

Benchmark Insights

SHRIMP 2019

ISSUE 1



*Technologies shaping the future of **shrimp** **production***













Foreword

Shrimp production is one of the fastest growing protein sources, worth around US\$ 39 billion worldwide in 2017¹. Growth, however, is impacted by disease outbreaks which have been reported to result in losses of up to 40%, amounting to billions of dollars annually.

We are seeing increasing awareness amongst all stakeholders around the environmental, ethical and economic impacts of aquaculture. A recent report published by FAIRR² highlighted 10 key risk factors in aquaculture including animal welfare, disease, effluents, habitat destruction, antibiotic use, and fish feed supply (see below).

Key risk factors in aquaculture²

	Antibiotic use		Transparency and food fraud
	Disease		Habitat destruction and biodiversity loss
	Greenhouse gas emissions		Effluents
	Animal welfare		Working conditions
	Feed supply		Community resistance

¹ Future Market Insights (2017) Shrimp Market.

² FAIRR Report (2019).

In a recent participatory poll conducted by Benchmark, 'citizens' came out on top as the stakeholder group which will be the biggest force for positive change in the next five years. Public awareness around how our food is produced is no new thing – farmers, producers, retailers and consumers are all citizens and we can and need to drive change.

Demonstrating social responsibility is now an essential part of proactive reputation management, as well as affecting a company's ability to attract top talent, community partners and consumers. Research published by the London Business School found that companies that genuinely adopted ESG (Environmental, Social, Governance) policies beat their peers who did not by 4.8 per cent a year over 18 years¹. Brands that establish a reputation for environmental stewardship among today's youngest consumers have an opportunity to not only grow market share but build loyalty among the power spending generations of tomorrow².

We know that none of us are as good as all of us

Through this report we would like to create insight into the key challenges in the shrimp industry, highlight experts' perspectives from multiple disciplines and showcase the opportunity for this healthy and nutritious protein source.

There is huge potential in co-ordinating the biological drivers behind the efficiency of production. Sustainability cannot be owned by one company alone. Collaboration is key in order to share expertise and develop effective solutions to positively impact people, animals and the environment.

¹ Edmans, A. (2012) The Link Between Job Satisfaction and Firm Value, With Implications for Corporate Responsibility.

² Nielsen (2015) The Sustainability Imperative.

Now is the time to bring all of our considerable expertise to the table for the benefit of all





Putting the right tools in the farmers hands will give them the greatest control they have ever had over their stocks.



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History of shrimp farming



Dedicated shrimp farming began on a global scale in the 1970's with production of 9,022 tonnes¹, escalating to over 1 million tonnes in 2000 to over 4 million tonnes in 2017, making it one of the fastest growing food commodities in the world².

The history of shrimp farming is comparable to that of terrestrial animal husbandry where traditional culture of wild animals at low density in a natural setting progressed to intensive culture of domesticated animals in a controlled setting. The difference is that domestication of terrestrial animals began thousands of years ago, but that of penaeid shrimp began in the last few decades.

Major milestones

Shrimp farming in its earliest form began centuries ago in Asia where wild shrimp juveniles migrated into tidal impoundments intended primarily for milk fish, mullet and other coastal finfish. This resulted in incidental crops of 100-200kg/ha/year of shrimp with no additional input aside from trapping/harvesting.

On the West coast of India, Bangladesh, and the Mekong Delta of Vietnam, extensive production techniques performed well due to abundance of wild juveniles and tidal ranges of up to 7m. Farmers would harvest by trapping shrimp as they migrated out with the tide. These systems would produce as much as 400kg/ha/year with selective harvesting, water management, and fertilisation, but harvests of 200kg/a/year were more common.

Little advancement in technology occurred until the twentieth century. The primary obstacle to development was the poorly understood life cycle of penaeid shrimp, which involves an oceanic reproductive phase, a complex series of larval stages, and an estuarine juvenile phase.

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¹ Ashton, E. (2010) The impact of shrimp farming on mangrove ecosystems.

² Global Aquaculture Alliance (GOAL) (2018) Global shrimp production review and forecast.



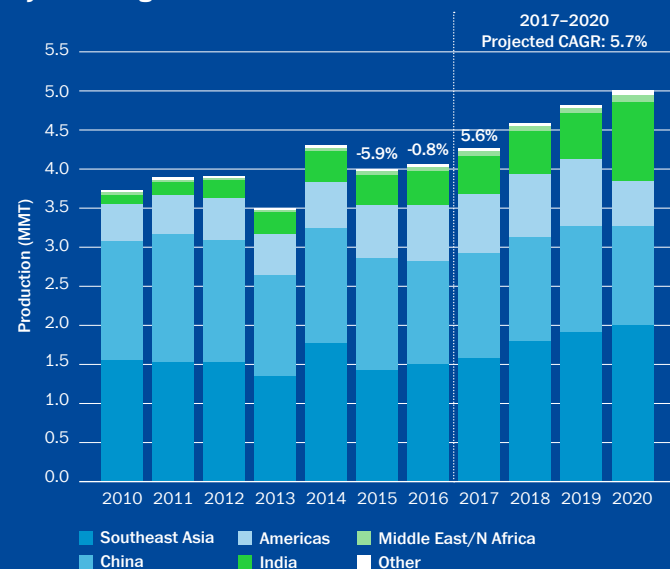
Production overview

Despite making up 6 per cent of global production, shrimp is responsible for 16 per cent of the production value of traded seafood¹. The shrimp market is expected to grow at a compound annual growth rate of 5.7 per cent between 2017 and 2020².

¹ SOFIA (2018).

² California Environmental Associates (CEA) (2018) Shrimp Aquaculture Landscape report prepared for Gordon and Betty Moore Foundation's (Moore) Ocean and Seafood Markets Initiative (OSMI).

Shrimp aquaculture production by world region: 2010-2020



Sources: FAO (2018) and GOAL surveys (2011-2017) for 2010-2016; GOAL survey (2018) for 2017-2020. Southeast Asia includes Thailand, Vietnam, Indonesia, Bangladesh, Malaysia, Philippines, Myanmar and Taiwan. *Macrobrachium rosenbergii* is not included.

Producers and exporters

The majority of shrimp production originates in Southeast Asia with the three largest exporters being India, Ecuador and Vietnam. China is the leading producer, contributing ~60% of farmed shrimp to world production. The highest demand for shrimp comes from Europe, the United States and Japan.



Penaeus vannamei
(or whiteleg shrimp)



Penaeus monodon
(or black tiger shrimp)

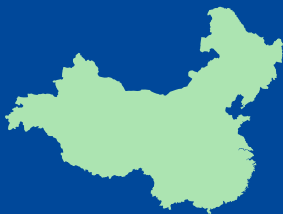


Macrobrachium rosenbergii (or giant freshwater river prawn)

The market is segmented into three species. The two main farmed species are *Penaeus vannamei* (~80% in 2018), the Pacific white shrimp (or whiteleg) native from the west coast of South America and *P. monodon* (~15% in 2018), the giant or black tiger shrimp native from Asia. Intensification of whiteleg shrimp is responsible for most of the growth of shrimp production, while tiger shrimp production remains stable¹.

No1 producer

China



EU remains the world's largest shrimp importer



No1 exporter

India



Systems

Shrimp farming systems are very diverse in their management, size and the people involved. Shrimp farms can be classified according to the stocking characteristics, yield and management. (See table 1)

Table 1: Characteristics of shrimp farming systems²

Parameter	Traditional	Extensive	Semi-intensive	Intensive	Super-intensive
Stocking density (no./m ²)	<1	<5	5-25	>25	115-130
Stocking characteristics	Wild post-larvae	Wild post-larvae some caught	Wild caught broodstock and wild or hatchery post-larvae	Broodstock wild caught or farm raised and hatchery post-larvae	Farm raised broodstock and hatchery post-larvae
Labour inputs (workers/ha)	Family	<0.1	0.1-0.5	1-3	5
Annual yield (tonnes/ha)	0.1-0.5	<1	1-5	>5	8-28
Environmental impact	Low	Uses wide mangrove areas	Mangrove conversion, salinization, water pollution	Salinization, water pollution	Low apart from high energy use

¹ California Environmental Associates (CEA) (2018) Shrimp Aquaculture Landscape report prepared for Gordon and Betty Moore Foundation's (Moore) Ocean and Seafood Markets Initiative (OSMI).

² Ashton, E. (2010) The impact of shrimp farming on mangrove ecosystems.

Supply chains

The export-oriented farmed shrimp supply chain always consists of four major segments: inputs (feed and PLs), farm, processor, and importer. The consolidation, vertical integration, and inter-segment interactions differ considerably across regions, but can be broadly grouped by geography into Latin America and Asia. Latin American farms tend towards vertical integration model.

Most farms in Southeast Asia, India and China are highly disaggregated, family-operated production units that feed into a large, opportunistic, and informal network of traders and brokers who in turn supply hundreds of processors¹.

Certification

Certifications and rating agencies include Best Practices in Aquaculture (BAP), Global G.A.P., Aquaculture Stewardship Council (ASC), Naturland, and Seafood Watch. To date, certifications only cover a small fraction of production in each of the top producing countries².

¹ California Environmental Associates (CEA) (2018) Shrimp Aquaculture Landscape report prepared for Gordon and Betty Moore Foundation's (Moore) Ocean and Seafood Markets Initiative (OSMI).

² Global Aquaculture Alliance (GOAL) (2018) Global shrimp production review and forecast.



Sustainability challenges

Faced with a growing global population but finite natural resources to call upon there is an urgent need to increase the productivity and efficiency of aquaculture, creating a healthy and sustainable source of protein.

Top business critical risks in shrimp production — key environmental, economic and ethical concerns and challenges

Disease

There are significant mortalities resulting from episodes of current and emerging disease challenges. On average 40% of shrimp production is lost to disease.

Genetics

There is a need for quality seedstock and access to disease free broodstock.

Food safety/antibiotic use

There is a need to ensure that products are antibiotic free. Hotspots of antibiotic use in shrimp production can accelerate development of antimicrobial resistance (AMR) and increase export risks.

Pollution

Major environmental issues include the pollution of waterways with pond effluents, chemicals and medicines, soil and groundwater salinization.

Shrimp feed

Wild fish is often processed into fishmeal and incorporated into shrimp feed. There is a requirement to replace the high volume of fish meal needed in diets in a cost effective way.

There are also issues related with feed quality. The long-term expansion of aquaculture requires sustainable and scalable supplies of alternative feed ingredients.

Biodiversity loss

There has been extensive mangrove deforestation in the past for growing shrimp. In some countries mangrove clearances are now banned.

Employment opportunities and livelihoods

Local poor communities sometimes may not benefit from the profits of shrimp farming bringing social imbalance.

There are a number of groups promoting socially-responsible farming.

Welfare

Eyestalk ablation remains the major welfare concern. Ablation in shrimp production is the removal of one (unilateral) of a broodstock females eyestalks.

Stocking density in intensive production is often overly high. High stocking densities contribute to disease problems.

Education

There is a need for technological improvement of farming methods which requires considerable efforts in education and technology transfer to farmers.

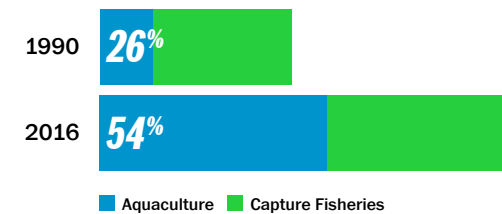
Sustainable food production is one of the biggest challenges today



Aquaculture plays a big and increasing role in meeting the global protein demand.

World production of shrimp: capture fisheries & aquaculture

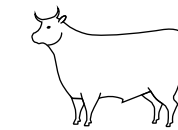
Aquaculture accounted for 54% of world shrimp supplies in 2016.



Sources: FA O(2018) and GOAL (2011-2018). China includes freshwater production of *P. vannamei*.

A good FCR

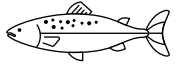
Aquaculture has a lower feed conversion rate (FCR) than that of terrestrial animals.



1kg Beef



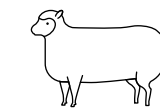
3.5-9.0kg



1kg Salmon



1.1-1.3kg



1kg Sheep



4.0-6.0kg



1kg Shrimp



1.1-1.9kg



1kg Pork



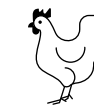
2.6-4.4kg



1kg Bass



1.3-1.6kg



1kg Poultry



1.4-1.8kg



1kg Tilapia



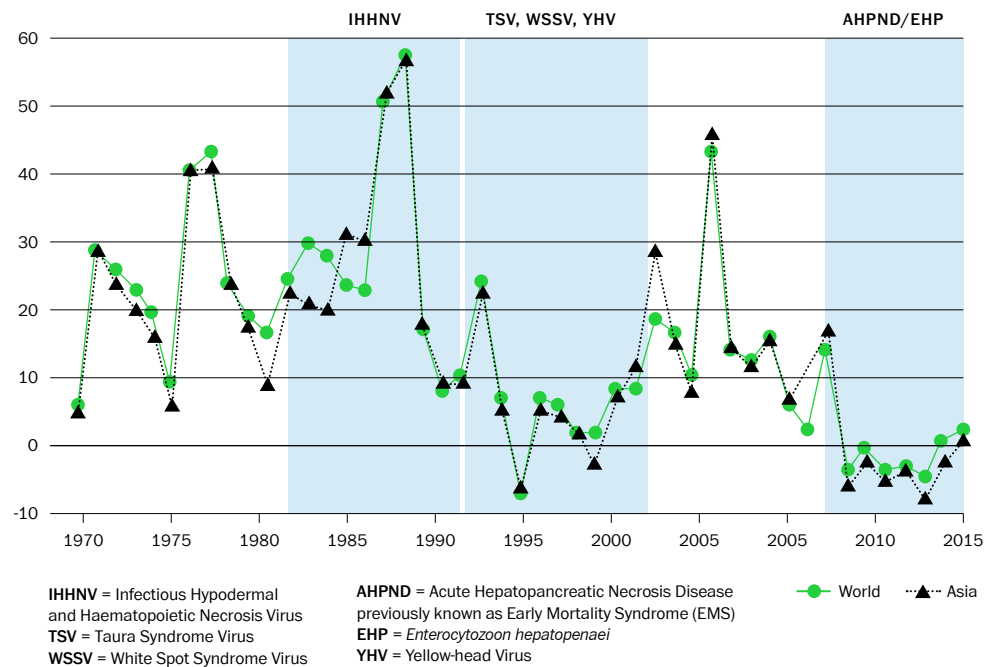
1.2-1.6kg

Source: Rabobank 2018.

Disease is one of the industry's most limiting factors

Disease constrains growth

The graph below shows the percentage year-on-year change in the growth of Asian and global shrimp production. Episodes of disease have been a key factor in shaping growth.



Source: Shinn et al. (2018) Asian Fisheries Science, S31, 210-255.

Top three disease challenges in shrimp

WSSV*

White spot syndrome virus (WSSV) is a large DNA virus that only infects crustaceans; it is an OIE (the World Organisation for Animal Health) listed notifiable disease.

Signs/symptoms: In culture systems, the shrimp may not show any distinctive signs but may be lethargic, stop feeding or begin aggregating at the edge of ponds. Clinical signs can include the presence of white calcium deposits up to 3 mm in diameters which can link to form larger plates, shrimp can appear dark with a red/pink colour to the body and appendages, may have heavily fouled gills and external shell, and, heavily infected shrimp may have a white midgut.

Losses: Infections can result in a typical 40% loss of stock over the first two years of infection on site; historically, this is the most significant pathogen impacting on commercial crustacean production.

* White spot syndrome virus — the top viral agent.

† Acute hepatopancreatic necrosis disease — caused by pathogenic isolates of *Vibrio parahaemolyticus* (and other species) bearing a *Pir* toxin releasing plasmid — the top bacterium.

‡ *Enterocytozoon hepatopenaei* — a fungal microsporidian causing hepatopancreatic microsporidiosis — top parasite.

AHPND†

A pathogenic isolate of *Vibrio parahaemolyticus*, a rod-shaped bacterium, that carries a plasmid encoding two toxins that results in AHPND. This disease is commonly called 'early mortality syndrome' or 'EMS' by farmers. Infection resulting in AHPND is also an OIE listed disease.

Signs/symptoms: Infection results in significant shrinkage of the hepatopancreas and the shrimp frequently have soft shells and guts with discontinuous contents or no content. Early signs of an infection include slow growth, a shrunken, pale hepatopancreas.

Losses: Infections can result in entire loss within 30 days. Infection resulting in AHPND is currently the number one bacterial pathogen problem within the global shrimp industry.

EHP‡

EHP infects the hepatopancreas of shrimp which can result in severe growth retardation, morbidity and, in heavy chronic infections, mortality.

Signs/symptoms: Although shrimp continue to feed, there is arrested growth; a drop in food conversion ratios (FCR) may provide the first indication of a potential EHP infection.

Losses: While mortality rates may be low, the farmer's decision to prematurely harvest may be based on farm production economics.



Image: WSSV infection in shrimp carapace.

At least **US\$ 45 billion** was lost to shrimp diseases in whiteleg shrimp (*P. vannamei*) production alone over the past decade and is the biggest barrier to sustainable production.¹

¹ Shinn et al. (2018) Asian Fisheries Science, S31, 210-255.

Scale of the problem

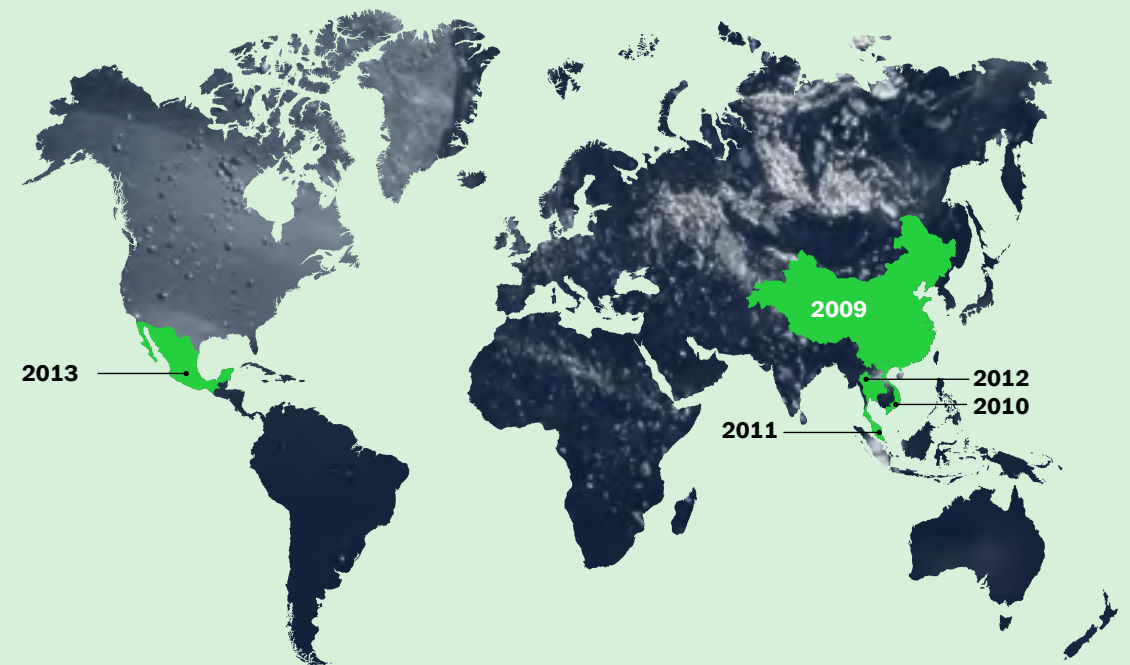
AHPND hit Asia hard in 2009, firstly in China, then Thailand and Vietnam. In Thailand as an example, production of whiteleg shrimp in 2010 was close to 600,000 tons which subsequently crashed to 189,000 tons. Losses up to 2017 were in the region of US\$ 7 billion but closer to US\$ 11 billion if you take into account for losses in feed sales and value added product through export.

Across Asia the losses due to this one disease were approx. US\$ 45 billion (assuming the same levels of production could have been sustained).

The industry responded well and have done well to manage AHPND but outbreaks and losses still occur. This bacterial disease is now causing major problems elsewhere in Asia for example, in India.

In Thailand, the main concern is now EHP – which causes shrimp growth to arrest. Mortalities result from chronic infection; calculating precise losses is difficult but for Thailand these are estimated to be in the order of US\$ 180 million per annum.

Figure 1: Geographical distribution of (EMS/AHPND) in the world



Setting a new benchmark for shrimp welfare

Eyestalk ablation, or removal of the eyestalk, to manipulate hormone synthesis making egg production more predictable and efficient is common practice in shrimp hatcheries worldwide.

With global aquaculture under increasing pressure to improve animal welfare standards. Sourcing commercial strains of non-ablated shrimp is high on the list of priorities for producers and retailers as consumer demand for higher welfare seafood grows.

Growing consumer demand for higher welfare products

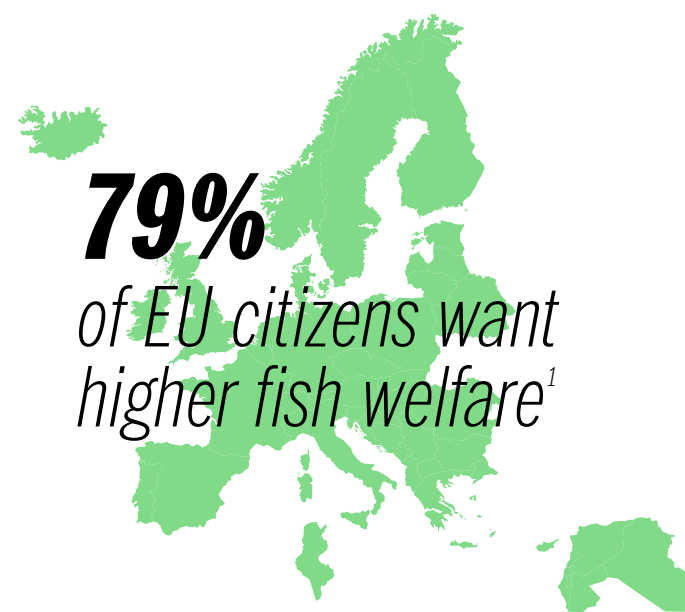
The idea that the welfare of shrimp and prawns would one day receive similar recognition to other farmed species was once considered unlikely, but influential organisations like the FAIRR Foundation and the Business Benchmark for Farm Animal Welfare (BBFAW) are leaving no stone unturned in the drive for greater transparency and action on sustainability throughout the food chain – reviewing and ranking FTSE companies right through to upstream suppliers and producers. While the power-spending customers of tomorrow (millennials and generation X & Z) are seeking out products that give solid assurances across a range of sustainability factors, including animal welfare and are quick to reject brands that fall short on their sustainability pledges.

Leading challenge for EU retailers

Retailers are taking note and, when it comes to shrimp and prawn products, the quest for non-ablated shrimp is a top priority.

The practice of eyestalk ablation has been used in global shrimp production since the 1970s to offset the effects of captive conditions which can prevent females from developing mature ovaries, and cause unpredictable egg production.

Removal, or the ablation of, one of a shrimps eyestalks reduces the levels of a hormone that prevents reproduction, ensuring shrimp mature on a regular basis, making egg production more predictable and efficient. It is now common practice in shrimp hatcheries worldwide to ablate one eyestalk (unilateral ablation) of the female broodstock.



¹ ComRes (2018) EU citizens and leading fish stakeholders demand better welfare for fish.




A welfare concern

A number of studies indicate it is highly likely that ablation causes pain and stress. Studies noted behaviours associated with pain such as flicking, non-sheltering, recoil and disorientation^{1,2}. Moreover, experiments using local anaesthetics prior to the ablation process show an inhibition of various responses associated with the presence of noxious stimuli akin to those observed in vertebrates, suggesting that crustaceans can indeed experience pain during the ablation process¹.

Public concern about the practice led to the European Commission introducing organic standards in 2009 that prohibit ablation. Some food retailers have also started to report the percentage of their shrimp supply coming from non-ablated broodstock in efforts to improve transparency.

Someone with first-hand knowledge of the demand for non-ablated shrimp is Ruth Layton, co-founder of Benchmark, who has been working with blue-chip companies to drive improvements in the food chain for over three decades.



Ablation in the shrimp industry has been on the agenda of retailers in the UK and Europe since the 90's. It's encouraging to see several high-profile retailers now include information about ablation in their public reporting and others looking to source non-ablated shrimp. 

RUTH LAYTON
CO-FOUNDER OF BENCHMARK

¹ Barr et al. (2008).

² Diarte-Plata et al. (2012).



Business case for an alternative

While ablation may raise ethical concerns over crustacean welfare, there is also a strong economic argument for commercial producers to look for alternatives to a process that can increase energetic demands and result in a loss in egg quality and larval mortality. Although eyestalk ablation is still the most effective means of ensuring a steady supply of juvenile decapods for the crustacean aquaculture industry, it appears that some species can be effectively produced in captivity without resorting to ablation.

A collaborative study between the University of Stirling (UK), Lyons Seafoods (UK) and Seajoy (Honduras)¹ evaluated the reproductive performance of non-ablated *Panesus Vannamei* and the quality of their offspring under commercial conditions.

Spawning and hatching rate per day were similar between non-ablated and ablated females. Mating success, mortality of female and number of eggs and nauplii per tank per day of non-ablated group were significantly lower than ablated female. The number of eggs and nauplii per female per day, however, was higher in non-ablated than ablated females. In addition, the off-spring of non-ablated females had significantly higher survival to salinity stress test than larvae from ablated females. Identical survival, final weight, weekly growth, feed conversion rate and yield were observed in nursery and grow-out stages. Overall, the study demonstrated that non-ablated females can have comparable level of productivity to ablated females in intensive commercial hatchery conditions.

Meeting growing demand

Geneticists at Benchmark first started trialing rearing non-ablated females in 2008 and this is now standard practice across several of their sites. At Benchmark's multiplication site in Florida, the team receive the grandparent stock from the hatchery in Colombia and produce crosses which are then sent to Benchmark sites overseas and direct to farmers.

The team have conducted commercial-scale trials assessing the production parameters of their non-ablated stock.

Oscar Hennig, Operations Director, Benchmark Genetics, commented:

“Our trials comparing ablated and non-ablated shrimp allowed us to quantify the production parameters, including understanding how much nauplii to expect from a non-ablated female.

Whilst we have seen a consistent 30% reduction in nauplii production, this is offset somewhat by a higher survival during larval rearing in offspring of non-ablated stock. We have found that non-ablated females tend to have a longer life reducing the total number of breeders needed and require a lower female-to-male ratio.”

Hennig explained there is no need to change any protocol at the hatchery but that additional training may be required for technicians to navigate new husbandry requirements. For example, non-ablated females are quicker to respond which can make them slightly harder to catch.

The Benchmark team are further refining their non-ablated lines to enhance productivity and improve nauplii, while maintaining health and welfare. Feeding also has an impact. High-quality supplementary moist feeds, particularly in the pre-maturation stage, improves condition and performance and is highly correlated with egg production.

Layton visited the facility in Colombia to see the work first-hand.

“I saw the dedication of the team and the care they have for the shrimp. Speaking to them and watching them work, it was clear they were relieved they no longer had to carry out the ablation process.”

Layton concluded, “The next step for the team is to verify the quality parameters such as egg lipid content, survivability etc. in order to help further strengthen the case for non-ablation.”



I saw the dedication of the team and the care they have for the shrimp. Speaking to them and watching them work, it was clear they were relieved they no longer had to carry out the ablation process.

RUTH LAYTON
CO-FOUNDER OF BENCHMARK



Expert insights

Hear from professionals working across the industry on how their work is driving sustainability in shrimp production.

A sea of opportunity



INTERVIEW WITH
PHILIPPE LÉGER

Philippe Léger, former CEO of INVE Aquaculture (INVE)*, the pioneer of advanced nutrition products, explains how he entered the aquaculture industry in the 80's. The mission to produce protein that will support a growing population is what inspired Philippe at the outset, and still does today.



Can you start by explaining your background, and how you started working in the aquaculture industry?

I graduated in 1978 with an MD in Pharmaceutical Sciences and was invited to study further for a PhD in virology, toxicology and organic pharmaceutical synthesis. I did, however, choose to do something 'different'. I enrolled for an MD in Environmental Science and Management. In classes on mariculture – where I first learned about aquaculture – I met Patrick Sorgeloos as a captivating teacher who is now referred to as the 'father of Artemia'. He invited me to undertake a PhD on the application of Artemia as a food source in aquaculture.

Aquaculture at that time was a very small and emerging industry that really fascinated me for its potential of radically changing the way seafood could be produced in a sustainable way. Already at that time overfishing and pollution of oceans was in the news.

During my PhD there were a number of interesting things we discovered as a team of young bioengineers and biologists. Our findings motivated us to set up a spin off from the University of Ghent and in 1983 the company was incorporated as Artemia Systems (now INVE).

Our pioneering work stemmed from our scientific findings and ideas. Translating them into technical products that were of interest to solving some biological hurdles faced by the aquaculture industry under development. At that time hatchery production of shrimp and fish fry was the bottleneck for the growth of the industry. Alongside this we worked to specify and improve the quality parameters of artemia as a hatchery feed and developed a number of products that we still sell today as artemia and live food enrichment diets.


What drives you on a daily basis?

What drives me today is the same as what drove me at the outset. I was thrilled that there was a new industry emerging and one that was holding a big promise in feeding the world with healthy seafood. I believed that I could make a bigger impact in aquaculture rather than in the crowded pharmaceutical business. Today the seafood challenge has not diminished with the population growing faster than was predicted 40 years ago.

It was thrilling and truly inspiring to work closely with the pioneers of shrimp and marine fish aquaculture. We learnt and understood the challenges they were facing, and developed products and technologies that could help to solve them.

The industry still faces many challenges so the same aspect of working closely together with customers, forging strong partnerships and product development is a stimulating driver for us. Contributing to the success of this promising industry has driven me for nearly 40 years now.



Not being discouraged when 'the going gets tough' ...only then 'the tough gets going'! I'm a strong believer of this attitude. Never give up. 

PHILIPPE LÉGER

What are the challenges you see for the industry in the next few years?

The aquaculture industry is still very young and faces multiple challenges. One of the biggest I would say is the consistency and predictability of outputs and volatility in the industry due to disease, along with antibiotic use, use of water resources, cost of raw materials, animal welfare and climate change.

Volatility in market prices is a big challenge we are facing today and the lack of equilibrium and distribution of profits in the value chain is an issue.

I believe that all of these challenges can be addressed through research efforts like Benchmark is doing and other partners in the industry – working together is the answer to all of these.

Not being discouraged when 'the going gets tough' ...only then 'the tough gets going'! I'm a strong believer of this attitude. Never give up.



Pioneering genetics

Marcela Salazar, Benchmark's shrimp production manager and one of the pioneers of shrimp genetics, explains how shrimp breeding programmes have evolved and outlines future opportunities with the introduction of new technology.

Can you tell us a little bit about yourself and what inspired you to become involved in shrimp genetics?

I'm a medical doctor by training, but I've always preferred research over clinical practice. I was trained in immunogenetics in Boston, where I worked on projects that included designing new methods for histocompatibility testing in bone marrow transplantation. When I got back to Colombia, I joined CorpoGen, a biotechnology company that was pioneering molecular biology research in Colombia.

Getting into the world of shrimp was an accident — inspired by the appearance of white spot syndrome virus (WSSV) on the Pacific coast of Colombia in 1999. At the time CENIACUA (The Center for Aquaculture Research in Colombia) asked Corpogen to implement the PCR diagnostic test for the pathogen and to help in the prevention and control of this virus.

I was involved from the beginning and found a new, exciting field with an excellent team of young researchers. I was hired as scientific director of CENIACUA in 2000 and since then I have been researching shrimp diseases and genetics.

What impact did becoming part of Benchmark have on your shrimp breeding programmes?

Becoming part of a big company that, from the beginning, believed in the potential of our shrimp was exciting. As CENIACUA we were mainly focused on achieving the breeding goals but did not have the resources to commercialise the product. As part of Benchmark we are focused on producing the best animals for the market conditions, using state-of-the-art technology and facilities, and on selling them to our customers, all within the scope of sustainability.

Being part of Benchmark also means we can count on the support and collaboration of other parts of the group, such as Morten Rye and his team at Benchmark Genetics; Oscar Hennig, Bruno Decock and the team in Asia, who are doing an incredible job of showing the potential of our animals under trials and commercial conditions; and working with INVE (Benchmark Advanced Nutrition) to create a synergy between genetics and nutrition that will help both companies. Learning from the experience of other breeding programmes has enriched ours enormously too.

I'm also proud to be working with one of the best teams you can find — we've been working together for many years and have people with experience in all fields of shrimp breeding. We are a multi-disciplinary team with

experience in plant breeding, veterinary and human medicine, biology and genetics, which is important when dealing with shrimp — they always like to have the last word and the last laugh.

What facilities do you have at your disposal?

Our main laboratory is located on the Atlantic coast of Colombia, near Cartagena, and is isolated from all other aquaculture facilities in Colombia. The climate is optimal for the growth of *P. vannamei*, and we have plenty of space to expand and produce the number of broodstock required by the market. We also have access to a laboratory on the Pacific coast of Colombia where we can work with a white spot resistant strain without compromising the biosecurity of the breeding nucleus. Meanwhile our challenge test facilities are located in Bogotá, more than a 1000 km from the breeding nucleus, allowing us to safely work with pathogens that are exotic to Colombia.

What areas are you currently focusing your research on?

We are currently introducing genomic selection for resistance to WSSV and acute hepatopancreatic necrosis disease (AHPND) in our populations. Our priority is to produce clean, safe, specific pathogen-free (SPF) animals with high growth potential, but these must also be resistant to pathogens and adapted to environmental conditions.

What achievements are you most proud of in the shrimp field to date?

We're very proud of having been able to keep the breeding programme going during very hard times. In terms of academic achievements, we described the effect of hyperthermia in WSSV infection, we showed that apoptosis is part of the antiviral shrimp response, we identified the negative correlation between growth and WSSV resistance in *P. vannamei* and we have been able to produce robust shrimp with high growth potential.

Is the commercial shrimp sector increasingly interested in the power of genetics?

Yes, although selective shrimp breeding is relatively recent compared to other species such as salmon, the market for broodstock has been steadily growing. The most reliable data on the export of genetically improved *P. vannamei* broodstock comes from Hawaii, home to some of the main breeding programmes in the US. It shows that, from 2003 to 2015, the numbers of broodstock increased from nearly 100,000 in 2003 to 800,000 in 2015. In 2017, the export value was nearly US\$ 30 million. There are also several breeding programmes in Asia that are growing year by year.



What is specific pathogen resistant (SPR)?

SPR shrimp refers to genetic characteristics that allow them to be resistant to infection from a particular pathogen or tolerant to the development of the disease caused by a particular pathogen.



What are the key traits sought by shrimp producers – both in your region and globally?

The main trait targeted by shrimp producers in all regions is growth – we all need an animal that grows fast. In Latin America, the widespread use of large earthen ponds means that robustness is also a priority. In recent years, after several outbreaks of disease, Asia has also been looking for animals with high survival, making it a very interesting market for our SPF/SPR animals. The key lesson here is that one size does not fit all. We are developing different lines – for example, early growth, low salinity and WSSV-resistant – that can be distributed to different environments and culture conditions.

Can you explain the difference between SPR, SPF, SPT and APE shrimp?

Let's start by classifying the four terms into two different groups: a) SPF and APE and b) SPR and SPT. The first group is based on the sanitary status of the breeders. Specific pathogen-free (SPF) animals are those that have been tested and determined to be free of designated pathogens. Under the guidelines established by USMFSP, SPF shrimp stocks must come from a population that has tested negative for

specific pathogens for at least 24 months and must be raised in highly biosecure facilities, following biosecure management measures, with a suitable surveillance programme in place that uses both molecular and histopathological tools. The key term here is 'specific' – SPF does not mean they are free from all pathogens, so the relevant pathogens should always be listed. On the other hand, APE (all pathogens exposed) is a term used to describe animals that have been raised in ponds or tanks where they have been exposed to one or more pathogens – either via challenge tests or under culture conditions. The term is misleading because the animals will never be exposed to all pathogens, but is the term used at the moment. Those animals can be carriers of the pathogens and are a risk for transboundary movements.

The second group of terms, specific pathogen resistant (SPR) and specific pathogen tolerant (SPT), refer to way the shrimp deals with the pathogens. Resistance is defined as the ability to limit parasite burden, in other words to fight the enemy. Tolerance, on the other hand, is the ability to limit the damage caused by a given parasite burden – in other words, to live with the enemy. There are two different types of defence against pathogens present in plants, invertebrates and vertebrates and both mechanisms can even be negatively correlated. In shrimp literature there is

a misconception that resistance is a qualitative trait and animals are either resistant or susceptible, while tolerance is a quantitative trait with different degrees of tolerance that can be affected by the environment. In reality both traits are qualitative, and both can be affected by the environment. It is very difficult therefore to say if a given line is resistant or tolerant and the market is using the term SPR/SPT. As for SPFs, if a line is marketed as SPR or SPT it should list the pathogen(s), they are resistant or tolerant against.

What are the main challenges the shrimp sector needs to overcome and which of these would you most like to have a role in solving?

The main challenge for us is to produce a fast-growing shrimp that is not only resistant to pathogens but is also resilient under commercial culture conditions. Growth in shrimp has a very good heritability and is very easy to select for. However, the negative correlation of these traits with resistance to some pathogens, such as WSSV, and with environmental conditions, such as low oxygen levels, makes our work more interesting and challenging. It's a question of how to increase growth rates without increasing mortality levels.

*The numbers of
broodstock increased
from nearly*

100,000
in 2003

to **800,000**
in 2015



Adopting new technologies



INTERVIEW WITH
NONGLAK 'ANNE'
THAISIN

Nonglak 'Anne' Thaisin, founder and CEO of Quality Farm, has been producing vannamei shrimp in Thailand for 27 years. Here she explains how adaptability and the development of new production systems as well as new feeds and health products is essential to maintaining sustainable production.

What inspired you to start producing shrimp?

Before starting my own shrimp business, I worked at the government's revenue department. One day, while on the bus to work, I heard people talking about how successful a shrimp farmer was in Kanchanadit District. After a good harvest this farmer had made 400,000 THB profit per pond, which, at that time, was very impressive. This made me want to try growing shrimp and I started by renting a small six pond farm with help of a bank loan. After a successful harvest I was able to use the profit to open a store distributing aquaculture-related products.

Three years later I resigned from my government job in order to focus full time on the shrimp industry as an aquaculture product distributor and shrimp farmer. I'm now producing about 280-330 tonnes of shrimp per year.

What have been your hardest challenges to overcome so far?

Shrimp farming is a never-ending learning path. Challenges such as disease and shrimp prices are a farmer's daily concern and evolve and change frequently. This makes us need to constantly monitor and analyse situations, think about solutions and quickly adapt to these evolving challenges.

Compared to when I first started, shrimp farming is getting more and more difficult, due to the increased frequency of new diseases and combination of diseases, such as, acute hepatopancreatic necrosis disease (AHPND), *enterocytozoon hepatopenaei* (EHP), white faeces syndrome (WFS) and shrimp hemocyte iridescent virus (SHIV), as well as challenges related to environmental pollution.



What has been your proudest moment as a shrimp producer to date?

My proudest moment was when I produced 330 tonnes of premium quality shrimp in a single year. These shrimp were large, attractively coloured and met both GAP 2011 and BAP 2019 production standards. I'm proud that our shrimp are attracting buyers from the European market.

How important are diets in ensuring the consistency and quality of shrimp production?

The quality of the feed is extremely important and many factors affect the quality, such as the size of the feed particles, palatability and smell, stability in the water, the protein content and nutritional profiles. If the feed is correct it helps us reduce the feed conversion rate (FCR) and thus maximise profitability and the consistency of a diet is vital too.

Good feed also helps keep our workers motivated, as they recognise particular brands for quality that brings them success in production. At the end of a production cycle it is the workers who request to use a particular brand for the next crop.

Why did you decide to start using INVE's advanced nutrition products?

First of all, INVE is a trustworthy company and known to be reliable. Since starting to work with them I've been producing shrimp successfully, and their products have helped me to prevent and solve the main production challenges, such as white faeces syndrome (WFS), early mortality syndrome (EMS), environmental pollution and vibriosis. Being a distributor of aquaculture products, I've wanted to share my experience and recommend and encourage my customers to use INVE products in order to be as successful as me.

Which ones do you use and why?

In terms of feeds I use the Sano S-PAK range as well as FRiPPAK Raceway, as I don't have a nursery at my farm but stock the post-larvae directly from the hatchery to the grow-out farm. This means the shrimp are small when first stocked into the grow-out ponds and would otherwise struggle to find feed due to the strength of the currents from the paddle wheels as well as the size of my ponds. The S-PAK range is therefore very important at the early stages, as its high quality protein content makes it very enticing as well as giving it good water stability. This product is very complete in terms of nutritional value but will also boost their health since it contains immune-enhancer (not provided in regular starter diets).

FRiPPAK Raceway has very suitable pellet sizes for the early stages of shrimp culture. It has the most complete nutritional profile for good shrimp growth, particularly at the early stages when the growth rate is the highest.

How do you help to ensure the health of your shrimp and maintain suitable water quality in the pond?

Firstly analysis is done, based on visual observation compared to optimum health standards and experience in shrimp production. This analysis is done on the feed tray, by observing shrimp behaviour, their colour, the content of the gut, their shape, the faeces and the leftover feed in the tray.

Additionally, we sample the water and the shrimp once or twice a week and these samples are then analysed in a lab. These tests will help to check the water quality as well as the shrimps' biological condition and we screen for pathogens (such as

bacteria, viruses and microsporidia), conduct intestinal checks and histopathology and check the water chemistry.

Once we have the analysis reports from both the lab and our on-site visual observations, we will take actions accordingly and fine-tune our production protocols if necessary.

For example, if we see a rise in vibriosis count in the environment over time, we will use INVE's Sanocare PUR to disinfect the water, in order to reduce the concentration of vibriosis in the environment. Six hours later we will apply Sanolife PRO-W, INVE's Bacillus-based probiotic, which is designed to improve rearing conditions in the pond (degrade waste and control algal bloom). As a consequence of improved rearing conditions, the abundance of harmful bacteria is reduced.

How do you choose which products to be used in each pond?

There are countless health products in the market, for a wide range of prices and I choose them based on their value and returns. Some might appear expensive but are actually helping improve farm condition, performance and profitability.

Another important point is their ease of use. For instance, Sanolife PRO-W environmental probiotics are highly concentrated (5x10e10 CFU/g) and do not require fermentation. As the product can be directly applied to the water there's no risk of cross-contamination, unlike those that require fermentation. When applying it in the pond we are sure about what is going into the environment and get the results expected: control of harmful bacteria, a reduction of pH fluctuations and the creation of an optimum environment for the shrimp throughout the culture period.

How has optimising your feed and health strategies affected the performance of your shrimp ponds?

Optimising our feed management and health protocols have helped us achieve a consistent and sustainable level of production, which helps us manage our cash flow. It has also reduced the risks of challenges such as disease outbreaks and our shrimp now have a consistent growth rate.

In our farm area in Surat Thani, for example, white spot syndrome virus (WSSV) outbreaks are very common, but our farm has managed to avoid infections from WSSV by using smart disinfectants and probiotics to increase biosecurity. Besides WSSV, WFS has been adversely affecting the zoo-technical performance of the farms in the area for about two years. We have also seen this syndrome but only 10-15 per cent of our shrimp are affected and we can still control production until the shrimp reach our target harvest size, which tends to be between 15-25g, depending on market demand. Other farms in the area have had to harvest prematurely when hit by WFS.

How would you like to see your own farm develop?

Shrimp farming relies on the surrounding environment. Using products that are not environmentally friendly and safe can reduce the sustainability of the whole shrimp industry. Our farm will therefore develop in an environmental friendly way to ensure the sustainability of the industry.

Our farm only uses registered products that are safe for the environment and our production methods have to be sustainable – for example, minimising the release of waste water and treating it before release. Safety for the workers must also be considered.

How do you think INVE can help you achieve your goals?

By continuing to supply top quality products following good standard manufacturing processes. Continuous development of such products and services to answer farmers' needs in a sustainable way will definitely help our shrimp business too.


How do you see the shrimp sector as a whole developing over the next decade?

Shrimp farming will become more difficult every year. Problems and challenges such as diseases, shrimp prices and regulations will affect production. Added to that, global competition is getting tougher, which also has an impact on the business.

The environment is deteriorating and water and soil are getting more and more polluted. Shrimp farming must therefore constantly evolve and new farming and production methods (such as indoor farms, nurseries and zero-water exchange systems) should be studied and evaluated to overcome future challenges.

Another key factor for the successful future of the shrimp industry is the ongoing genetics work: improvements in disease resistance, growth rates and the adaptability of shrimp to changing environmental parameters will be another factor needed for the sustainable development of our industry.



Shrimp farming must constantly evolve and new farming and production methods should be studied and evaluated to overcome future challenges. 





Penaeus vannamei is
the leading farm-raised
species, representing
~80% of production¹

¹ California Environmental Associates (CEA). (2018) Shrimp
Aquaculture Landscape report prepared for Gordon and Betty Moore
Foundation's (Moore) Ocean and Seafood Markets Initiative (OSMI).

Insight into disease challenges



INTERVIEW WITH
ANDY SHINN

Andy Shinn is Director of Fish Vet Group Asia, and a world renowned aquatic parasites expert. Here Andy explains why disease challenges in shrimp production is one of the industry's most limiting factors.

Can you describe your career and experience to date?

I have 30 years' experience of working with aquatic parasites and hold a PhD in Veterinary Aquaculture. Before joining Benchmark, I was the former head of Aquatic Parasitology and senior lecturer at Stirling University.

I joined Fish Vet Group (FVG) in Asia five years ago, where I set up a research aquarium and challenge facility in Chonburi to conduct disease challenge work.

What activities are you currently involved in, and how does your work contribute to the sustainability of the sector?

We now have three labs in Chonburi, Thailand and I assume the management of these. Our core activities include disease challenge work on whiteleg and tiger shrimp, Nile tilapia, Asian sea bass and grouper where we create environments for different bacterial and viral pathogens to trial our health and nutrition products and vaccines.

I also play a role in the development of cPCR diagnostic kits for shrimp, which is a piece of technology that we have been using in the salmon industry for some time to provide quick real-time analysis of disease outbreaks. We are trialing these cPCR kits as part of a project aiming to improve health management in shrimp farms in Thailand in collaboration with IDH – the Sustainable Trade Initiative, the Walmart Foundation and the Sustainable Fisheries Partnership (SFP).

As well as testing new products and identifying disease, another area of my work is to understand some of the factors that contribute to episodes of disease. We have, for example, through a series of published trials looked at biofloc and tilapia-conditioned greenwater on AHPND related mortalities in whiteleg shrimp.

Disease and chemical use is a huge challenge not only for the shrimp industry but for global aquaculture and if we are able to develop preventative solutions to mitigate disease and reduce chemical and antibiotic use this is a good step forward for the industry.



We stand on the edge of a great sea of possibilities, with the right tools we can glide across it or without them remain on the shore wondering what opportunities may have been missed.

ANDY SHINN



Can you describe the current major disease challenges in production?

The top three disease challenges in shrimp are white spot syndrome virus (WSSV), acute hepatopancreatic necrosis disease (AHPND) and *Enterocytozoon Hepatopenaei* (EHP).

The main threat of disease challenge is man — the Asian shrimp industry has a mindset that must change. This includes taking responsibility for the health and welfare of the stocks in their care.

In a cultural context, this can be complicated and while it perhaps unfair to overgeneralise, the following factors may contribute to increased rates of certain diseases:

Farm management

The vast majority (ca. 80%) of Asian shrimp farms are of a small size which means that farm budgets are limited. In many states there is no mandatory disease testing of shrimp leaving hatcheries or being added to ponds.

Biosecurity

The scale of culture systems are such that the implementation of biosecurity measures are either physically difficult or expensive.

Water management

There is a vast range of farm systems in operation from open, extensive through to intensive, closed systems — for those sharing common water sources (e.g. rivers and lakes), the challenges of maintaining biosecurity are greater as good site health is in part also dictated by the level of biosecurity practiced by a farm's neighbours.

Health surveillance

The general rate of health surveillance of stocked populations is low — many governments offer a free diagnostic service which somewhat arguably shifts some of the responsibilities of health management; in many states there are low, or in some states there are no stock movement records. There is also no compulsory destruction of diseased stocks which means the probability for pathogens to persist and to spread is higher.



Biofloc

Biofloc in intensive closed culture systems is favoured, as organic material can be recycled by microorganisms to help break down waste and hazardous products (i.e. waste feed, faeces, nitrogenous compounds) into non-toxic substances and into aggregates of a protein-rich organic material consisting of bacterial biomass, microalgae, faecal material, protozoa etc., that can be consumed back as additional protein and feed by the shrimp.

Interestingly, research showed significantly lower levels of mortality when we challenged whiteleg shrimp with a pathogenic isolate of *Vibrio parahaemolyticus* causing AHPND held in biofloc or in greenwater taken from systems in which tilapia had been cultured. Such trials give us greater insight into the culture conditions facilitating to disease outbreaks but, more importantly, how we might manage and control them.

Image: Fish Vet Group team in action on shrimp farm in Thailand.

How is the industry working to tackle the disease challenges?

There are a number of preventative management initiatives that have helped to reduce the challenge of disease such as:

- **Lining of ponds** with polyethylene liners
- Installation of **shrimp toilets** to collect and remove faecal waste uneaten feed, moults etc
- **Better pond bottom management** through the use of toilets and by observing the distribution of sludge following the draining of ponds and then redeploying aerators to ensure proper pond bottom cleaning
- **Cleaning and maintenance** of liners
- **Water treatment**
- Installation of **crab and bird predator nets**
- Stocking with shrimp that have been **genetically selected** to be **more resistant to disease**

There is, however, much to do such as:

- **Greater awareness** of the routes of shrimp diseases
- **Disease testing** prior to stocking and throughout the production cycles
- Increased **biosecurity**
- Use of **functional feeds** that include ingredients that help promote general gut and shrimp health
- **Breeding** of specific pathogen resistant shrimp lines
- **Closed system farms** that are less susceptible to contamination and have effective on-site management.

Unfortunately farm production economics all too frequently overrides health and biosecurity management.

In another study we have been involved in, we looked at a number of factors, including the probability of a disease outbreak, the intensity of production and the investment in biosecurity measures. Perhaps not surprisingly, in systems with a low intensity of production with no or low biosecurity, there are high probabilities of disease outbreaks, but these losses are generally low when outbreaks occur.

By comparison, for systems with high intensity production and with high levels of investment in biosecurity, there are low probabilities of disease outbreaks, however, the losses can be extremely high when disease events do occur.

Do you think we will ever eradicate any of the major disease challenges?

No, a vision of eradication I think is unrealistic.

In most cases, the key will be in the development of better management and control to minimise the magnitude and frequency of disease episodes and loss.

Some of the bacterial and viral agents are so ubiquitous in their infection, that their eradication is unlikely. The potential for viruses to mutate and for bacteria to acquire transposable disease elements which may change their current pathogenecities are also a concern.



What is a shrimp pond toilet?

A shrimp pond toilet is essentially exactly what it sounds like. A drain in the middle of a circular or square shrimp pond that is used to carry away excess solids and sludge.

As shrimp toilets are more expensive to install and maintain, they only really make sense in intensive, super-intensive and hyper-intensive systems where the capacity for a rapid build-up of shrimp waste (or uneaten feed) can prove toxic and dangerous to stock. This is why tracking ammonia is critical.

What diseases are on the horizon?

Predicting the unpredictable is a difficult question to answer but perhaps not impossible as history can help inform our future.

We can learn from our past experiences and, perhaps, where certain threats may arise and loosely in what form. There is, therefore, a need to be prepared and to have in place the tools for surveillance and for the early detection of new threats.

As global aquaculture operations continue to intensify, greater environmental pressures placed on viral and bacterial communities may consequentially lead to the emergence of new isolates with increased virulence.

With that said, we are aware of some more immediate threats such as shrimp hemocyte iridescent virus (SHIV) which is causing losses in China. Again we need to be vigilant and to ensure our programmes of surveillance include the necessary tests to detect this pathogen in any given population.


Where do you see the future?

I see more sophisticated whiteleg shrimp farms and management in the future. There will always be challenges in any biological system, however the implementation of new technologies and better management can help to reduce risks and create more sustainable systems.

There are a number of disciplines that I see as important in moving this forward.

- **Data** and the continued development of farm analytics which increases farm efficiency;
- **Genetic technologies** to breed stronger shrimp that are more robust and have a higher level of resistance to disease;
- **Diagnostic methods** with increased sensitivity, specifically detection of pathogens at lower levels which would thereby detect the initial stages of infection and simultaneous diagnosis of multiple diseases;
- **In-pond sensing** – the use of eDNA approaches to monitor the health of cultured populations and in the early detection of potentially pathogenic agents;
- **Improved welfare standards** in commercial production without the need to ablate an eyestalk of broodstock to stimulate maturation, and in humane methods of slaughter.



The implementation of new technologies and better management can help to reduce risks and create more sustainable systems. 

ANDY SHINN

Greater transparency
allows consumers to
make more informed
buying decisions



Better data management



INTERVIEW WITH
RALF ONKEN

Ralf Onken, Head of Software Development at Benchmark, explains the power of data to drive and demonstrate progress in the food chain.

Ralf's most recent project involves working with producers to manage key performance and sustainability metrics with the aim of creating more transparency and accountability in the shrimp farming sector.

How did you first get involved with data management?

I began my career writing software in the human healthcare industry to measure pain and infections and recognised the value that this created in assessing progress of treatment plans for patients.

I moved into the food production industry five years ago, where I started to work with major forward-thinking food producers to standardise their data capture and results for their key production measurements.

What are the key opportunities and benefits of using data tools in the food chain?

I believe data tools can serve two related goals: increase transparency and trust across the food chain, and help producers drive improvements on their farms.

Producers often use manual data sheets to record information for their farms by countries and regions. This means that information is often not stored in a single

area where the data can be analysed and put to use easily. This presents a major opportunity for us to help standardise, record, analyse, and share data in a way that will both drive well-informed action, create best practice and generate transparency and trust between different actors in the food chain.

I like to think that data provides a platform for more proactive thinking. By introducing data management tools to a food production system we remove the guess work out of farming, it becomes much more predictable over time and farmers can follow their data in 'real time' and act quickly.

Data offers the opportunity for producers, retailers and regulators to compare themselves to others, and to stand up and present evidence-based statements and stories about their results and outcomes, thus increasing transparency. Data and technology are empowering in this way, giving producers a level of control that they may not have had previously.

You mentioned changing behaviour, standardisation and sharing, can you explain a little more about this framework?

Changing behaviour is linked to the discipline of self-declared data. It is often a cultural change to train people to collect data and see the benefits it provides in improving production.

A practical example of this is the use of screening for particular diseases. In the shrimp industry we are working with producers using mobile diagnostic tools to identify diseases. This information together with environmental and production data such as temperature, salinity, dissolved oxygen, mortality, feed information, and growth data helps to build a picture of factors that could lead up to a particular disease outbreak.

Standardisation allows farmers to be measured and benchmarked against each other to help identify where key challenges as well as best practice may exist.

In some food production systems prophylactic treatment of antibiotics is often common practice. This means that medicines are used before there is a disease outbreak. This can increase the risk of antibiotic resistance developing. Through better recording and use of screening data, producers can begin to predict and prevent diseases, and thereby reduce their prophylactic antibiotic use.

Finally, and by far the hardest element is sharing. People are naturally cautious about sharing their data but once we show them the insights they can gain from recording and tracking it, they are able to see the benefits.

For me, the most important element is building trust with our clients, protecting their data and ensuring the outcome allows them to better manage and grow their business.

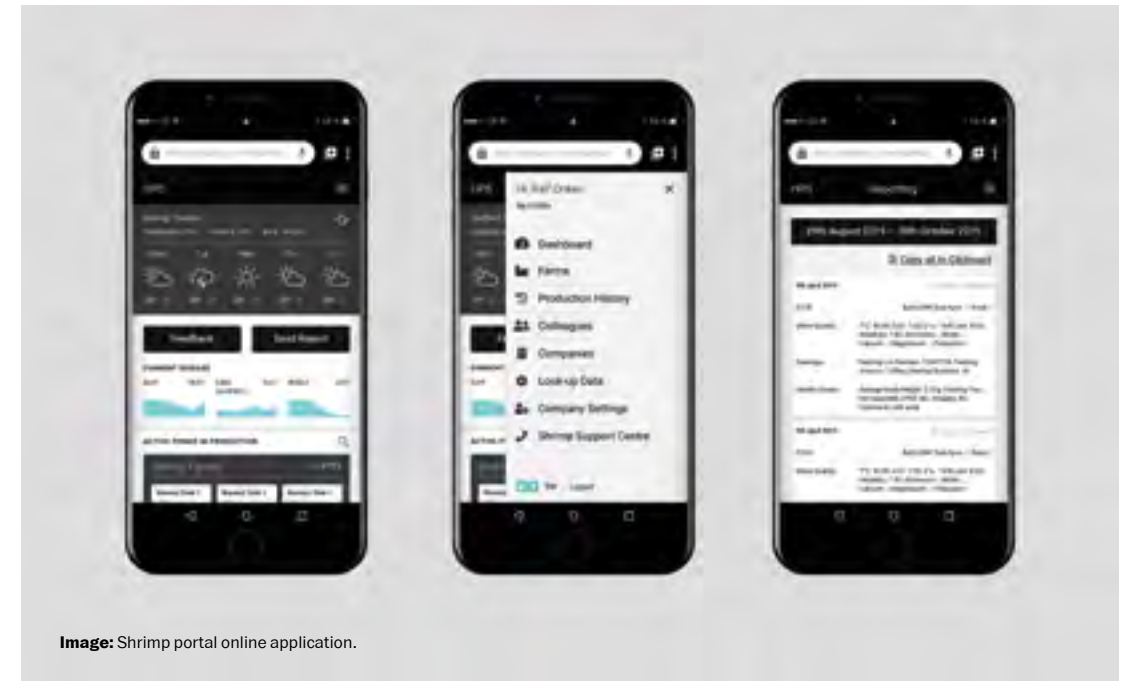


Image: Shrimp portal online application.



Putting the right tools in the farmers hands will give them the greatest control they have ever had over their stocks.

RALF ONKEN

Can you explain a little more about your work in the shrimp industry in Asia?

The project that I am currently working on is a collaboration with shrimp producers in the Chumphon, Surat Thani and Rayong provinces in Thailand. Together with the Sustainable Fisheries Partnership (SFP), IDH – the Sustainable Trade Initiative and the Walmart Foundation. We are developing management advice and tools that help farmers and the industry as a whole to reduce the potential impact of disease outbreaks through early warning systems.

The database that we have built collates information from multiple sources and builds related user interfaces for data input and data use /provision of advice to enable farmers

and industry managers to reduce disease outbreaks at individual farms and at the area-level through improved farm management and coordinated action.

Within the mobile shrimp diagnostic programme running in Thailand, we now have increasing farmer engagement and accelerating momentum. The efficient use of the right tools in analysing samples and data reduces the time factor in making critical decisions that otherwise cripple farm operations. These are user-friendly and simple in input but powerful in their output.

Putting the right tools in the farmers hands will give them the greatest control they have ever had over their stocks. The aligned use of mobile analytical tools now will help us all achieve the strategic velocity and efficiency needed in farm management and production.

It seems that there are a lot of benefits to using data in food systems, what are the challenges stopping it being used more widely?

Trust and transparency. It's hard to put your trust into something that is intangible. Once you've provided your data it is stored in a cloud, away from you, and sometimes this is hard for people to grasp.

But the data doesn't need to be shared with everyone and we give data owners the possibility to withdraw their data when they wish to — it is always within their control. It's important to develop a strategy about who to share the information with, highlighting the producers and organisations that are going to provide mutual benefits.

Benchmark's systems are based on transparency and we work alongside experts from Deloitte to independently check and validate the level of security.

Consumers and farmers and retailers are demanding more transparent systems and we work with visionary retailers that will drive forward best practices and will have a real positive impact on the industry.

If money was no object, what would the best system and solution be for the industry?

There are two things I'd like to see and they're both focussed on transparency. Firstly, open dialogues with the farmers on market prices. Secondly, sharing information about the value chain across the whole supply, from farm to citizens.

When I sit back and look at the food supply chain from afar, I see a huge issue in that citizens don't know where their products come from and farmers don't know where their products go. By bridging these two ends of the supply through better data and information flow, we can allow complete transparency in terms of demands from the citizens and tailored and fair production for the farmers.

It would allow you to see what kind of impact the farmers have on the whole value chain. For example, antibiotic use is an issue of importance for citizens. Better data management enables greater transparency, which in turn allows consumers to make more informed buying decisions — that's a win-win in my eyes.



Image: Fish Vet Group analysing shrimp samples.



We work with visionary retailers that will drive forward best practices and will have a real positive impact on the industry.

RALF ONKEN

Data-driven decisions



Image: Liris Maduningtyas, CEO and co-founder of Jala, visiting a shrimp farm.

Liris Maduningtyas, CEO of Jala Tech, offers a fresh perspective on the sector she joined in 2016 and has since helped to revolutionise – both in her native Indonesia and beyond.

What inspired you to join a business focusing on the shrimp farming sector?

I was working as a field engineer for Schlumberger, but a downturn in the oil and gas sector in 2015 made me think about other options. I'd never considered working in aquaculture before, but at that time some friends from my home town were researching the sector – and this group, then called Atnic Ekotekno, formed the core of what was to become Jala.

I was initially taken on as an intern, then moved to a marketing role after three months. In order to carry out market research I decided to start visiting shrimp farmers in person. I only had one farming contact initially when I set out touring Java by car, but built up contacts as I went. And, after a month, I had managed to visit 50 farmers, travelling all around the island in the process.

Although shrimp is one of the world's most lucrative seafood commodities, and Indonesia was the largest shrimp producer in South East Asia back then, farmers – only 25 per cent of whom were under 40 years old – were still using instinct to make their decisions. I felt that a data-driven basis to make decisions was more important, especially for those less experienced in the sector, and my trip confirmed the need for new technology to help improve shrimp production.

Was it a daunting task given that you were relatively new to the sector?

Absolutely. I was new to the sector and had to try to understand both aquaculture production and Jala's technology in order to explain the rationale for the two to be combined. This was the main reason why I spend most of my first year with the company visiting shrimp farmers, but I think it helped that I was able to speak a number of local languages when I was travelling around.

How did you rise from intern to CEO so swiftly?

My engineering background, combined with my experience of marketing when I started with the company; my understanding of the farmers gained from my tour of Java; my understanding of the product and the experience gained during the growth of Jala in its first year — this led to Aryo Wiryawan, the chairman of the company, asking me to take over as CEO after my predecessor had returned to academia.

What does Jala Tech offer its clients and do you feel you've made a difference to the sector, both nationally and internationally?

Jala offers farmers a product that combines data entered manually by the farmers with data uploaded automatically by IoT (internet-of-things) technology. We've shown that those using our product increase their productivity by an average of 20 per cent. Using an SaaS [software-as-a-service] business model, we offer farmers a real-time farm-management system that can predict shrimp growth, give early warnings of possible disease outbreaks and support farmers with recommendations based on data analysis — in particular data relating to water quality.

Where are your clients based?

Our main focus is on Indonesia, but we have also done some pilot projects in Thailand, Vietnam and Malaysia. Over the past two years, more and more farmers are open to data-driven production and our systems are now used in 3,000 ponds — up from only 300 a year ago.

Can you tell us a little about the scale of Indonesia's shrimp sector, the scale of the average farm there and the typical challenges facing the sector?

Indonesia has roughly 30,000 hectares of active shrimp farms, producing around 300,000 tonnes of shrimp a year. Small-scale producers harvest between seven and 10 tonnes per cycle, while medium and large-scale producers can reach up to 25 tonnes per cycle.

The main challenges for producers in Indonesia are diseases — in particular white spot syndrome virus (WSSV), white faeces disease (WFD) and infectious myonecrosis virus (IMMV). Climate change is also a problem — as it's increasingly hard to predict the weather and the seasons, it's hard for farmers to make decisions about when to stock their ponds or when to harvest.

The sector is also suffering from a reduction in prices, which started in August 2018 — and prices keep declining. We're not really sure why this is — some people blame the increased competition from India, others point to changes in the US market, which in 2017 accounted for 70 per cent of our shrimp sales.

I also feel that too many people in the sector are not sufficiently open to new knowledge or adaptable to new farming techniques.

What are your proudest moments in the sector to date?

Successfully raising seed-round funding for my company and, since then, growing Jala to a company that employs 22 people and helps 1,000 shrimp farmers.

What would you most like to achieve?

To reach a point where we're able to help a million farmers.



Image: Liris Maduningtyas, CEO and co-founder of Jala, visiting a shrimp farm.

*Our systems are now used in **3,000** ponds — up from only **300** a year ago*

How do you see the company, and the shrimp sector, evolving over the next decade?

I would like to see Jala become a decacorn (a tech company worth over US\$ 10 billion), serving aquaculture with data-related solutions, IoT, innovation,

overcoming problems in the industry and assisting millions of farmers. As for the shrimp sector in general, my main hope is that it becomes increasingly sustainable — by adopting more eco-friendly farming practices, the use of more sustainable feed ingredients and ensuring that hatcheries are producing consistently high-quality seed stock.

*Indonesia
has roughly*

30,000

*hectares of active
shrimp farms,
producing around*

300,000

*tonnes of
p. vannamei
a year**

* Approximate 2018 figure.



Raising the bar in sustainable aquaculture



INTERVIEW WITH
**CHRISTOPH
MATHIESEN**

Part of the World Wildlife Fund (WWF) team that established the Aquaculture Stewardship Council (ASC) standard for salmonids and shrimp, Christoph Mathiesen has extensive experience in the industry.

Here, he explains how the ASC standards were developed and the impact they have had in reducing the environmental and social impact of the industry.



Tell us about your history working in the shrimp industry?

My first introduction to the industry was in 2004 when I was working as an independent consultant in Vietnam on sustainable aquaculture development and later on for WWF to develop new standards for better managed for shrimp production. My background is in Geography and International Development Studies.

Can you explain how the standards for the ASC were developed?

The work began in the mid 2000's as a global development project. It was co-ordinated and funded by WWF with additional private funding. The first phase was the establishment of 'aquaculture dialogues' which involved setting up individual meetings and roundtables with all interested parties to discuss where the bar should be set for responsible aquaculture — this covered seven species, including shrimp.

WWF began a sustainable farming project for shrimp across three provinces in southern Vietnam. This involved sitting down with farmers, local governments, experts and consultants to establish how to improve management practices at farm level and how to align requirements for quality and sustainability from international seafood traders.

The outcomes of WWF's project in southern Vietnam allowed us to provide input to the global steering committee in the Shrimp Aquaculture Dialogue. The main input was to secure standards that were also applicable to small holder farming. We spent some time benchmarking standards against different sized farms to ensure they would be effective at each level. The draft standards were reported back to the steering committee for review ahead of the establishment of the official Aquaculture Stewardship Council standards.

In your view, what are the top three most pressing issues in shrimp aquaculture?

In my experience of working with shrimp farmers in Vietnam and elsewhere, there are a number of socio-economic and environmental challenges. The top three that I would pick out are — the organisation of small holder farmers, management practices and environmental degradation.

Many small-scale farmers often do not have access to the same infrastructure, markets and knowledge as larger-scale producers. This can lead to issues such as uncoordinated water intake and outlets — often resulting in higher risks of disease outbreaks and economic losses. Getting farmers organised into co-operatives was a significant challenge but also an opportunity in Vietnam.

The improvement of management practices was also an issue that needs to be addressed. Farmers need to be more informed about the risks and opportunities, achieving the best price for their crops and the benefits of using the most effective additives and feeds. Many small-scale farmers used to be rice farmers. They moved into shrimp farming — hoping to make good profits in a bit of a gold rush movement.

Environmental degradation and the overall environmental impact of shrimp industry was the primary reason WWF got involved. Major issues include the loss of mangroves, pollution of water streams with chemicals and medicinal residues, and the loss of biodiversity and habitats.

In your view, what impact has ASC had on the shrimp industry?

Working with small-scale farmers in the launch phase of ASC, the impact was huge. The anticipation that the standard was coming and the opportunity for all farmers to be part of that helped to accelerate and facilitate better local community management. For example, organising small-scale farmers, working more closely with international seafood traders, local governments and importantly, sharing knowledge.

There has definitely been a paradigm shift in the market as a result of the ASC standards. It is now more commonly expected that producers must verify their environmental impact and what they are doing to make improvements.

What are consumers' biggest concerns around shrimp production?

The use of antibiotics and pesticides are the two main concerns I think, followed by wider environmental issues and labour conditions.

For consumers, having a 'healthy, clean product' is a major concern but this differs from country to country. There has been a lot of campaigning and awareness raising in several European markets about the environmental impact of shrimp farming. On a global scale I think the growing concern is around the purity of products — which ASC is helping with.

What would you do to improve the sustainability of shrimp production?


If I had unlimited funds, one of the areas that needs improvement is water infrastructure. This would considerably reduce the risk of disease spread but requires heavy investment. Alongside this you would need to have consistent training of farmers and cooperatives in better management practices to ensure the economic risks are reduced while looking after the environment.

Where do you see the future of shrimp production?

I think we'll continue to see what we have seen in other areas of production — greater consolidation and bigger, more industrial farms. I think we'll also see continued demand for responsible production and standards such as ASC.

I believe there will also be more collaboration across the whole supply chain from producers to traders to retailers. Retailers can have a huge impact and drive a positive shift when they get more directly involved on the ground. This also creates a great opportunity to share stories with consumers about how their food is produced.



Retailers can have a huge impact and drive a positive shift when they get more directly involved on the ground. 

CHRISTOPH MATHIESEN

Antibiotic-free shrimp production

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Producing shrimp without the use of antibiotics is a realistic goal for all shrimp producers, according to Loc Tran, founder of ShrimpVet.

Given that he is putting this theory into practice on his own shrimp nursery and grow-out farm in Vietnam it is hard to argue with his logic.



Image: Dr Loc Tran,
founder of ShrimpVet.

What are most important means to negate the need to use antibiotics in shrimp production?

The key place to start is the need to apply biosecurity in your production unit, and that can be done by better water treatment, biosecurity measures, diagnostics and being sure that the facility is pathogen free.

Bearing in mind that we have to deal with the ubiquity of Vibrios and other types of bacteria, the second step is to keep the environment clean — through better pond management and also water treatment and removing sludge and effluent during culture. It's also crucial to use probiotics to take care of the waste — organic waste and also other kinds of effluents like ammonia, nitrite and hydrogen sulphide. By keeping the environment clean you will have clean stock and clean water, and the animal will be very healthy.

We also need to keep the aquatic animal's gut microbiota healthy by applying active probiotics for microbiome moderation. By doing that, vibrios cannot produce enough toxins to cause damage to the animals.

In the feed itself we can apply feed additives, prophylactics and quorum-quenching products to minimise the impact of bacterial infection. Particular ingredients include acidifiers, monoglycerides and phytogenics, which provide a good substrate to replace the use of antibiotics because they can suppress the growth of harmful bacteria and promote a healthy microbiome in the animal gut.

All of these methods are only effective, however, if farmers are well educated and well informed about new developments in farming technology so that they're able to see the broader picture. They also must have a very clear farming protocol from day one.

How has applying these techniques affected your own production?

The ShrimpVet lab was founded about six years ago and our main activities were initially in R&D and diagnostics. However, we soon began to realise that in order to better assist farmers we had to apply those concepts into shrimp production. This is why we founded a hatchery – it gave us the chance to start applying these concepts of biosecurity, probiotic maturation in the water, probiotics in feed and better management of the environment. This allowed us, eventually, to produce very high-quality shrimp post-larvae and we can now apply the same concept to our grow-out farm too – we now have a pretty decent sized farm, all our ponds now plastic-lined and we apply probiotic activation from the nursery phase, as well as all the disease-control concept lines mentioned earlier.

How has this worked out for you?

Everything has become very consistent – the survival rate at our hatchery is always about 50 per cent, we don't have any issues with luminescent disease or early mortality syndrome (EMS) or other bacterial diseases in the hatchery. At the grow-out farm level we don't encounter either EMS or white faeces when we apply a clear farming protocol with proactive disease-control measures.

How many cycles have you gone without using antibiotics?

We've operated the hatchery for three years – we stock with new nauplii every day in each production unit and each production cycle will last for about three weeks, so we have done at least 30 cycles already. After several cycles we began to master the skill.

On the grow-out farm we have completed several cycles too now and have advocated similar practices in other farms in Vietnam and across Asia. We've also persuaded farmers in Latin America to follow suit – in late 2017, for example, there was a big issue with mortalities in hatcheries in Salinas in Ecuador. We did our diagnostics so we knew what was going on; we advised the hatchery operator to follow the protocol and now we don't hear much about the problems in the hatchery. We've also educated farmers across India and in many other countries in Asia to follow these procedures.

Would you like to see your methods become the standard operating procedure (SOP) for the shrimp sector globally?

It might be too much to come up with an SOP for farming because the shrimp business is very dynamic and we keep facing new challenges every day. But I would say that sharing ideas is important so we can all deal with the situation as it evolves and can plan for any emerging threats.

Image: Dr Loc Tran, founder of ShrimpVet.



Loc has found that antibiotic-free production has made his results much more consistent.

Aquaculture advocate



INTERVIEW WITH
**GEORGE
CHAMBERLAIN**

President of the Global Aquaculture Alliance, George Chamberlain, here explains the work of GAA in promoting responsible aquaculture practices through education, advocacy and demonstration.



Can you provide a brief introduction to the role that the Global Aquaculture Alliance plays in supporting a sustainable aquaculture industry?

GAA advocates, educates, and demonstrates to keep aquaculture on the path toward sustainability. We advocate by relying on sound science to defend aquaculture from misinformation and exaggerations. For example, when GAA was being formed in 1997, shrimp farming was accused of converting 50 per cent of the world's mangrove area to ponds. One of GAA's first projects was to engage leading mangrove experts from around the world to gather the facts. It turned out that the actual mangrove conversion loss was less than 5 per cent. We have dispelled similar exaggerations about over harvesting of fishmeal, dioxins in fish and antimicrobial resistance, to name a few.

We educate through our annual GOAL meeting, online magazine, online community, online courses, white papers, films, and social media. Our objective is to provide information to help drive change and continuous improvement. The GOAL meeting does this by bringing together a cross section of stakeholders from the entire value chain to discuss issues and solutions.

We demonstrate by developing certification standards to provide third party assurances to seafood buyers and consumers. The Best Aquaculture Practices programme now certifies about 1.7 million tonnes of farmed seafood, and the programme is growing at about 30 per cent per year.

How closely do you engage with the shrimp sector?

GAA's vision has always included the entire aquaculture industry. However, the practicalities of beginning as a start-up in 1997 forced it to initially focus on a single sector — shrimp. The organisation quickly expanded to include tilapia, catfish, pangasius, salmonids, marine fish and molluscs. Although the BAP programme started with shrimp farming standards, today it certifies a much higher volume of salmon (956,000 tonnes) than shrimp (386,000 tonnes). This is a reflection of the more consolidated nature of salmon farming.

What are the major challenges you see in shrimp aquaculture?

The major issue continues to be disease, but the type of disease challenges is changing. Originally, the main concerns were viral diseases, which can be managed with specific pathogen-free (SPF) broodstock and proper biosecurity at the hatchery and farm. Now, we are facing more bacterial diseases such as early mortality syndrome, running mortality syndrome and white faeces. A microsporidean parasite disease called *Enterocytozoon Hepatopenaei* (EHP) is also spreading. These are diseases that are not easily eliminated from a facility by disinfection and dryout. Management includes use of SPF broodstock and biosecurity, but also use of genetic lines that have been bred for disease tolerance and use of probiotics to inhibit the growth of bacterial pathogens.

As shrimp farmers around the world are getting more proficient at managing these diseases and global production continues to rise, prices are falling. This is leading to a recognition of the importance of unified shrimp marketing programmes to increase consumption.

At the GOAL meeting last year in Guayaquil, an organising committee was formed to develop a US shrimp marketing initiative. Similar initiatives are needed in each of the other major markets.

Producers are also being driven to continually drive down the cost of production by implementing more efficient technologies at each step of the production chain. This is one of the most fascinating areas of aquaculture.

What does a sustainable shrimp industry look like to you?

In order to meet the needs of a rapidly growing population with increasingly limited resources, the shrimp farming industry needs to sustainably intensify. The biggest driver of improvements is genetic selection, which is rapidly improving growth rate, disease resistance, reproductive performance and other traits. Now emerging in multiple locations around the world are small well-controlled intensive systems stocked with fast growing genetic lines that efficiently and consistently produce high yields. Such systems are adaptable to automation and mechanisation in a manner similar to standardised barns used in the poultry sector. Examples of groups developing such systems include CP Group in Thailand, Marinasol in Peru and Camanor in Brasil.


If you had unlimited funding, what would you do to improve the sustainability and profitability of the sector?

Aquaculture has a very bright future if it continues on the path toward sustainability. The key is work closely together to help the whole sector remain aware of the opportunities to continually improve and to identify challenges and proactively deal with them.



Image: Chamberlain hopes that GAA helps our children and grandchildren face the challenges of sustainably intensifying aquaculture.



Producers are also being driven to continually drive down the cost of production by implementing more efficient technologies at each step of the production chain. 

GEORGE CHAMBERLAIN

What is the outlook for the shrimp industry?

When solutions to white spot syndrome virus were developed at the end of the 1990's, shrimp farming quadrupled in volume. Now we are on the brink of a similar transformation, and I believe a similar leap in volume is again possible.

Benchmark at a glance



Driving sustainability in food production.

We bring together technology and fundamental biology to deliver products and solutions that support farmers throughout the growth cycle. We do this by improving the genetic make-up, health and nutrition of their stock — from broodstock and hatchery through to nursery and grow out.

By optimising the genetics, health and nutrition of our customers' stock, as well providing them with the knowledge to determine livestock performance and understand disease threats, we can increase the productivity and sustainability of their business.



Benchmark®

Benchmark's offering

Larvae quality is one of the main drivers for successful shrimp farming which is why Benchmark's products help early-stage shrimp develop to their full potential throughout the production chain.

Investment in our products and services has a high return relative to the substantial costs resulting from major disease challenges. Our offering drives consistency in supply and supports the long-term growth and sustainability of our customers' business – improving yield, quality and animal health and welfare.

Our technology



Genetics

Improved genetics are the best start for disease resistance.



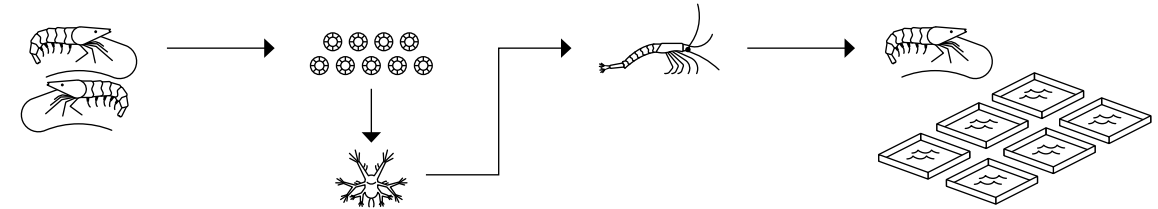
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Specialist feed promotes growth and immunity.



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Broodstock

Hatchery

Nursery

Grow-out

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Hatchery stage shrimp

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Broodstock diets

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SHAPING AQUACULTURE TOGETHER



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Investments in new technologies remain as important as ever to the sustainable growth of the industry



Committed to
the sustainable
development
of the aquaculture
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