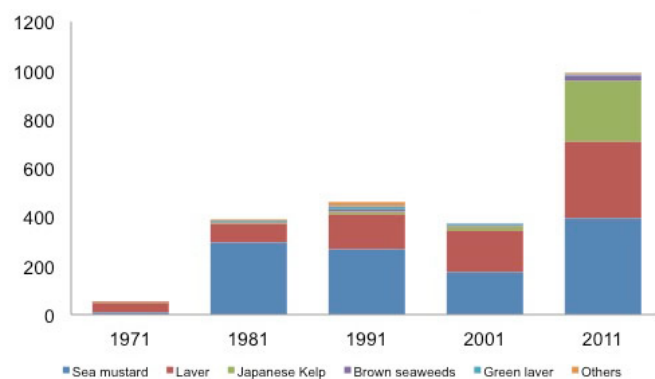


Figure 5. Trends in seaweed aquaculture production (x1,000 tonnes).



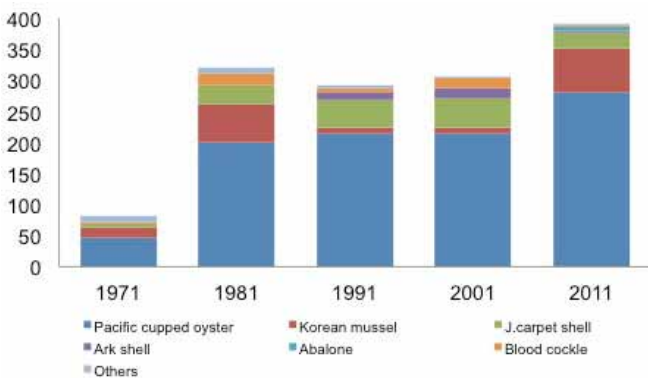


### Shellfish

Mollusc aquaculture ranked second after seaweeds in terms of aquaculture production in Korea. Due to the ideal temperate environmental conditions for molluscs culture, particularly in the southern coast, the Korea Peninsula has a variety of species. Consequently in Korea, mollusc aquaculture is a rapidly growing industry. Presently around 1,217 farms occupying 7,635 ha are utilised for oyster culture and 876 farms occupying 3,853 ha for abalone culture (KSNO, 2011). Longline based oyster farming is practised on the southeast and southern coasts, including the Tong-young blue belts where the water depths are 5~20 m.

The farming of oysters, mussels, pearl oysters and sea squirts is based on these longline systems. Bottom culture techniques are used for benthic species such as ark shells and Manila clams. Normally, water depths for bottom culture are less than 20 m but occasionally can approach a maximum of 40 m. Marine mollusc production was dominated by the Pacific oyster *Crassostrea gigas* of 281,000 tonnes (71.31%), Korean mussel *Mytilus edulis* of 70,000 tonnes (17.76%), carpet shell *Ruditapes sp* of 26,000 tonnes (2.62%), abalone *Haliotis discus hannai* of 7,000 tonnes (1.77%) and ark shell *Anadara broughtonii* of 2,000 tonnes (0.50%). A few other important species include pen shell, cockles and venus clam totalling 1,000 tonnes (0.25%). Freshwater aquaculture mussel contributed only 5,300 tonnes (1.34%) of the total mussel production in 2011 (Figure 6).

Figure 6. Trends in mollusc aquaculture production (x1,000 tonnes).



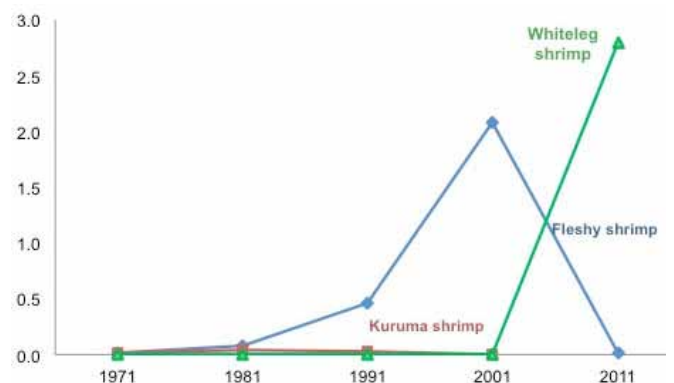
Molluscs culture has grown rapidly in Korea in the last three decades, due to a widening gap between supply from the wild and market demand. More particularly, abalone and oyster culture have gained attention because of their high value. Consequently production has been increasing consistently. Improper feeding practices, slow

growth rate and high operational costs in flow through systems are some of the major barriers in abalone aquaculture, while annual summer mortality has been severely affecting the culture of the oyster.

At present in Korea, crustacean culture is primarily with a single species of shrimp (whiteleg shrimp *Litopenaeus vannamei*) and some crabs. Fleishy shrimp *P. chinensis* and kuruma shrimp *P. japonicus* used to be the most important shrimp species being farmed, with the former cultured mostly in farms along the west of the peninsula and the latter in farms in the southern region. The whiteleg shrimp has become the principal species after the introduction of imported seeds in 2003 from the US. Whiteleg shrimp production has increased quickly and has been growing ever since in Korea. However, it is noteworthy that the interest in shrimp farming has grown rapidly since 1989 and a remarkable development has been taking place to increase production in the last few years.

Crustacean aquaculture is dominated by the whiteleg shrimp of 2,844 tonnes (99.55%) followed by the fleishy shrimp of 16 tonnes (0.45%) in 2011. However, the production has not grown significantly as compared to the whiteleg shrimp production of 2,705 tonnes in 2010 (Figure 7). The production of freshwater crustaceans has been fluctuating and in the year 2011, a negligible amount of 300 tonnes has been reported. Viral disease outbreaks have severely hit the shrimp farming industry in Korea like other shrimp producing countries in the world. Viral diseases wiped out the total crop in about 50% of shrimp farms in 2003. Dependence on imported brood stock and seeds together with sub optimal feed are some of the limiting factors in shrimp aquaculture.

Figure 7. Trends in marine shrimp aquaculture (x1,000 tonnes).



Jeong-Yeol Lee is Professor at Kunsan National University, Republic of Korea. He is responsible for Aquacultural Engineering and Environmental Physiology of fish at Aquafarm. He is also the Executive Director of the Local Organization Committee of 10th Asian Fisheries and Aquaculture Forum and

Fourth Symposium on Cage Aquaculture in Asia ([www.koference.org](http://www.koference.org)) to be held from April 30 to May 4, 2013 in Yeosu and World Aquaculture 2015, in Jeju, Korea. Email: [yjeong@kunsan.ac.kr](mailto:yjeong@kunsan.ac.kr)



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# Better market access for Bangladesh shrimp

In January, a workshop was held on 'EU and US standards for aquatic products'. It was jointly organised by the Bangladesh Shrimp and Fish Foundation (BSFF) and Fishery Products Business Promotion Council with support from the WorldFish Center and USAID Bangladesh.

During the workshop, the BSFF announced that it provides free legal services to help ease the country's market access of aquatic products to the key EU and US markets. This is under a memorandum of understanding signed in 2012 between the US based law firm Sidley Austin and BSFF under which the foundation receives free legal support.

The workshop was attended by representatives from the Department of Fisheries, concerned ministries, Bangladesh Economic Growth Programme, Bangladesh Foreign Trade Institute (BFTI), Bangladesh Tariff Commission, Business Promotion Council, EU, USAID, WorldFish Center, Bangladesh Aquaculture Alliance (BAA) and Bangladesh Frozen Fish Exporters Association.

Speakers at the workshop focused on effective measures both from the government and private sector to raise awareness among the stakeholders on various compliance and standards issues applied in the major importing countries, according to a report in the Financial Express. They said proper compliance with sanitary and phytosanitary (SPS) measures applied in the importing countries have become problematic for the country's producers and exporters mainly due to their ignorance and lack of awareness of such regulations. They also emphasised a need to enhance the capacity of the farmers, processors and exporters of fishery products in a bid to meet international standards. National efforts should aim to improve the SPS standards at both the plant and field levels and to strengthen testing and monitoring. Additionally, the controlling capacity of the authorities such as the Department of Fisheries should also be geared up.

Dr Mahmudul Karim, Executive Director of BSFF, presented a key note paper describing BSFF initiatives to sustain and expand market access of Bangladesh aquaculture producers in the EU and USA markets. The mission of the foundation is to join national efforts to grow the rural based aquaculture industry in the country. He added that, "fish and shrimp farming in Bangladesh is mostly small scale but still accounted for 80-85% of fisheries exports, with almost 80% of the income from shrimp alone. Production is from small 0.5 ha farms for the freshwater prawn *Macrobrachium rosenbergii* and from 3-5 ha farms for the black tiger shrimp *Penaeus monodon*. In both species, the average productivity is 200-500 kg/ha. The supply chain includes ancillary activities such as bamboo basket and net making for pest control. A total of 12 million people are involved in the fisheries and aquaculture industry.

"Requirements from the 27 EU member states include consistent application of food safety & HACCP standards at all levels of production, handling and marketing. In the US, the new US FDA Law: Food Safety Modernization Act (FSMA) 2011 is shifting focus from responding to contamination to preventing contamination at all stages. Thus quality management and control throughout the food chain, which is an extremely difficult task, essentially requires an active public private sector partnership approach."



Dr Mahmudul Karim

The industry has in recent times had to navigate a number of regulations impacting the marketing of marine shrimp and freshwater prawns to its main export markets, including the US Bioterrorism Act 2002, anti-dumping and EU Non-tariff Trade Rules, the AFL-CIO Petition, USTR allegations of Child Labour violations in shrimp processing plants, and nitrofurantoin contamination involving freshwater water prawns in Belgium in 2008-09. To ensure better preparedness of the industry, BSFF, in association with the Department of Fisheries has prepared nine sets of Code of Conduct for nine categories of stakeholders.

## Vannamei shrimp in Bangladesh

In the fiscal year 2011-2012, shrimp exports registered a decline of 12-13%, which producers attributed to the white spot syndrome virus affecting black tiger shrimp production. The annual production of this shrimp is around 45,000 tonnes. Following calls from industry, it was reported in February that the authorities have allowed the cultivation of the vannamei shrimp. Exporters argue that demand for comparatively low-cost vannamei shrimp is high in their main export markets, the US and EU. They also said that black tiger shrimp production could not compete globally with the higher-yield and more affordable vannamei exports of neighbours such as India, Thailand and Vietnam. In its October 2012 shrimp report, Globefish said that black tiger shrimp prices dropped to USD 10.20/kg in July 2012 for size 16/20, down from USD 12.20-13.30/kg in June 2012. It was also reported that buyers asked to renegotiate consignments. Industry also expects production to increase with vannamei shrimp farming which may yield 2 tonnes/ha as compared to the current 200-500 kg/ha for the black tiger shrimp.



Harvesting shrimp, picture by Hervé Lucien Brun

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# Rebuilding the industry in Indonesia

**As shrimp production is on the upward trend, stakeholders face the US countervailing duties case and look at increasing local consumption in the long term.**

Indonesia is one of the seven countries named in the countervailing duties (CVD) petition by the Coalition of Gulf Shrimp Industries (COGSI) which is seeking relief from subsidised shrimp imports into the US. The other countries are China, Ecuador, India, Malaysia, Thailand and Vietnam.

At the Suratthani Shrimp Farmers Meeting in February, Iwan Sutanto, president of Shrimp Club Indonesia (SCI) presented on the progress in shrimp farming in Indonesia after the IMNV (infectious myonecrosis virus) in 2009 and the new strategies adopted by farms. SCI is a grouping of 13 chapters of mainly intensive vannamei shrimp farmers and stakeholders from all over the archipelago. It is a vital group of farmers operating 15,000ha of production area and producing 150,000 tonnes in 2012 which is 40% of national production. SCI members stock shrimp at 80 to 125PL/m<sup>2</sup>. The majority of traditional farmers culture monodon shrimp at 25-50PL/m<sup>2</sup> in extensive systems. Aside from SCI members and a number of shrimp integrators, the largest contribution to national production is from the three large farms operated by PT Central Proteinaprima (CP Prima).



“The reason why our production is so much lower than Thailand, although we have a large potential area and low labour costs, is because production went down after 2010. We produced 400,000 tonnes in 2008. Today, at SCI we are on our way to achieve higher production. Our members have reduced stocking density from 200PL/m<sup>2</sup> before the IMNV outbreak and practise three partial harvest producing 80, 60 and 30/40 per kg size classes. However, farms in Lampung still face some problems. Although we are increasing production, there are crop losses from the integrated farms. We only expect a production

of 420,000 tonnes in 2013, instead of the government estimate of 480,000 tonnes.”

With regards to the CVD case, the bone of contention in Indonesia is how the US Department of Commerce has 12 points on the subsidy element for shrimp in Indonesia. In the Jakarta Post, it was reported that the US group quoted government loans for the fishing and aquaculture sector, provisions of shrimp breeding stock, export credit insurance and guarantees, exemptions of import duty and value added tax in bonded zones and tax incentives from the Investment Coordinating Board (BKPM).

According to Iwan, the government program for traditional farmers is not to lower production costs but to raise the living standards of these farmers. The free supply of post larvae is to help them with the first crop only. “The reason we have good production is that because of high prices, we no longer have idle ponds in Java. Imagine- there is a mention that our bank interest is subsidised when we have one of the highest rates in the region. We have to fight this petition as the US market is important to us, just like Thailand.”

The Trade Ministry said that the US is Indonesia's biggest shrimp market. Shrimp exports to the US surged by an average of 4.2% from 2007 to USD 559.4 million in 2011, accounting for 48.2% of overall shrimp exports. In 2012, the increase was 4.8% for the January-October 2012 period to USD 484 million.

“In the long term, we want to follow the situation in Malaysia where prices are high because of its large domestic demand. In Indonesia, we estimate only 20% is consumed locally and if we can increase this, we will be able to maintain high prices. We have plans for a ‘eat shrimp day’ to encourage consumption.”



## International Seminar-Workshop on Mud Crab Aquaculture and Fisheries Management (ISMAF2013)

10 to 12 April 2013, Tamil Nadu, India

ISMAF2013 is a meeting for mud crab scientists, researchers, industry practitioners and academicians. It will be held at the 100 seater auditorium at the Technology Transfer Training & Administrative Complex of Rajiv Gandhi Centre for Aquaculture at Sirkazhi. The organisers are the Rajiv Gandhi Centre for Aquaculture (RGCA) and Aquaculture Department, Southeast Asia Fisheries and Development Centre (SEAFDEC/AQD) in the Philippines.

The previous symposia on mud crab were held in Australia (1997), Philippines (1998, 2004), Vietnam (2001) and China (2009). With the same goals, the present seminar-workshop seeks to bring together mud crab scientists, industry practitioners/stakeholders, and the academia from various parts of the globe to discuss the present status of the industry, share insights on relevant issues and identify the problem areas for further research and development on mud crab aquaculture and fisheries management for a sustainable mud crab industry. Conducting this seminar-workshop in India is appropriate as considerable amount of work related to mud crab hatchery, nursery and grow-out technologies have been done in the country.

The seminar program includes

- Country papers dealing on the status of the mud crab industry in India, Philippines, Indonesia, Myanmar, Thailand, Vietnam and Malaysia.
- Technical sessions dealing on biology, ecology and physiology, genetics, domestication and selective breeding, husbandry, nutrition and diseases, fisheries and resource management, post-harvest product development and marketing.
- Workshop on husbandry (broodstock management, hatchery/nursery and farming).
- Field trips to mud crab hatchery and demo farms.

More information: <http://www.mpeda.com/society/ismaf.pdf>; Dr Emilia T. Quinitio, Email: [etquinit@seafdec.org.ph](mailto:etquinit@seafdec.org.ph) Dr. Anup Mandal Email: [rgcacgl@gmail.com](mailto:rgcacgl@gmail.com)

# The first purified enzyme against fumonisins

BIOMIN has launched FUMzyme® - the first purified enzyme that biotransforms fumonisins into non-toxic metabolites at VIV Asia 2013 in Bangkok, Thailand. This represents a great step forward in mycotoxin risk management, closing the gaps of adsorption amid increasing contamination levels and unidentified losses in animal performance.

Taking advantage of its 30 years of experience in mycotoxin risk management and its know-how in biotransformation, Biomin has introduced a completely new approach in counteracting fumonisins in animal production. FUMzyme® is a purified enzyme that biotransforms fumonisins into non-toxic metabolites in the gastrointestinal tract of animals. The detoxifying activity of this revolutionary enzyme was confirmed in numerous *in vitro* and *in vivo* experiments.

“Fumonisin elicit a toxic effect on the sphingolipid metabolism. The ratio of the sphingoid bases sphinganine and sphingosine in serum serves as an indicator (biomarker) of the effects of fumonisin on animals” says Ursula Hofstetter, director of the Competence Center Mycotoxins at Biomin. “For the first time, using the sphinganine/

sphingosine ratio (Sa/So) as a biomarker, the detoxification of fumonisins by FUMzyme® can be clearly demonstrated”.

Climate change and the international transportation of raw materials are only two of several factors that increase fumonisin contamination all over the world. Recent findings have revealed natural fumonisin contamination levels of 77 ppm in finished feed. Pig and poultry farmers are not only suffering from unidentified losses in performance and immunosuppressive effects, but also species-specific clinical problems. So far, the only existing possibility of alleviating fumonisin intoxication was to bind fumonisins by adsorptive substances. Unfortunately, due to the molecular structure of these mycotoxins and the pH dependence of the reaction, it can only be insufficiently adsorbed in the gastrointestinal tract.

FUMzyme®, the result of years of intensive research at the Biomin Research Center in Tulln, enables Biomin to keep the lead in the development of revolutionary strategies to counteract mycotoxins. It is available as part of the Mycofix® product line. For more information: <http://fumzyme.biomin.net>

## Book Review

# Biofloc Technology: a practical handbook Second edition

By Yoram Avnimelech with chapters added by Peter De-Schryver et al., Maurício Emerenciano et al., Dave Kuhn and Addison Lawrence and Andrew Ray. Softcover, March 2012

This is a follow-up of the first edition of the guide to Biofloc Technology (BFT) published in 2009. Dr Yoram Avnimelech said that the BFT working group (formed during World Aquaculture 2006) often receives new information on biofloc practices from around the world. Thus when the first edition was sold out, the decision was to publish a new version rather than a second print.

The first edition was written in response to the demand on knowledge of BFT. It guides the reader through the story of BFT. As the technology is being adopted either fully or partially in many parts of the world and interest is increasing, this second edition has new chapters written by experts; summarising new developments and revealing new insights into the exciting world of BFT. In Chapter 13, Andrew Ray discusses the super intensive shrimp BFT systems with above 300 PL/m<sup>2</sup> (up to 900PL/m<sup>2</sup>) with typical yields of 3-6kg/m<sup>3</sup>. Organic loads are above holding capacity and careful monitoring is a prerequisite. There are few commercial systems and he describes experimental BFT and aeration systems at the Waddell Mariculture Centre in South Carolina, Texas Agrilife Research Mariculture Centre in Texas and Thad Cochran Marine Aquaculture Centre in Mississippi, USA. The optimisation of BFT is given in Chapter 15 on the biology and biotechnology behind bioflocs by Peter de Schryver, Nico Boon, Willy Verstraete and Peter Bossier.

Maurício Emerenciano, Gabriela Gaxiola and Gerard Cuzon have a chapter on BFT applied to shrimp broodstock rearing. According to them, the culture of biosecure brood stocks to avoid vertical

infections is important to prevent the global spread of viruses. In systems applied for broodstock, usually more than 15g, the rule is the management of stocking density protocols, total control of suspended solids, etc. The chapter on Ex-situ BFT by David D Kuhn and Addison Lawrence looks at the production of biofloc based proteins as replacements for fish meal in aquaculture. Commercial application of BFT in shrimp particularly in Indonesia is described by Dr Nyan Taw in chapter 17. The chapter is based on the communications from farmers on biofloc practices and how to solve problems. The chapter also includes a short review on BFT at the PT Suri Tani Pemuka farm in Indonesia.

As interest in BFT is increasing in Asia, there is now a Vietnamese version of this second edition. A Chinese translation is in progress. The English version is available from the World Aquaculture Society at USD70 ([www.was.org](http://www.was.org)). For more details on the Vietnamese version, contact Professor Hoang Tung ([htung@hcmiu.edu.vn](mailto:htung@hcmiu.edu.vn)/ [htunguof@gmail.com](mailto:htunguof@gmail.com)).



# Vision for Thai marine aquaculture

Large scale aquaculture will see the parallel development of sea bass and pompano

The Thai Department of Fisheries (DOF) wants to encourage large cage farming technology and under the 'Thai-Norway Technical Cooperation Project: development of aquaculture and governance for a sustainable utilisation of Thai sea waters 2010-2014', a meeting was held in November to select the species for future marine fish production in Thailand. A range of participants attended, including: selected Thai industry associations and companies; farmers from Krabi, Phang-nga and Phuket; representatives from the Institute of Marine Research (IMR) Norway and other Norwegian experts; representatives from DOF and its Coastal Fisheries Research and Development Centres in Phang-nga, Phuket and Krabi.

The Thai project manager, Dr Suttinee Limthammahisorn, presented the progress to date of the project implemented with IMR. The first phase from 2005-2006 was on 'Post-tsunami assessment of living marine resources and the development of a strategic plan for sustainable marine fish farming'. This also included the reconstruction of the marine aquaculture sector following the tsunami disaster. The target of this was to introduce Norwegian style floating cage technology and to set up a pilot marine fish farm.

The second phase saw the development of marine aquaculture, including an assessment of fishery resources in the Andaman Sea, Thailand from 2007-2011. The main purpose of this project was to provide assistance by introducing new marine aquaculture technology. The project focused on large cage farming and mass fry production systems. The third phase had four main objectives related to marine aquaculture: strengthening of government competence and governance; assistance in innovation and new technologies emphasizing on hatchery production including cage farming and value chain development; further elaboration of general regulations including fish health procedures and environmental impact assessment conditions; and social aspects in its future development.

According to Dr Panisuan Jamnarnwej, president of Thai Frozen Foods Association who presented the 'Future market for farmed marine fish (big scale production) in Thailand', availability, reliability and affordability are three key selling points. The potential of various species



was presented by experts: Finn Skjennum on sea bass and cobia; Niels Svennevig, on pompano and yellowfin tuna; and Paiboon Bunlipatanon, director of Krabi Coastal Fisheries Research and Development Bureau, DOF discussed the potential of groupers and hybrid groupers.

There is interest from the private sector on large scale aquaculture and offshore aquaculture. The meeting selected two main species for future large scale aquaculture development. Sea bass, specifically large size sea bass, is the first priority since technology is available in its breeding, nursing and grow-out. However, the concern is on the flesh texture of frozen sea bass and further testing on the quality of the frozen fish may be needed. The other species is the pompano as it has a high value and demand in international markets. It is recommended that the DOF focus on these two species in parallel.

## NEXT ISSUE

**May/June 2013** issue will feature

• Hatchery & Breeding Technology • Marine Fish • Fish meal and Oil Replacements • Recirculation Aquaculture Systems

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# Technology transfer in aqua feed formulation



Further to a contract on logo authorisation to Indian feed company, Nexus Feeds Ltd on December 22 2011 in India, Taiwan based HANAQUA signed another contract with Nexus Feeds for the technology transfer of aquafeed formulation on February 5, 2013. The contract signing ceremony was hosted by Peter Chiang, the founder of Hanaqua in Kaohsiung, Taiwan.

The session was attended by stakeholders in the aquaculture industry of Taiwan including academician and researchers, government officials and industry, in particular, Dr I-C Liao, the Academician of Academia Sinica; Dr Shi-Yen Shiau, the National Endowed Chair Professor; and many other professors in the fields of nutrition, physiology and environment. Dr Fern-Lan Chern, the Fisheries Agency of Council of Agriculture, Executive Yuan, Taiwan, Paul Hsu, chairman of PHYCOS International Co., Ltd. were also present.

The hosts also led the brain-storming session on 'Taiwan's ride on the development of global aquaculture industry'. The discussion concluded that, although Taiwan has had more than 50 years of experience in commercial production, players in the supply chain are now facing the need for an alliance in international marketing for a greater contribution in the global seafood supply. Several participants highlighted the urgent need of transforming 'Taiwanese field experience' into 'Taiwanese scientific experience' in the aquaculture production. There is no doubt that field experience is vital but a scientific approach can upgrade its technical structure.

G. Rama Krishna Reddy, CEO of Nexus Feeds Ltd, expressed his confidence on the cooperation as well as for the support from Hanaqua and its affiliated technical team, the Taiwan aquaculture team.

## A leader of the aquaculture health market

In November, the VIRBAC group announced the purchase of the majority shares (51%) of the CENTROVET group, the leader of the animal health market in Chile. This will allow Virbac to be a key player in the fast-growing segment of the veterinary market: products used for protection and treatment in aquaculture. In this agreement, it will have the option to acquire the remaining capital stock at the end of a five year period.

Founded in 1979, Centrovvet has become a major player in aquaculture health, building unique know-how and expertise in the development and manufacturing of innovative products for cold water aquaculture, in particular in the field of salmon and trout vaccines, where Chile is currently a major producer in the world. In addition to injectable vaccines, the company has developed and introduced to the aquaculture market proprietary oral delivery technologies for vaccines, in which it is currently the only player in the market. Based in Santiago, it employs around 300 people and manufactures a broad range of injectable and oral vaccines, pharmaceutical specialty products and nutritional additives. It is investing in a R&D program which includes a pipeline of high potential projects.

In addition to the growth potential of the Chilean market itself, the worldwide VIRBAC commercial network will be a significant opportunity for international growth of Centrovvet's products, in particular vaccines for the aquaculture industry worldwide. From a financial standpoint, Centrovvet is experiencing rapid growth and generates an excellent profitability, driven by the increasing penetration of its vaccines range and the growth of salmon production in Chile. Revenues totalled USD58 million in 2011 and over USD42 million in the first-half 2012, a growth rate of approximately 60%.

This transaction gives Virbac a major strategic opportunity to become a leading player in a market which should continue growing its share in the production of proteins dedicated for human consumption, and to capitalize on the transactions already concluded in Asia in the recent years in this field (Biosolution, SBC). It is expected that this acquisition will have a positive impact on Virbac's operating and net earnings as soon as in 2013. More information: [www.virbac.com](http://www.virbac.com)

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# JV in shrimp farming business in Thailand

Mitsubishi Corporation (MC) and Thai Union Frozen Group (TUF Group), one of the largest manufacturers and exporters of seafood in Thailand, have agreed to set up a shrimp farming Joint Venture Company (JV) in Thailand in December 2012. This JV will provide an enhanced network for procuring good quality shrimp raw materials. MC will hold 49% of shares in the JV, while Thai Union Feedmill (TFM), a TUF subsidiary and second largest shrimp feed manufacturer in Thailand, will hold 51% of shares.

The total project cost is estimated at JPY 3 billion (USD 32 million), including plans to purchase existing mid-scale shrimp farming companies and set up new ones along the Thai coast, all giving due regard to environmental concerns. The project targets a total annual increase in production capacity of up to 10,000 tonnes by fiscal year 2018. The JV also plans to enter the hatchery business from fiscal year 2013 for full traceability and food safety.

MC says that the current global demand for both wild and farmed shrimp is approximately 6.5 million tonnes per annum. However, due to economic growth and increasing populations in emerging countries, demand is expected to rise, outstripping supply in the coming years. Safety and security requirements for shrimp products are also likely to become more stringent. In this context, MC and the TUF Group will work together through the JV to grow the shrimp business, covering operations from upstream to downstream, with the aim of securing safe and reliable shrimp.

The goal is to be well positioned to respond to imminent increases in global demand for shrimp products, while maintaining a high level of traceability. MC has already entered the salmon farming business in Chile last year. The decision to join forces with the TUF Group to



*TUF at the European Seafood Exhibition in 2011*

enter the shrimp farming business in Thailand is consistent with MC's strategy to enhance its procurement network for safe and secure marine products through the diversification of cultured fish species and production locations. This strategy will help MC to respond to increasing global demand for food products and to fulfill the role of providing a stable supply of resources to the market. More information: [www.mitsubishicorp.com](http://www.mitsubishicorp.com)

## Brazil as next seafood powerhouse

Brazil has all the necessary ingredients to become the next seafood super power, rivalling established producers such as Thailand, Norway and even China, according to a report by Rabobank. However, in spite of its intrinsic natural resources and large availability of grains, the Brazilian seafood industry still has to overcome significant barriers to realise its potential.

Rabobank's view is that despite the challenges, the Brazilian aquaculture sector—led by private and governmental investments—will enlarge its importance in the global aquaculture scenario. Rabobank analyst Guilherme Melo said that Brazil has a coastline of 8,500 km bordering the Atlantic Ocean which stretch across a diverse range of tropical and subtropical climates that are ideal for aquaculture. It has 12% of the planet's available freshwater reserves, with over 5.5 million hectares of federal controlled land. The vast production of grains is an advantage in the production of species that consume a vegetarian diet. A feed cost advantage was also a substantial factor behind the growth of the poultry and pork industry in Brazil, which are now the second and fourth largest in the world, respectively.

Although Brazil has enormous potential to become a prominent aquaculture player, growth is still 'crawling'. In 2010, aquaculture contributed 479,000 tonnes to the seafood supply of 1.2 million tonnes. Although aquaculture production remains low, it has grown rapidly in recent years. Rabobank identifies a number of 'bottlenecks' that Brazil needs to overcome in order to achieve its aquaculture potential.

On the regulatory side, one of the weaknesses is the legal framework concerning the use of water for aquaculture. There is considerable

bureaucracy to overcome to obtain all of the permits/licenses to start an aquaculture operation. Low yields and size heterogeneity also prevent the flourishing of the sector in Brazil. This issue could be partially solved if the relationship between the links of the chain were more coordinated and integrated as they are in the case of pork and poultry production.

As there are many species being grown with a wide range of environments—usually on small-scale farms—it is not economically feasible for companies to produce specific rations suitable for each situation on a large scale. The result of this situation is a combination of poor quality feed and high prices. Infrastructure is also another important obstacle for the sector. Many areas that have been granted to aquaculture farms are very far from roads, ports, feed blenders, consumption areas, and so on, which poses additional challenges to the operation and, consequently, economic feasibility of such projects. The lack of public information about the sector has likely prevented investors from better assessing the potential of such a market.

Despite these challenges to be overcome, Rabobank believes the outlook for the seafood sector in Brazil is quite bright. The growing domestic consumption together with opportunities in the export side will contribute to put the country on the radar of the leaders in the global seafood companies, and may also entice Brazilian meat giants to venture into the aquaculture space. More information: <http://rabobank-food-agribusiness-research.pressdoc.com/38868-rabobank-report-brazil-is-a-seafood-industry-giant-in-the-making>

After the first successful meeting in 2007 in Hanoi, Asian-Pacific Aquaculture 2013 returns to Vietnam, this time in Ho Chi Minh City, closer to the marine shrimp and pangasius catfish production areas of Vietnam. It will be hosted by the Ministry of Agriculture & Rural Development (MARD), Vietnam.

APA 2013 will be a chance for the international aquaculture community to visit and see the rapidly expanding aquaculture industry in Vietnam. Those attending will be able to see what is happening in Vietnam's aquaculture to create this growth as well as aquaculture developments in the rest of Asia. There will also be opportunities for farm tours which will be organised by MARD. Details on farm tours will be provided later and updated on the website.

### Trade show

Together with the conference, there will be an 88-booth trade show for global and local companies to display the latest innovations and products. To date, some of the exhibiting companies include the Fish Breeding Association, Taiwan, INVE Aquaculture and Nutriad (Belgium), Evonik (Germany), Biomin (Austria), Alltech and YSI (USA), Aquatv and Faivre (France), Femagrow (Thailand), as well as Vietnamese universities, research centers for aquaculture and governments.

### Special producer program

Asian-Pacific Aquaculture 2013 will have a special Farmer's Day with the latest in practical knowledge for Vietnam's aquaculture producers.

### 5th International Oyster Symposium (IOS5)

The World Oyster Society will hold its 5th Oyster Symposium in the same location. Registration for Asian Pacific Aquaculture 2013 will include attendance to this 5th Symposium.

### Technical program

Sessions and workshops at Asian-Pacific Aquaculture 2013 will cover all aspects of aquaculture in Vietnam as well as the rest of Asia. These are listed below:

#### Ecology & environment

Environment, biodiversity climate change, sustainable development of aquaculture and aquaculture standards & certification

#### Animal science, health and diseases

Physiology, morphology & histology, immunology, embryology, breeding & genetics, hatchery & larvae management, drugs and therapeutics and animal welfare

#### Nutrition

Feedstuffs and feed additives, prebiotics and probiotics, fish meal and oil, alternative feedstuffs and aquafeeds and antimicrobials in aquafeeds

#### Production systems

Cage-culture, bio-floc systems, recirculation systems, pond culture, offshore aquaculture, integrated multi-trophic aquaculture, raceway systems, organic aquaculture, reservoir based aquaculture and aquaculture and high techs,

#### Post-harvest technologies

Advances in seafood processing, bioactives and functional seafood, health, safety and inspection

#### Molluscs and crustaceans

Abalone, mussel, oyster, octopus, marine shrimp, pearl and queen conch culture, carpet shells, crabs & lobsters, crayfish and freshwater prawn

#### Freshwater fish culture

Carp, freshwater culture of barramundi, perch, Pangasius, Clarias and Ictalurus catfish, tilapia, eels, trouts, sturgeon, other coldwater species

#### Other species and topics

Seaweeds and algae, ornamentals, amphibian and reptile aquaculture, plankton culture and emerging species in aquaculture

#### Economics and social sciences

Aquaculture economics and management, development, welfare and poverty alleviation, marketing & trade, policy & regulations

#### Other topics & special sessions

Education, extension, and technology transfer, emerging issues in aquaculture development

#### Marine fish culture

Tuna, cobia and yellowtails, saltwater culture of barramundi, grouper and snappers, salmonids, mullets and other marine fish

**Deadlines:** Abstract submission: May 15, 2013;  
Early bird registration to September 13, 2013

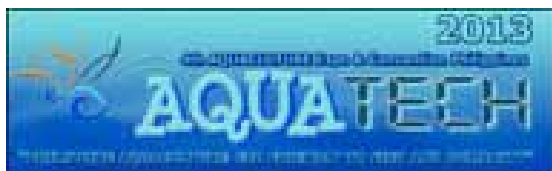
**More information:** [www.was.org](http://www.was.org); email: [worldaqua@aol.com](mailto:worldaqua@aol.com)

Trade show: email: [mario@marevent.com](mailto:mario@marevent.com) (Mario Stael);

Tel: +32 9 233 49 12

## What can you expect from AQUA Culture Asia Pacific in 2013

Volume 9 2013				
Number	3 – May/June	4 – July/August	5 – September/October	6 – November/December
<b>Issue focus</b> <i>Recent developments and challenges for the next step</i>	Hatchery & Breeding Technology	Food Safety & Traceability	Sustainable & Responsible Aquaculture	Culture Technology
<b>Industry Review</b> <i>Trends and outlook, demand &amp; supply</i>	Marine Fish	Catfish	Marine Fish	Freshwater Fish/Prawn
<b>Feeds &amp; Processing Technology</b> <i>Technical contributions influencing the final value of aqua feeds</i>	Fish Meal /Oil Replacement Feed Management	Feed Enzymes Product Quality	Feed Probiotics Good Manufacturing Practices	Nutrition & Formulation
<b>Production Technology</b> <i>Technical information and ideas</i>	Recirculation Aquaculture Systems	Hatchery Technology	Certification and Regulations	Hygiene & Food Safety
<b>Aqua business</b> <i>Feature articles</i>	Experiences from industry, including role models, benchmarking and opinion articles in shrimp/fish culture			
<b>Markets</b>	Market trends, product development and promotions at local and regional trade shows			
<b>Show Issue</b> <i>Distribution at these events as well as local and regional meetings</i>	<b>Vietfish 2013</b> June 25-27 Ho Chi Minh City, Vietnam	<b>The Aquaculture RoundTable Series (TARS 2013)</b> -Finfish Aquaculture August 21-22, Singapore	<b>18th China Seafood &amp; Fisheries Exposition 2013</b> November 5-7, China	<b>Asian Pacific Aquaculture 2013</b> December 10-13 Ho Chi Minh City, Vietnam*
<i>*Show preview</i>				
<b>Deadlines</b> Articles	<b>April 2</b>	<b>June 1</b>	<b>August 1</b>	<b>October 1</b>
<b>Deadlines</b> Advert bookings	<b>April 9</b>	<b>June 7</b>	<b>August 7</b>	<b>October 8</b>



May 23-24, 2013

Tagaytay City, Philippines

**This is an annual event for the aquaculture industry in the Philippines. This 4th Aquatech Aquaculture Expo and Convention Philippines 2013 will be held from May 23-24, 2013 at the Summit Ridge Hotel, Tagaytay City, Philippines.**

This year's event will have the theme, 'Philippine Aquaculture: Eco-Friendly to Fish and Humanity: Believe, Nurture, Grow'. "The target audience will not only be industry in the Philippines, but also in the Asia Pacific Region. The overall objective of the event is to get industry in the region to come together, to learn, contribute and support aquaculture development," says Mary Ann Venturina, event marketing coordinator of organiser, Events Quality & Interactive Promotions (EQUIP), Inc.

The third Aquatech was held in April 19-20, 2012 in Angeles City, Pampanga. The conference was titled 'Profitable Aquaculture: Supporting Sustainable Practices' and drew almost 150 participants from around the Philippines and from nearby Asian countries. Both local and internationally based speakers including SEAFDEC, WorldFish Center, ASA-IM, Food & Agriculture Organisation (FAO),

NOVUS International, Santeh Feeds Corporation, Alsons Aquaculture Corp, Tiger Property Developers' Group, TGA Foods Corp and Aquatic Biosystems spoke on the importance of responsible and sustainable practices in aquaculture. There were also discussions by consultants from University of the Philippines Los Baños (UPLB) and Central Luzon State University (CLSU). Presentations from three companies showcased latest equipment and technology.

"The 2-day conference gave participants a chance to ask questions and discuss issues quite extensively through a panel discussion. The participants were very happy with the quality of the speakers and materials presented," said Venturina.

More information: Email: [mgv.equipinc@yahoo.com](mailto:mgv.equipinc@yahoo.com) (Mary Ann Venturina)

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](mailto:zuridah@aquaasiapac.com)

### March 17-22

#### 9th International Conference on Molluscan Shellfish Safety

Sydney, Australia  
 Web: [www.icmss2013.com](http://www.icmss2013.com)  
 Email: [icmss2013@iceaustralia.com](mailto:icmss2013@iceaustralia.com)

### March 24 - 25

#### Aridland Aquaculture Symposium & Workshop 2013

Al Ain, United Arab Emirates (UAE)  
 Web: [www.was.org](http://www.was.org)  
 Email: [worldaqua@aol.com](mailto:worldaqua@aol.com)

### March 26-27

#### Recirculation and Aquaponics Workshops

Abu Dhabi, UAE  
 Web: [www.was.org](http://www.was.org)  
 Email: [worldaqua@aol.com](mailto:worldaqua@aol.com)

### April 10-12

#### International Seminar-Workshop on Mud Crab Aquaculture and Fisheries Management (ISMAF 2013)

Sirkazhi Taluk, Tamil Nadu, India  
 Web: [www.rgca.org.in](http://www.rgca.org.in)  
 Email: [rgcaho@gmail.com](mailto:rgcaho@gmail.com)

### April 23-25

#### European Seafood Exposition

Brussels, Belgium  
 Web: [www.euroseafood.com](http://www.euroseafood.com)

### April 30-May 4

#### 10th Asian Fisheries & Aquaculture Forum and Fourth International Symposium on Cage Aquaculture in Asia (CAA4)

Yeosu, Korea  
 Email: [10afaf@koference.org](mailto:10afaf@koference.org)  
 Web: [www.koference.org](http://www.koference.org)

### May 22-26

#### World of Seafood

Bangkok, Thailand  
 Web: [www.worldofseafood.com](http://www.worldofseafood.com)  
 Email: [s.teo@koelnmesse.com.sg](mailto:s.teo@koelnmesse.com.sg) (Sharon Teo)

### May 23-24

#### 4th Aquatech Aquaculture Expo and Convention Philippines 2013

Tagaytay City, Philippines  
 Email: [mgv.equipinc@yahoo.com](mailto:mgv.equipinc@yahoo.com)  
 (Mary Ann Venturina)

### May 30-June 2

#### Aquarama 2013

Singapore  
 Web: [www.aquarama.com.sg](http://www.aquarama.com.sg)  
 Email: [squarema\\_2013@online.ubmasia.com.sg](mailto:squarema_2013@online.ubmasia.com.sg)

### June 3-14

#### Shrimp Pathology Short Course-Disease Diagnosis and Control in Marine Shrimp Culture

University of Arizona - Tucson Arizona, USA  
 Web: <http://microvet.arizona.edu/research/aquapath/index.htm>  
 Email: [ritar@email.arizona.edu](mailto:ritar@email.arizona.edu)

### June 25-27

#### Vietfish 2013

Ho Chi Minh City, Vietnam  
 Email: [info@vietfish.com.vn](mailto:info@vietfish.com.vn)  
 Web: [www.vietfish.com.vn](http://www.vietfish.com.vn)

### August 9-12

#### Aquaculture Europe 2013

Trondheim, Norway  
 Web: [www.easonline.org](http://www.easonline.org)

### August 21-22

#### The Aquaculture Roundtable Series (TARs 2013) –Finfish Aquaculture

Singapore  
 Web: [www.tarsaquaculture.com](http://www.tarsaquaculture.com)  
 Email: [conference@tarsaquaculture.com](mailto:conference@tarsaquaculture.com)

### September 4-6

#### Genomics in Aquaculture Symposium (GIA 2013)

Bodø, Norway  
 Web: [www.gia2013.org](http://www.gia2013.org)  
 Email: [secretariat@gia2013.org](mailto:secretariat@gia2013.org)

### November 7-9

#### Expo Pesca & AcuiPeru

Lima, Peru  
 Web: [www.thaiscorp.com](http://www.thaiscorp.com)  
 Email: [thais@amauta.rcp.net.pe](mailto:thais@amauta.rcp.net.pe)



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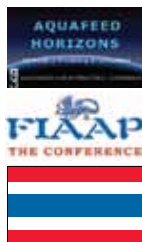
### Specialist conferences

The exhibitions will be supported by their own specialist conferences. They will include:

**Aquafeed Horizons Asia 2014**

**The FIAAP Conference 2014**

**The Thai Feed Conference 2014**



### Supported by

The Thailand Convention and Exhibition Bureau



### Co-located with GRAPAS Asia 2014

[www.grapas.eu](http://www.grapas.eu)



### Contact details

For visitor, exhibition stand space and conference information please visit:

[www.fiaap.com](http://www.fiaap.com) or  
[www.victam.com](http://www.victam.com)





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