

# FISH FARMING TECHNOLOGY

I N T E R N A T I O N A L

# AQUA FEED

## RAISING ANIMALS & FISH IN A POST-ANTIBIOTIC ERA

- Resilience in Covid times: Landing in the safety net of adaptability
- Climate Change: How it will impact the seafood industry
- Conditioning & pelleting: A focus on finding the right process & choosing the correct ingredients
- Precision Fish Farming
- Remote monitoring in shellfish farming: Using big data and unsupervised learning to better forecast productivity and ecosystem impacts

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# WELCOME

**When it comes to our personal safety and that of those we come into contact with on a daily basis, Covid is still high on our lists of concerns. We are also already beginning to understand that we may have to 'live' with Covid and its potential for harm, for some time to come.**

Whilst this is a depressing if not distressing thought, there is the prospect that we may still be able to go about our regular work activities while minimising our exposure to the current and possibly future variants. Although this is not true for all occupations, especially for those working in such areas as health, education and services that come into close contact with multiple people.

Yet, in amongst this assortment of all activities, some will offer less risk when engaging with others.

With all of this said, I'm still looking forward to attending my first large-scale exhibition this year when I visit IPPE in the American city of Atlanta. I'm relying on the organisers to have thought through and developed a strategy that will help visitor and exhibitors to protect ourselves - from either contracting or spreading Covid - whenever large numbers of people gather at an event such as this.

There is an even greater risk for those of us who are travelling from outside the USA, with the big question on my mind being; what happens should me or my team contract the disease and how best to plan for all eventualities?

Planning a trip such as this - and I suspect we will all have to face up to these challenges in the near future - takes time and a rational consideration and decision-making approach.

However, there is no reason good enough to remain at home.



**Roger Gilbert**  
*Publisher – International Aquafeed  
and Fish Farming Technology*

The world moves on and we need to as well - while abiding by government edits and policies. It appears to me that there is better co-ordination between countries and better communications that should avoid some of the tragic and challenges travellers have to cope with in the past.

So, on a more positive note, as I and my team prepare this edition for distribution at IPPE 2022, I can say that the five of us are looking forward to once again returning to Atlanta to meet with old friends, reacquaint ourselves with our customers and readers alike and make new connections and still enjoy what has come

to represent for us the American experience in a wonderful city. I hope we get to meet you there as well!

Now, let me turn my attention to this month's magazine.

We have a strong line up of interesting aquaculture news and features. Editors Professor Simon Davies and Erik Hempel set the scene for us in terms of nutrition and technology topics and Dr Brett Glencross and Dr Antonio Garza de Yta contribute their first thoughts of 2022.

We publish the second part of our focus feature on antibiotic resistance and look at the issues that we have to address in terms of keeping our fish healthy and away from antibiotic treatments. We also have sophisticated technical articles and down-to-earth farming such as our report on prawn and shrimp farming in Bangladesh.

Reading our magazines in print is such a pleasure. So please let me know if you would like me to mail you monthly editions or you could visit our <https://magstand.com/aquafeed> website directly, where you can choose your options and manage your own subscription! Good reading.

## Aqua Feed Processing Course dates announced

Progressus AgriSchools of Thailand and International Aquafeed magazine, published by Perendale Publishers Limited, are pleased to announce its Aqua Feed Processing 2022 course dates.

The Aqua Feed Processing Course will run over 12 weeks from February 22, 2022 to May 24, 2022 offering one two-hour online Session per week on Wednesdays and culminate in a Certificate of Attainment that will help to convey the topics studied.

"Becoming a reputable manufacturer that provides nutritional, quality and safe food to aquatic species is a hard status to achieve," says Yiannis Christodoulou the founder and Executive Director of Progressus AgriSchools.

Joining the school to hear and learn from a select group of aquafeed industry experts and trainers, who are prepared to discuss all there is to know about aquafeed manufacturing, is a unique opportunity.

The Aqua Feed Processing Course will join two other 12-week courses offered by Credo, the two partners' online school management team and led by Joe Kearns of Joe Kearns Consulting, who has had some 40 years in aquafeed extrusion and related technologies.

Amongst a variety of topics to be covered, the aquafeed schools will deliver learnings on food production process, equipment and instruments required for aquafeeds manufacturing with a focus on areas such as extrusion, packaging, mixers and coating.

"It will also include an in-depth look into processing conditions and

how those can be optimised while keeping to stringent quality and safety standards required by regulatory bodies and aquafeed industry," says Mr Christodoulou.

"We look forward to welcoming all those who have a keen interest in the manufacturer of aquafeeds."

The School is also offering a feed manufacturing course over a 12-week period from March 9, 2022 to June 8, 2022.

Details of the course will be available on the OMS web site at where you can register: [www.onlinemillingschool.com](http://www.onlinemillingschool.com)

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Pre-Register



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Pre-Register

**Last year we ended by reporting on the COP26 meeting in Glasgow, UK and the need to address climate change and how we need to pay closer attention to our environment. We also discussed how we can mitigate CO2 output from industrial processes and human activities.**

In 2022 we can expect more of this when COP27 meets in Sharm el-Sheikh, Egypt this year, in what will be a crucial summit if the world is to limit global heating to 1.5°C. Agriculture is being centred and we in aquaculture must also be able to reciprocate, adjust and fine tune our industry to accommodate change.

In our feed sector there is much we can do to continue our sustainability agenda in the right direction. We are already examining the sources of our feed ingredients and raw materials for fish and shrimp diets in more detail and beginning to quantitate carbon footprint and various sustainability indices.

For years we have scrutinised the use of marine ingredients in terms of their finite capacity to supply high quality protein and energy such as oils essential for fish production and health.

Fortunately, with good stewardship wild fish stocks can deliver a consistent supply but only within defined boundaries. Fishmeal and oil are indeed excellent raw materials and especially for high value species but must be used wisely and strategically as they are now for carnivorous species like salmon, trout, seabass and seabreams.

## **Evaluating seaweeds as a dietary feed additive**

The other issue is soybean meal as it is now increasingly being questioned due to the need for expansion to address its use for the human food market but also in many animal feeds as a key component in swine, poultry and fish rations.

The impact of soybean production in the Amazon and relationship to deforestation for plantations and cattle farming are very topical issues that are raising much criticism globally. This has raised the spectre of elevated methane production as a serious greenhouse gas contributor. This is where we may see aquaculture being helpful in many ways.

Indeed, as our regular columnist and friend Thierry Chopin has often promoted, seaweed is an amazing resource and has numerous societal advantages, making it an invaluable food commodity. Whilst it also offers many opportunities for advances in biotechnology for use in natural cosmetics, pharmaceutical, animal feeds and even biofuels. Scientists are now using seaweed as an additive to ruminant diets in order to suppress methane production in cattle as it modulates dietary digestion and promotes efficient metabolic assimilation of nutrients.

We in aquaculture are of course evaluating seaweeds as a dietary feed additive and some of my recent work with colleagues in Ireland have observed positive results with fish especially in terms of gut health and function. I am hoping we see much more of this interest in seaweed extending into further research as a feed additive for fish, shrimp and many other animals.

Speaking of alternate fish feed ingredients in 2021, I was involved in several studies to test the feasibility of more advanced high protein distillers dried grains for use in aquafeeds. The primary source was from the USA and linked to the bioethanol industries connected mainly to corn fermentation.

Consequently, we are now seeing a whole new stream of novel



**Professor Simon Davies**

*Nutrition Editor, International Aquafeed*

generation fermented corn or wheat protein products. This has captured the attention of the US Grain Council who have asked me to speak on this topic in the near future most probably in the UAE.

Another exciting project is with the UN to cover topics for a new book for the SDG Sustainable Development Goals initiative SDG 14 Life below water. This will be focused on how higher education can embed sustainability into teaching and research.

As editor of this book, I will be looking for topics that include coastal ecology, marine park management, fisheries ecology and aspects of aquaculture such as aquafeeds and the sustainability agenda.

## **Seafood is very important in our diet**

The pandemic is still a major threat and now we have the Omicron strain that has some significant mutations. However, this is how viruses work by being opportunist and challenging new hosts to enable propagation and spread of infection. A virus can wear many a new clothing!

The transmission of disease has always been very complex, and coronavirus is no exception. We must be on our guard and recognise that we must develop a more comprehensive range of defences based on robust and updated vaccine technology as well as novel anti-viral agents that can shield us from the emerging pathogens of this type.

In fact, strong evidence indicates the vital importance of good nutrition to aid us in mitigating infection. Among these are vitamins A, D and E and essential long chain fatty acids such as EPA and DHA.

Yes, and it's our consumption of oily fish that can greatly support our immune function. Our antibodies are proteins and must be synthesised as well as the phagocytic cells and our T-cells must have robust mechanisms to operate efficiently. Essential nutrients such as specific vitamins, trace elements like selenium and zinc are vital co-factors in our cellular based anti-oxidant defences.

I am of the strong opinion that we should be augmenting our vaccination strategy with high quality nutritional support and aquaculture products such as salmon and fish extracts. These are invaluable assets in our arsenal to fight viral and bacterial attack.

Seafood is very important in our diet and aquaculture will increasingly play a role in human health. Talking of oily fish and human health, I have a new paper in the European Journal of Lipid Science and Technology where we have demonstrated how a marine protist (SCP) biomass can effectively enhance the omega-3 levels in fillets of harvest size tilapia, giving them a superior fatty acid profile over conventional tilapia fed mainly vegetable oils.

On another matter, I was very fortunate and most honoured to be granted the Freedom of the City of London in November 2021 in recognition for my life-long work in the aquaculture biosciences. This was a wonderful occasion at a ceremony held in the Guildhall, London.

I was able to bring attention to fish farming and the incredible global activities in aquafeed science and technology to a different audience of business and government stakeholders. Hopefully in future, I can spread the word of our important industry and interact more closely with the UK capital city.

Please have a safe and healthy prosperous New Year. Please continue to enjoy our magazine and keep forwarding interesting articles, features and news items on nutrition and health topics of interest to us all.



As we move into 2022, we are also entering the International Year of Artisanal Fisheries and Aquaculture (IYFA 2022) which was proclaimed in 2017 by the 72nd Session of the General Assembly of the United Nations (UNGA), with FAO serving as the lead UN agency.

The objectives of IYFA 2022 are as follows:

- 1 Enhance global awareness about, understanding of, and action to support the contribution of small-scale artisanal fisheries and aquaculture to sustainable development, and more specifically in relation to food security and nutrition, poverty eradication and the use of natural resources.
- 2 Promote dialogue and collaboration between and among small-scale artisanal fishers, fish farmers, fish workers, governments, and other key partners along the value chain, as well as to further strengthen their capacity to enhance sustainability in fisheries and aquaculture.

From an aquaculture point of view, we have perhaps paid little attention to artisanal operations over the years. Not surprising, really, for our focus tends to be on large-scale operations and very modern and complex technology.

While large-scale aquaculture is pretty well documented and measured, for example through FAO's fisheries statistics, we know much less about artisanal aquaculture. We do not know how much seafood is produced by this sector, and we have limited knowledge about the technologies used and how effective they are.

What we assume is that artisanal aquaculture plays an important role in providing food for many poor people. We also assume that it provides many rural residents with work.

But perhaps we should study artisanal aquaculture more deeply in order to see how the technology used can be improved, from different perspectives: environmental, economic, production efficiency, etc.

In an environmental perspective, it seems safe to assume that artisanal aquaculture is more sustainable than the modern, industrial aquaculture. Artisanal farmers and fish farmers have always had to live in harmony with nature.

I remember from my own childhood, growing up in the countryside in Norway, that waste such as cow manure was spread on the fields every spring to fertilise the soil. And there was indeed very little waste from any food production, as all parts of the animal or the fish were utilised somehow.

Economically, artisanal aquaculture first and foremost contributes to household consumption. Consequently, much of the production never enters any statistical records. But it is nevertheless important to the people who are engaged in it.



**Erik Hempel**  
*The Nor-Fishing Foundation*

## The problems with artisanal aquaculture

One of the problems with artisanal aquaculture as it has been practiced by government-sponsored programmes is that it often requires local voluntary labour participation on a continuous basis, while only producing one or two harvests a year that can pay the local labourers for their efforts. The locals need money every day, and therefore often leave such projects to find other work that will give them an income

today rather than in six months.

Technologically, artisanal aquaculture is rather primitive, and could perhaps benefit from various modernisations. Not necessarily by introducing modern equipment, but perhaps by introducing a more systematic approach to how the activity is run.

I have mentioned earlier how a small-scale fish farmer in Indonesia improved his economic performance by starting to keep track of feeding procedures, by noting down the feeding times and amounts fed, and the growth of the fish over time. Such simple improvements would probably enhance artisanal aquaculture economically far more than the introduction of modern (and often expensive) equipment.

One of the other problems facing artisanal aquaculture, is the availability of feed. Not only that, the composition of the feed is often also a problem because of lack of knowledge on the part of the fish farmer. Important contributions to artisanal fish farming could be made by helping the artisanal farmer develop nutritious feeds based on local raw materials.

After having lived in Africa for many years and observed aquaculture there, it is my impression that the aquaculture potential of that continent is vast. There are enormous inland water resources that are still largely untapped in terms of aquaculture activities.

One of the concerns that investors have voiced, is that these regions lack the infrastructure to be able to develop larger scale aquaculture. They have difficulties getting inputs to the operation, and the harvested fish to market.

My response to this is that perhaps they should not focus on far-away markets. In a study we did about a decade ago, we found that local markets paid a much higher price for farmed tilapia, for example, than export markets could offer.

In addition, artisanal aquaculture would be able to supply more food to the local communities by focusing on the local markets.

From the point of view of global aquaculture, one can hope that the International Year of Artisanal Fisheries and Aquaculture and its related activities will contribute to making artisanal aquaculture and fisheries more important, profitable and sustainable.

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# THE BIG PICTURE

Resilience in Covid times  
Landing in the safety net of adaptability  
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## Testing green grass protein for viability as a fish feed ingredient

In the search for new fish feed ingredients, Aller Aqua will test green protein. Produced by BioRefine, the material is an organic protein concentrate made of grass harvested from 3000ha land in Denmark.

Out of this, the company produces 7000 tonnes of green protein concentrate applicable for animal nutrition per year. The green and organic protein concentrate has a similar nutrient profile to soybean meal and could therefore be a great replacement in Aller Aqua fish feed.

For comparison, Denmark imports around 50,000 tonnes of organic soy annually.

The company BioRefine has been launched by three agricultural companies DLG, Danish Agro and DLF with a strong intention to create a climate- and environment-efficient alternative protein source for animal feed.

“BioRefine has the ambition to continuously establish more biorefineries, and thereby increase the proportion of

feed protein ingredients produced in Denmark,” says Vagn Hundebøll, CEO at BioRefine.

“We are very happy about the cooperation with Aller Aqua and will closely follow the results conducted by Aller Aqua Research.”

The functionality of BioRefine’s green protein in fish feed will be evaluated in feeding trials conducted at Aller Aqua Research, Aller Aqua’s trial station located in Büsum, Germany.

In nutrient digestibility and growth trials the green protein will be tested in feed for rainbow trout, the main fish species in Danish aquaculture. Due to its regionality, grass protein could be a valuable raw material for reducing the carbon-footprint of fish feed.

“New raw materials are seldom found, and here we have an entirely new and locally produced raw material. It is a perfect match for us because this is the kind of raw material we are searching for.

“We are looking very much forward to be the first company testing and possibly later on including this raw material in our feed,” says Dr Hanno Slawski, Group Research & Development Director for Aller Aqua.

Recently, Aller Aqua became the first fish feed company to label their feeds with their respective CO<sub>2</sub> equivalent. This was greatly appreciated by the market and client feedback has shown that knowledge about the carbon footprint of fish feed is of great interest to all stakeholders along its value chain.



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## CMA clears Scottish Sea Farm acquisition of Grieg Seafood Hjaltdland UK

**T**he UK's Competition and Markets Authority (CMA) has today cleared Scottish Sea Farms' bid to acquire Grieg Seafood Hjaltdland UK, paving the way for the deal to complete.

In June 2021, Scottish Sea Farms – which is co-owned 50/50 by Lerøy Seafood Group and SalMar ASA – signed a Share Purchase Agreement to acquire 100 percent of the shares in Grieg Seafood Hjaltdland UK from Grieg Seafood ASA for the purchase

price of GBP 164 million.

Included in the deal are the company's freshwater hatchery, processing facility and 21 marine farms around the Shetland Islands and Isle of Skye which, combined, produced approximately 16,000 tonnes (HOG) of Atlantic salmon in 2020.

This complements the geography of Scottish Sea Farms' own operations across mainland Scotland, Shetland and Orkney, putting the salmon

grower on track to produce 46,000 tonnes in 2022.

"This is hugely positive news that promises farmers from both companies greater opportunity than ever before to create the best growing conditions, working collectively as one team with regards to the key factors of fish health, stocking regimes and sea lice management," says Scottish Sea Farms Managing Director Jim Gallagher, commenting on the CMA announcement.

"This, in turn, will enable us to offer customers a more secure and stable supply of premium quality Scottish farmed salmon."



# Scottish Sea Farms



**Brett Glencross**

## *Climate change, marine ingredients, and a 'blue food' revolution*

**I**n the city of Glasgow last month, not far from where I live in my adopted home country of Scotland, many of the world's leaders convened at the 26th United Nations Climate Change conference (COP26).

Most of the focus was on the required collective efforts to address future climate change challenges. A range of outcomes were achieved, including agreements on lowering emissions, phasing out the use of coal and improved forest conservation.

However, something that to me at least was conspicuous by its absence, was clear progress on food production systems. We all know the science the on how we have arrived at this point – centuries of carbon pollution, mostly in the form of carbon dioxide, and methane among others, that we now collectively refer to as greenhouse gases (GHG).

Whilst there are many different origins of these GHG's, it is notably the emissions from the global food production system that is one of the main drivers. Therefore, clearly a reduction

in global food consumption through reducing our calorie and protein intake and/or population reduction is one strategy, but not a politically attractive one.

The main strategy appears to focus on reducing GHG emissions through a reduction in fossil fuel use and/or the capture of those emissions to try and achieve a net zero balance. Maybe the other "balance" we should be thinking about is how much we rely on food production from terrestrial versus marine systems.

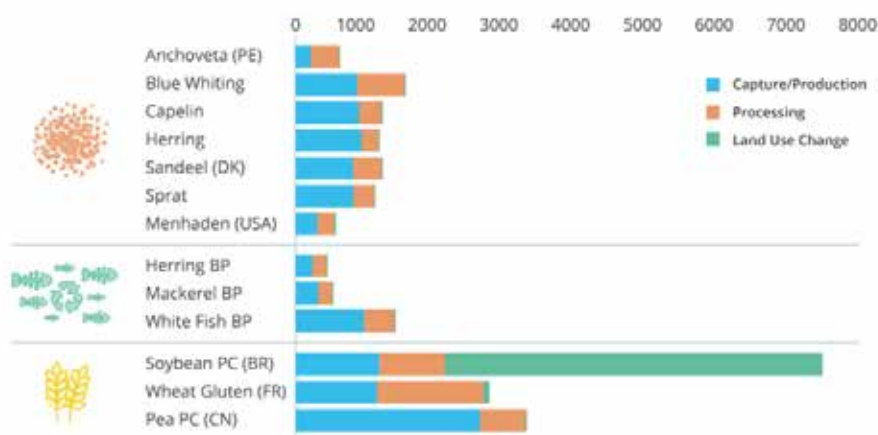
It seems that most of thinking in terms of improving food production footprint is based in terrestrial agriculture of livestock and crops, GREEN food production systems. But what about food production from marine capture and farming, what about BLUE food?

### **Having a restorative impact on GHG emissions**

A recent study by MacLeod et al. (2020) has shown that marine food production via aquaculture is in a very good position to assist with the reduction of GHG emissions. The authors showed that aquaculture is typically a lower emitter compared to virtually all other animal production systems.

The authors also demonstrated that increasingly moving our animal protein production systems off land and into the sea to create a 'blue food sector,' where we move our reliance away from terrestrial ecosystems to create a better balance in ecosystem reliance by producing more food from the sea, will be one strategy to address our reduction of GHG emissions.

Indeed, in Naylor et al's (2021) recent 20-year retrospective of global aquaculture they highlighted the role that culture of molluscs and seaweed can have in terms of net carbon removal from the system. Imagine that a food production system that actually has restorative impacts on GHG emissions. That could be one of the benefits of a blue food revolution.



**Figure 1:** Carbon footprint of different raw materials widely used by the aquafeed industry.

Source: based on data provided by Dr Richard Newton, University of Stirling, UK

**Dr Brett Glencross is the Technical Director of IFFO - The Marine Ingredients Organisation.**  
Over the past 25 years he has worked in various academic, institutional, and industrial roles across Australasia, the Middle East and Europe.



Improving efficiencies of resource use is another central theme in this sustainability story. In terms of animal production, again aquaculture reigns supreme in this regard. The lack of a need to burn energy for body temperature regulation, combined with other features like being able to completely metabolise protein to ammonia, make fish among the most efficient of all animals to farm.

The other emerging element to that story is the use of ‘circular’ ingredients in animal production. Responding to this demand there has been a boom in new enterprises promoting insects, single-cell proteins, and microalgae, among others but notably the only circular ingredients with any scale are the use of fishmeal and oil from trimmings and by-products.

In 2020 this sector of the marine ingredients industry produced close to two million tonnes, clearly putting it in a different league to the newer emerging “novel” ingredients sector.

In fact, if we combine the low carbon aspect of marine ingredient production with the “circular” protein strategy we take something that has a pretty good environmental footprint; low CO<sub>2</sub> discharge, low energy use, and little to no reliance land or freshwater, and make it into something super special, an ingredient with superb nutritional properties and an even lower carbon footprint (see Figure 1).

#### Examining various alternative proteins

By comparison, when we examine the various alternative proteins and oils now being used and/or considered and we

find that they typically have a high demand for energy, a higher CO<sub>2</sub> footprint and use substantially more land and freshwater.

So even though they contribute desperately needed new nutrients into our feed-chain, this is not without some environmental cost. Maybe something we need to further consider here is the carbon cost of an ingredient as an additional use criterion in feed formulation, and I note that several feed manufacturers are now publicly reporting their abilities to do as such.

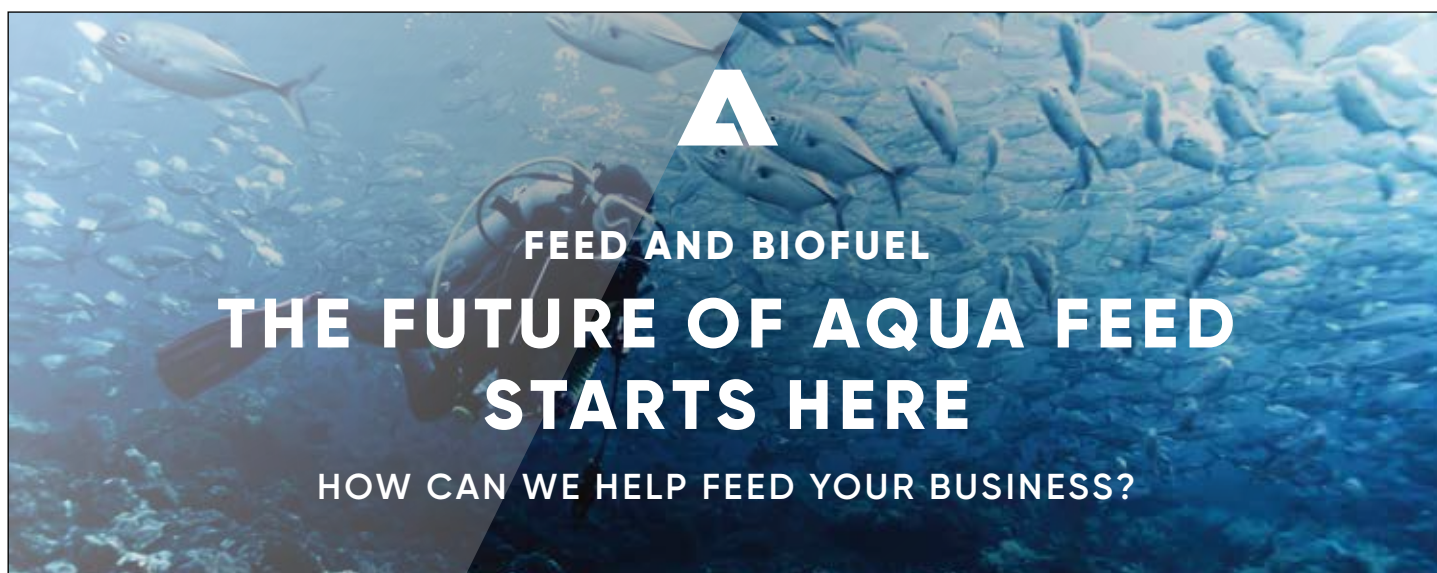
Notably, such a move would transfer additional cost to the higher carbon footprint ingredients, while at the same time encouraging the use of those ingredients with a low carbon footprint and at the same time monetising that point-of-difference to further encourage production of the low carbon footprint ingredients.

Irrespective of the strategy we adopt to reducing GHG emissions, this whole issue of sustainability and carbon footprint is going to become increasingly highlighted and sooner or later the carbon-cost will become part of the cost we all pay.

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**Antonio Garza de Yta**

## *The World Aquaculture Society in 2022*

**W**e are living extremely difficult times where our ability to adapt is more important than ever. During 2021 we had to postpone most of our events, due to Covid restrictions put in place worldwide. I am confident that our global team is taking every consideration to guarantee the safety of our members, partners, participants and guests.

More than ever, WAS is proving to be a very resilient organisation and in despite the current events, we are consolidating and strengthening our position globally. I would like to take this opportunity to extend my highest recognition to John Cooksey and his team for all their effort and adaptability that have been challenged at the highest levels.

WAS looks forward to returning to some degree of normalcy in our meetings in 2022. However, Covid remains with us and continues to create uncertainty, particularly with respect to restrictions on international travel.

Therefore, to better accommodate to our members' needs, the Board is making the following exceptions to standard policies for 2022:

### **1. Annual Membership Meeting (AMM)**

To better accommodate a membership that may be experiencing travel restrictions, we will hold three equivalent in-person AMMs, which may also be known as

the Annual Meeting (terminology used in By-Laws) or the Business Meeting, in 2022. The regularly scheduled AMM will occur at Aquaculture 2022 in San Diego to serve our North American members. The second AMM will occur at World Aquaculture 2021 in Merida, Mexico in May 2022 to serve our Latin American and Caribbean members.

The third AMM will be held at World Aquaculture Singapore 2022 in Nov/Dec 2022 to serve our Asian Pacific members. At each of these meetings, at least a subset of Officers and Directors will be available to provide updates on Society activities and answer questions. As the pandemic has strained the Society's finances with respect Officer/Director travel, all three AMMs will include a virtual component.

### **2. Board Meeting**

The Board voted to move the scheduled Board meeting from San Diego to Merida to allow more time for travel to return to normal and, thus, provide a better opportunity for holding an in-person meeting. Virtual Board meetings may be held as necessary during either the San Diego or Singapore conferences.

### **3. Change of Officers and Directors**

New terms for Officers and Directors normally begin at the end of the regularly scheduled AMM, which in this case would have been San Diego. However, because we will be holding three AMMs this year, we will change Officers/Directors at the end of the AMM in Merida.

All other Society functions are expected to operate normally in 2022. We hope these changes allow for greater engagement among the board and the members as we continue to navigate these challenging times.

Regardless of the difficult times, aquaculture has grown in relevance globally. Proof of that is the Shanghai Declaration, which was adopted on September 25, and the importance that was given to aquaculture during the Food System Summit, in New York and COP 26 in Glasgow. I hope we have time to discuss more about these topics on our following events.

Finally, I would just like to wish to you all, aquaculture professionals and enthusiasts around the world, that during this new year you are surrounded by your family and loved ones; and that peace, harmony and love fill your homes.

I sincerely wish, with all my heart, that happiness, joy and good health accompany you and your loved ones during all 2022. The best for the year to come!

WAS Event	Location	Date
Aquaculture 2022	San Diego, California	Feb 28-Mar 04
Aquaculture Africa 2021	Alexandria, Egypt	March 25-28
World Aquaculture 2021	Merida, Mexico	May 24-27
Aquaculture Canada & WAS North America	St. Johns, Canada	August 15-18
LACQUA 2022	Panama City, Panama	November 14-17
World Aquaculture Singapore 2022	Singapore	Nov 29-Dec 02



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For the third module students pick from one of the following three options:

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**Aquaculture Nutrition:** provides an introduction to the anatomy, physiology and nutritional requirements of key fish and invertebrate species. It also assesses the sustainability of feed production technology and discusses the relationship between nutrition and fish health.

**Aquaculture Health:** provides an introduction to the disease processes in cultured fish and invertebrates including viral, bacterial, parasitic and non-infectious disease. The module also looks at the importance of management in minimising the impact of disease and optimising cultured species welfare and sustainability.

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# Raising animals & fish in a post-antibiotic era

by James Cooper, International Aquafeed Correspondent, UK

**In this, our second part of our focus on the use of antibiotics in feed and farming practices, our regular correspondent James Cooper looks at the changing attitudes in the supply chain, why more consumers are beginning to demand antibiotic-free protein, and what action our industry could or should be taking in order to avoid a future where bacteria become resistant to antibiotic treatments**

It's nearly 80 years since an antibiotic was used to treat the first human patient, but we're still learning about the effects of antibiotics and their usefulness in human and animal health.

The reality is that antimicrobial resistance (AMR) remains a growing problem, despite concerted efforts in certain countries to deal with the threat associated with the routine use of antibiotics in farming systems.

Whilst novel and innovative feeds, and pro and pre-biotics have an important role to play, producers are now reconsidering their production systems to ensure good quality animal and fish husbandry, as well as providing conditions to allow more natural animal development.

What has become glaringly apparent in recent years is that the systematic overuse of antibiotics in human and animal medicine is undermining their ability to cure life-threatening infections in people, by creating an army of dangerous bacteria which are resistant to antibiotics.

Experts predict that 10 million people a year could die from antibiotic resistant infections by 2050 if nothing changes.

One driver of resistance is the overuse and misuse of antibiotics in human healthcare. But the other major factor driving resistance is the widespread use of antibiotics in agriculture and aquaculture, and none more so than in pig and poultry production, where worldwide demand is fast growing.

And while great progress has been made in some developed countries to reduce consumption, antibiotic consumption is still

rising at a steady rate.

No one involved in intensive meat production can pretend to be unaware of the problems of AMR, so isn't it time we seriously consider the practicalities of quite how to achieve a significant reduction in antibiotics use in intensive farming systems? Is it even possible?

## The European case

And a big part of the problem, as far as the farmer is concerned, is the structural need for disease prevention created by fast growing breeds and high stocking rates required to produce meat at a price point demanded by the supermarkets.

However, at the other end of the supply chain, the consumer is also becoming an increasingly interested stakeholder. Whilst AMR has now reached epidemic proportions, the complexities of the problem remain misunderstood and out of sight for most of the general population. But that's all changing.

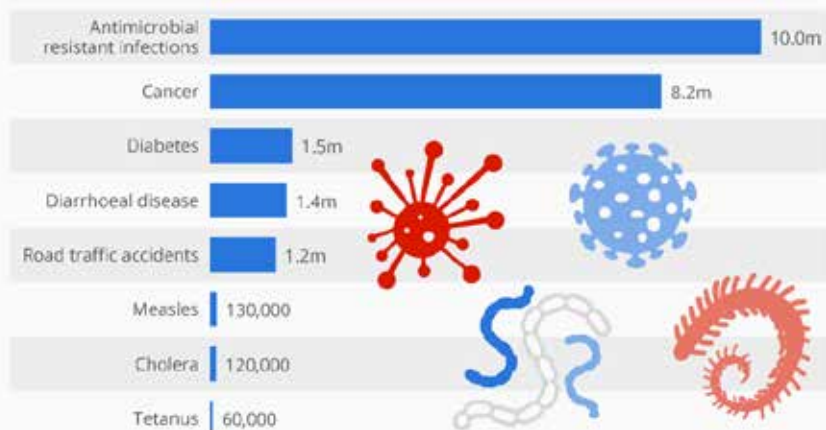
A recent study looking at consumer attitudes in five EU countries, towards diseases in intensive production systems found that, while the public is largely unfamiliar with modern animal production systems, they none-the-less perceive intensive production systems negatively.

In the study, more natural and proactive interventions to control production diseases were preferred. Preferences mainly involved changes to housing, housing-related management, and hygiene practices, with more reactive and medicine-based interventions being least preferred, as these linked into general health and welfare concerns associated with intensive livestock production.



## Deaths From Drug-Resistant Infections Set To Skyrocket

Deaths from antimicrobial resistant infections and other causes in 2050



#StatistaCharts Source: Review on Antimicrobial Resistance

statista

Concerns, perceived risks, and benefits were identified, and shown to be highly influential regarding attitude formation and subsequent consumer behaviours.

Given this lack of public awareness, coupled with elevated concern in the popular media and highly focussed campaigns about AMR, what has become overwhelmingly apparent is a need for supermarkets to be more proactive in terms of the information they are providing to the public.

Pressure too is building for governments to make laws and policies to bring down the use of antibiotics in both land and aquatic food animals, driven largely by consumer groups, national and global health bodies, and worldwide agricultural organisations such as the FAO.

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### New rules for EU

Let's be clear. Low, or sub-therapeutic, use of antibiotics for growth promotion has been illegal in the EU since 2006, but varying levels of routine and group disease prevention has nonetheless persisted in most EU countries.

While all remaining licenses for using antibiotics for growth promotion were removed in 2006, no new law was introduced saying that antibiotics couldn't be used routinely under veterinary prescription.

Following decade-long talks, on 28th January 2022, strong new EU legislation will finally prohibit all forms of routine antibiotic use in farming, including preventative group treatments.

Under the new rules, treatment will be allowed for an individual or a restricted number of animals but only in exceptional cases when the risk of an infection or of an infectious disease is very high and the consequences likely to be severe.

It's a commendable and concerted attempt by the EU to close the back door and put an end to irresponsible use in the industry.

So, in practice this means that for many farmed animals across the EU their good health will need to be achieved by avoiding routine antibiotic use and instead using alternative approaches. These may be such as reducing stocking rates, improvement in feed, use of pro-biotics such as lactobacillus bacteria (which serve a protective role against more dangerous bacteria), and improving basic animal husbandry and welfare.

Whilst the new European rules won't be applying to the UK, in the UK farm antibiotic use has already been cut by about 50 percent between 2014 and 2019. Several factors have contributed to this fall including voluntary action taken by farmers, the expectation of tighter regulations to come and the introduction of new supermarket policies.

"We've set ourselves some really tough targets because the industry recognises it's so important to preserve these antibiotics for the future," says Dr Zoe Davies of UK's National Pig Association.

"[Animal] health and welfare are inextricably linked, you can't separate one out from the other, it's about common-sense biosecurity and making sure you stick to it religiously.

"You make sure you only use what you need to, and this is where diagnostic work is so important in terms of identifying exactly what bugs you've got, rather than using a broad-spectrum antibiotic where you can get resistance. Instead, you only use what is going to work on that specific bug, for the right amount of time," Dr Zoe Davies explains.

"The vet has to have a very good justification for putting medicines into the diet before the animal starts to exhibit clinical signs."

But will this approach be enough? Supermarkets are increasingly being held to account for their policies on antibiotics use in their supply chains, where far more work is required is required to bring about real change say campaigners.

"It tends to be the case that if you just leave it to industry, it will only really go so far. And there are major difficulties in getting as comprehensive change as is needed. Particularly when it relies on the consumer understanding and demanding changes," says C  il  n Nunan, a scientific adviser to the Alliance to Save Our Antibiotics.

"Unlike some of the practices that can occur in farming, such as the use of hormone growth promotion in some



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countries, it's not the case that all antibiotic use, or certainly we don't believe that all antibiotic use is wrong. It's not the case of black versus white. It's also not the case that the main issue for the consumer is that there might be residues of antibiotics in the foods that they eat. It's more complicated than that," he adds.

"The consumer is still confused. When you go to the supermarket, what do you choose? It's not clear in terms of labelling. So, if it's all just left to industry to deal with, then what is the motivation for industry to entirely adopt responsible use? What is the motivation for it to reform certain husbandry practices that are leading to problems?" continues Mr Nunan.

### What do 'antibiotic-free' systems look like?

Broiler chicken welfare in particular is under increasing scrutiny due to concerns regarding growth rate and stocking density. With 23 billion alive at any given time, chickens are now the most populous bird on the planet - ten times more than any other bird - an astonishing achievement for a small jungle bird that originated in Southeast Asia.

It's by far the fastest growing meat product but, pound for pound, the price of chicken has fallen sharply.

"In the poultry industry, one of the huge changes that has occurred over the last 40 or 50 years is that chickens that essentially have been bred to grow faster and faster. This is widely known to be the number one cause of welfare problems," Mr Nunan says.

He points to the Netherlands as an example of how industry can adapt and improve when it needs to: It's the tale of the infamous plofkip and a furious campaign from one animal welfare group, 'Wakker Dier' which changed hearts and minds across the supply chain.

The Netherlands is a country that punches well above its weight in terms of intensive agriculture and food production and it's the most chicken-dense nation in the world where there's an average of 47 million broiler chickens alive at any given moment. In the region of Venray, they outnumber people 86 to one.

In 2015, Holland's three biggest supermarkets, Albert Heijn, Jumbo and Lidl, announced they were going plofkip-free. Plofkip, directly translated, means exploded chicken - the Dutch byword for the fastest growing breeds of meat chickens - typically Ross or Cobbs, which live just 42 days to reach a slaughter weight of at least two kilograms.

The highly successful campaign aimed at the consumer, showing images of 'normal' healthy breeds of chickens sitting next to enormous chickens at a particular age, and the difficulty these had for walking amongst other things, shamed supermarkets into stopping sales of this meat.

In one fell swoop sales of this type of chicken were cut in half, and ultimately all the Dutch supermarkets committed to only selling chickens that were from the slower growing breeds that the consumer was now demanding.

They didn't go nearly so far as the welfare campaigners we're calling for, and breeds weren't as slow growing as called for, but they did move to significantly slower growing breeds. The intensity needed to preserve a viable, profitable product was retained.

Whilst the campaign was clearly motivated by welfare standards, there was a knock-on effect; a co-incidental but dramatic reduction in antibiotics consumption. Both the industry data and the official government data showed that there was a far lower antibiotic use with the slower growing breeds, about six times lower per animal.

Crucially, however, as Mr Nunan notes, the campaign was a result of voluntary action, and therefore not regulated. So,

because two-thirds of Dutch poultry meat is exported, what has now emerged is essentially a dual industry where the higher welfare, slow growing birds are produced for domestic consumption, but the majority of production remains the lower welfare breeds for the export market.

"What this shows is that industry can very quickly change and operate profitably after that change, but if there are no rules the industry will only go so far as it needs to," states Mr Nunan.

There are other cases where industry insiders are driving up standards, and where consumers are willing to pay more for a standardised product.

Compared to the Dutch model, which is still intensive, at the other end of the quality scale is 'Label Rouge' - the 50 plus-year-old French poultry standard. It's an industry standard essentially motivated by two factors: One, the sheer will of the agro-livestock sector to re-evaluate the quality of their products, the other being the institutional will to protect the smaller producers from the effects of industrial scale poultry farming.

Birds are on average twice the age of conventional intensive breeds before slaughter, with nearly double the available space to roam around. That's a greater cost for the producer.

It doesn't sound like a recipe for mass-market commercial success, does it? Yet, responding to growing consumer demand, what has emerged is a vast market model and a quality chain that generates confidence among consumers, leading to them prefer the Label Rouge brand over the standard one despite a higher average cost of 50 percent.

Label Rouge commands 25 percent of chicken sales in France, according to Marie Guyot, director of Synalaf (the National Union of Poultry Labels of France).

Quite apart from economics, there's obviously an ethical and quality dimension here that consumers seem to have understood and embraced. But crucially it's achieved by maintaining a good level of efficiency and making use of new technologies.

Label Rouge birds are vaccinated for coccidiosis and are given probiotics plus de-wormers in their feed, and antibiotics can be used only if prescribed by a veterinarian.

Slow-growing genetics and a low-density production system clearly also offer distinct health advantages; leg problems and sudden death are minimal, and birds have good immunity (mortality for conventional broilers in France is six percent during a six-week grow-out; it is half that for Label Rouge production, even during a much longer grow-out of 12 weeks).

### Animals & antibiotics

In 1986 Sweden passed legislation to prohibit regular input of antibiotics in their pig industry, and worked hard to find measures to compensate for routine group treatments of animals with antibiotics.

The move required mobilisation of the whole production system including farmers cooperatives, vets and researchers all engaged in different aspects of animal health. New hygiene routines were established, and new types of feed were developed along with vaccines and other precautionary measures.

During the first decade after the ban, the effects of the routine treatment became clear. Implemented without any wider preparations at farm level, pig meat producers and veterinarians had to cope with an increased incidence of infectious diseases and higher mortality among piglets both during the suckling and the weaning periods. This triggered a systematic development process with disease prevention and biosecurity as key ingredients.



Whilst no two farms are exactly alike, one key characteristic that emerged from the new production system is that weaning of piglets is not allowed to take place until 90 percent of the piglets are more than 26 days old. This period considered most critical in terms of the health of the piglets and associated with high risk of infections such as diarrhea, where there is a greater need for treatment with antibiotics.

Whilst the transition was not without problems the total consumption of antibiotics decreased from about 50mg/PCU before the ban of growth promoters, to the current figure estimated to be 12.5mg/PCU.

After gaining membership to the EU in 1995, their pig industry collapsed as an influx of cheaper pig products entered the market. It took a rebranding exercise for 'Swedish meat' and a growing awareness of AMR for the industry to be finally compensated for all the work done to get rid of antibiotics. As one meat producer expresses it, "antibiotic resistance awareness is the best thing that happened to us."

This example brings into sharp contrast other highly antibiotic dependent production systems, like Italy's Parma ham and salami industry, which is representative of modern animal production practices and where antibiotic use is a core element.

By comparison Italy has a consumption estimated to be 244mg/PCU, or the UK which at around 105mg/PCU 2.

### The real price of meat

There are so many examples around the world that demonstrate how it's possible to raise commercial breeds profitably, but without routine use of antibiotics. So, what lessons can be taken?

Actually, it's pretty simple. As an industry, in the drive to produce cheaper protein, what we must simply bear in mind this question - who are the winners? It's not the producers and it's not the consumers, who are largely oblivious of the intensive rearing practices, and it's certainly not the animals themselves; it's really only the supermarkets who gain from a constant cost-shaving exercise of producing cheaper and cheaper meat.

There's no getting away from the elephant-in-the-room. Welfare: Unquestionably, the number one issue to deal with in the quest to reduce antibiotics consumption in intensive farming. And clearly there are powerful new drivers that will improve standards as farmers are compelled to adapt and modify practices forged over decades. We must also trust that farmers want to continue to offer the best possible products to their consumers.

Intensive farming is not suddenly going to become free-range and organic, but nor does it need to. If the industry genuinely cares about protecting these valuable medicines for future generations, those who are supposed to adopt a legal ban must first share the ideas that the legislation rests on and be willing to invest in structural change.

It's clear that what is needed is a global and sustained approach, reforming all aspects of antibiotic use, and full transparency in the production systems that are sustaining it. For as long as consumers want cheap and plentiful meat, it will continue to be bred evermore intensively.

For the supermarkets, the trick will be getting consumers to accept the increased costs of higher welfare, which consumers also want, that reflects the true costs of production.



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# Resilience in Covid times

## Landing in the safety net of adaptability

by FISA, Peru

The past 18 months have probably been the most dynamic times for most industries. Normally, when some kind of economic 'disaster' occurs it affects certain industries at a time. This could be the real estate industries together with the financial industries or mining industries together with production industries, and so on.

But only once in a century does it happen that almost the entire world economy goes into a spin with domino effects that don't seem to end.

It all started with a pandemic that closed industries and production lines for a few weeks - and that's without mentioning the full lockdowns most of us had to endure. After full closure of industries, there was a ramp up period that had to be managed together with high infection and mortality rates.

This in turn forced companies to alter entire production methods and redesign safety and working procedures, while trying to maintain production efficiency levels.

### Relative tranquillity on the Covid front

Following the initial 'shock' period, there were periods of relative tranquillity on the Covid front but then we all started feeling the butterfly effects of each regional lockdown.

Great fluctuation in prices of raw material, extended delivery times as a result of the production stoppages and ramp up periods and after all of the above.

With issues with global logistical supply also causing unheard of shipping industry price increases, with these companies now grateful if they can get reasonable shipping schedules - even at the higher prices.

It is under these and other local political and economic restraints that FISA has been as creative and dynamic as possible in order to overcome as many obstacles as possible.

This has allowed the company to maintain its status as a leading supplier of nets and cages that always delivers on time and never leaves an existing customer unattended.

When dealing with the previously listed difficulties, the company proceeded to implement some major changes in its working methods, and it is from here where FISA would like to share some of these adaptations.

### Covid human resource department

First, the company had to reduce to a minimum potential Covid transmission to personnel in the company. This implied reducing maximum capacity per m2 leading to a reduction in manpower on certain machines and a loss in efficiency.

As a result, it had to increase working hours to include Sundays and some unnecessary night shifts. It is during these past months that we have greatly digitalised its company and managed to neutralise some of these effects with a brighter future in the horizon.

At the same time as reducing the number of workers at any given time, we had to increase traceability capacity thus separating personnel into clearly identified groups via color wrist bands that helped identify all those in contact with any worker that tested positive to Covid and allowed to implement the adequate isolation procedures.

As part of the requirements for maintaining isolated teams we had to split the lunch break so what was normally a single 45-minute lunch break turned into four and even five 45-minute breaks for different teams. This same procedure had to be applied to the changing rooms hours and the work entrance and exit hours.

In addition to the above, for some exceptional cases we had to organise specialised transport for the high-risk personnel so they could avoid the crowded public transport. In the case of very high-risk workers, we had no choice but to request they remain at home while receiving full pay.

In order to coordinate and succeed with the previously listed targets, FISA had to create an entire new department that we called the 'Covid Human Resource department' and this





department is still active during three shifts the seven days of the week and has to serve both our production plant located in Lima and our highly labour intensive net loft located 90km north of Lima.

Following the initial shock and stabilisation period, the company FISA had to start ramping up production and guaranteeing deliveries. A first step we took was guaranteeing raw material.

#### Avoiding potential working closures

In April and May 2020, it was very unclear what industries and

countries would remain open or closed and for how long. It was under this uncertainty that FISA decided to increase its strategic stocks of raw material by 50 percent and not risk potential inadequate volumes on the production line. This meant placing immediate orders with suppliers despite not having confirmed sales.

In addition to increasing raw material volumes, it was decided necessary to maintain higher inventories of goods in process and in some cases finished goods, this in order to avoid potential future working closures in Peru.

Fortunately, the above mentioned steps proved fruitful and during the second half of 2020 FISA managed to fully supply its customer base with existing and new orders.

The current additional increase in shipping costs and instability of shipping capacities has forced FISA to further increase strategic volumes of raw materials, despite the financial costs and the increased capital allocation that is further affected by fast increase in petrol prices that has led to even higher prices of our raw materials.

The company believes that over time, all organisations will have to adapt to existing realities and learn how to produce more efficiently in a dynamic world.

In addition, it would seem that the world is going thru a ramp up period that will hopefully lead to stabilisation, with a return to a balance between supply and demand in the entire production chain.

The company hopes that its supply consistency continues to prove itself and FISA's increased efficiency will lead to future price cuts, once raw material prices and shipping conditions stabilise.



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# Obtaining high-quality spawns & viable larvae

## How to reliably produce immature fish using synthetic hormone biotechnology

**Sandra Ramos was one of three finalists of the Student Spotlight Award at Aquaculture Europe, Madeira.**

Having attended the Universitat Autònoma de Barcelona (UAB) in 2015 with a bachelor's degree in Environmental Biology, Sandra is now working on her PhD on the flathead grey mullet in IRTA, with the aim being to promote sustainable aquaculture and reproductive control of fish species with reproductive dysfunctions.

**Figure2:** Embryos of flathead grey mullet *Mugil cephalus* obtained after inducing gonadal development of immature individuals through to spawning with recombinant gonadotropin therapy.

by Sandra Ramos-Júdez and Neil Duncan, IRTA Sant Carles de la Ràpita, Spain  
& Ignacio Giménez, Rara Avis Biotec SL, Spain

Researchers from IRTA (Institute of Agrifood Research and Technology) and the company Rara Avis Biotec SL have obtained high-quality spawns and larvae. This feat has been achieved by inducing the complete maturation process through to eggs and sperm by using reproductively immature fish.

The study is the final part of a series of experiments designed to test species-specific recombinant gonadotropins, specifically recombinant follicle-stimulating hormone (rFsh) and recombinant luteinising hormone (rLh), as agents to induce the complete gonadal development in the flathead grey mullet (*Mugil cephalus*).

The work was conducted in a collaboration between the scientists Sandra Ramos-Júdez and Neil Duncan in IRTA, with Ignacio Giménez in the company in the installations of IRTA (Sant Carles de la Ràpita) with the species flathead grey mullet (*Mugil cephalus*).

These fish show a total reproductive dysfunction when held in captivity, with individuals from both genders displaying an arrest at immature stages of gonadal development. In the present work, when the experiment was initiated, all females were arrested with oocytes predominantly at a previtellogenesis stage, although some fish presented a low proportion of oocytes initiating vitellogenesis.

Whilst the majority of males did not produce sperm with the testes empty of spermatozoa and the few males that had sperm barely presented a highly viscous drop of milt. The induction

protocol applied to males and females was based on a previous study from the same group of researchers published in the Aquaculture journal.

The initial stages of the ovaries and testes development were induced with weekly administration of increasing doses of rFsh, followed by a combination of rFsh and rLh, and the final stages of development were induced by the application of higher doses of rLh while rFsh was reduced.

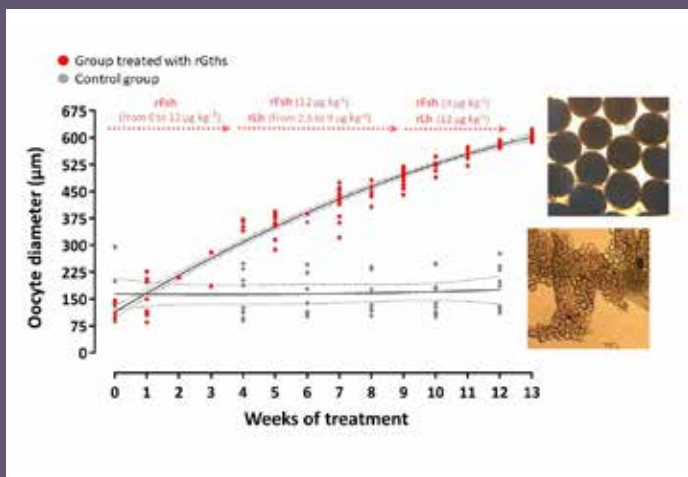
Once vitellogenesis was completed in females (see figure 1), ovarian maturation and ovulation were induced with the application of a priming and a resolving dose of rLh given 24 hours apart.

Spawning groups of females and males at a sex ratio of 1:2 or 1:3 (female:male) were formed and spontaneous spawns were obtained from all induced females. The mean initial fertilisation percentage of spawns was  $60 \pm 16\%$ , with a maximum of 84% of fertilisation.

Fertilised eggs developed embryos (see figure 2), and  $61 \pm 30\%$  of eggs hatched to provide good quality larvae. In clear contrast, those fish that were not treated with rFsh and rLh remained immature or did not show signs of further gonadal development throughout the study period.

The viability of larvae was examined in starvation conditions in 96-well plates at 21°C of incubation. 50 percent of larvae survived for 10 days after hatching, thereby, showing the high potential and viability of the offspring obtained after the





**Figure 1:** Growth of oocyte diameter in females. A group of females was treated with recombinant gonadotropins (rGths) and other group with saline solution (control). Females in the rGths group received weekly administration of increasing doses of rFsh during the initial stages of the ovaries development. It was followed by a combination of rFsh and rLh, and at the final stages of development, females received higher doses of rLh while rFsh was reduced. Those females that received the rGths treatment completed vitellogenesis, whereas control females remained immature or did not show signs of further gonadal development.

induction from immature stages through to spawning with recombinant gonadotropins to provide the opportunity to develop a larval culture in this species.

The hormones used are synthetic gonadotropins similar in structure to natural fish gonadotropins, based on cDNA sequences



**Figure3:** Sandra Ramos-Júdez during the administration procedures with a flathead grey mullet (*Mugil cephalus*) individual.



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Figure: Collection of eggs from the tanks in surface out-flow egg collectors.

previously isolated and sequenced from wild flathead grey mullets (by Dr. François Chauvigné and Dr. Joan Cerdà from IRTA-IBB-UAB).

Therefore, the synthetic gonadotropins have similar effect on the control of reproductive development as natural gonadotropins. These hormones were produced by the biotechnological company Rara Avis Biotec SL (by Ignacio Giménez), which uses recombinant technologies for the expression and production of gonadotropins in CHO (Chinese Hamster Ovary) cells.

The recombinant gonadotropins produced in these cells have shown to have a higher bioactivity and longer half-life (time circulating in the organism) in fish than those produced in other systems.

### Great potential as a cultured species

The flathead grey mullet was selected for several reasons; it permits sustainable production with low fishmeal and fish oil requirements, has good flesh quality and has great potential as a cultured species.

*Mugil cephalus* feeds on detritus and plant material and, therefore, does not require expensive (in environmental and economic terms) diets based on fishmeal and fish oils compared to other marine carnivorous aquaculture species in which replacement

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of these compounds without compromising fish growth and development and the quality of the final product is challenging.

Although market prices are currently low, good quality white fillet meat is obtained from this species. The combination of low feed costs and sustainable production (fishmeal and fish oils are mainly obtained from fisheries) can open up economically interesting markets for a sustainable and organic fish fillet. In addition, this species can be reared in a wide range of environments with different salinity, temperature, etc.

Currently, most *Mugil cephalus* culture is developed from the capture of wild fry or the induction of wild mature individuals. However, the studies on the induction of wild animals report a highly variable spawning success and/or variable fertilisation percentages.

Additionally, these practices depending on the capture of wild organisms are unsustainable in the long-term, do not assure a continuous provision of fry, and *Mugil cephalus* populations have been compromised by fishing pressure in the past.

Lastly, it is in a group of species, such as eels, that present a severe reproductive dysfunction and is a good model to test these sorts of hormone technologies to find solutions to these severe dysfunctions.

Together these points justify the necessity of developing protocols to control reproduction to produce hatchery juveniles of a species that exhibits severe reproductive dysfunction and does not mature in captivity.

### Future applications

The approach described in the present work using recombinant gonadotropins to induce immature individuals through to spawning, offers replicability and guarantees a high success in spawning and high egg quality in the flathead grey mullet.

From an applied point of view, the long-term protocol provided complete control of reproduction in immature individuals to finally obtain high fecundities from females (~1.7m eggs per female), with fertilisation and hatching of ~50 percent of the spawned eggs. These high fecundities indicate that the induction of six to seven females (~1kg) per season could permit, according to survivals reported in the literature, a hatchery to produce ~ one million fry.

The results obtained are promising for applying recombinant gonadotropins therapies to control the reproduction of new species or of those species that present reproductive dysfunctions in captivity, which would allow diversification of current aquaculture production.

The potential of recombinant gonadotropins therapies lies in reproducing any fish that does not reproduce naturally in the environment in which it is found (captivity).

Applications will include, for example,

- (i) species like *Mugil cephalus* that do not mature in the aquaculture environment;
- (ii) ornamental species of high value that do not mature in captivity;
- (iii) threatened or endangered species, both to maintain a broodstock to ensure the survival of the species and for their reintroduction into the wild.



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# Conditioning & pelleting

## A focus on finding the right process & choosing the correct ingredients

by Arthur vom Hofe, Segment Manager Feed & Oilseed, CPM Europe BV, the Netherlands

**E**very pellet mill operator has the same wish; the machine just needs to run, make good quality pellets at high capacity and for every type of feed or formulation. As a pellet mill supplier, CPM are often asked to give its opinion about the most ideal way to condition meal before pelleting for aquafeed. Our answer is always simple and revealing - unfortunately this kind of magical solution just does not exist.

Generally, it is understood that conditioning increases pellet mill capacity and pellet quality, whilst reducing energy consumption and wear costs. On top of this it can also improve the conversion rate for the animal, provide a hygienic treatment of the feed and may allow the use of lower cost ingredients.

However, the selection of the conditioning method is dependent on a wide range of process parameters. In order to make the right selection, you have to look to the input (chosen formulation) and the output parameters (required pellet quality). Failing to do so can result in a very costly machine with a negative impact on the production process.

Looking into more detail of the conditioning process (Preparation of the meal before pelleting) we can recognise three different treatments. It all starts in the grinding-mixing line where we produce a mix with a specific particle size. This particular aspect has a great influence on the pelleting process and the animal nutrition, however we will not elaborate on this subject in this article.

Here we will focus on the thermal treatment (adding energy by steam) and the mechanical treatment (adding electrical energy by kneading shearing and compressing).

### Choosing either thermal or mechanical energy

Depending on the characteristics of the material mix the

emphasis is more to the thermal side, mechanical side or combination of both in the conditioning process. In our experience, starch, fibre and fat content are parameters which greatly influence the outcome of this selection.

All pellet-conditioning systems make use of the parameters temperature, moisture and time. Pressure is applied in the pellet mill die. While at high starch formulations the time is usually less than two minutes, we recognise for high fibre formulations a retention time longer than six minutes to soften the fibres and to absorb the liquids.

High fat formulations are the most complex to transfer to good quality pellets and there we see systems which also use pressure and shear to condition the material before it is shaped in the pellet mill die. Figure 1 shows the relation of all parameters to the process in the most simple terms in one graph.

### Conditioning for a relatively short time

Formulations with a good combination of maize and wheat (typical poultry) are relatively easy to pelletise. They can be conditioned with the addition of steam for a relatively short time. If the wheat content is minimised and more maize is used the retention time requirement is increased and more mechanical energy is used in the pelleting process.

Through the years we have seen conditioners of different sizes entering the market. But all conditioners have basically the same requirements. First of all, they need to be (steam) efficient as with the increasing price of energy, it is essential to select a conditioner where special precautions are made to keep the total cost of ownership as low as possible.

Beneficial auxiliary systems are systems preventing steam escaping from the inlet of the conditioner and systems which inject the steam in or under the product so that steam consumption efficiency is optimised. A “spider” at the outlet will equalise the material flow to the pellet mill.

To minimise maintenance costs, bearings should not be



mounted directly on the conditioner shell but with some distance and they should also be sealed so they are protected from the hot and dusty environment inside the conditioner.

The mixing of liquids traditionally requires a high speed but short mixing time whilst steam conditioning requires more retention time and a longer conditioning time at low speed.

This resulted in stacked conditioning systems with a combination of both, offering optimal liquids mixing and improved retention time for steam absorption.

### **A new conditioning technology**

The California Pellet Mill (CPM) brings a new conditioning technology to the market. This makes it possible to fill the conditioner up to 70 percent and it provides extensive mixing of product particles with liquids and steam.

The improved conditioning machine provides higher possible temperatures, achieving better quality pellets and lower energy and operational costs, whilst also providing a high standard of blending for molasses and other liquids.

The design principle is based on the premise that the material is moving forwards and backwards through the conditioner and is rubbing against itself, with this then increasing liquid and steam absorption.

On top of this it has excellent product clean out characteristics after each run, a factor which improves the level hygiene and reduces cross contamination.

### **Hygiene is a key subject in conditioning**

Whilst we are on the subject of hygiene, this became a key subject in conditioning. Breeder feeds are nowadays processed under strict conditions and this have resulted in a whole range of hygienic conditioning equipment with very specific demands.

A hygienic conditioner must be easy to clean, so it has to be easily accessible with a large 'cleaning out' door. Under no circumstance product should escape which has not reached the required temperature. In combination with an improved temperature control the 'hot-start' function provides this feature even for the first product coming out of the conditioner.

An additional benefit of the hot-start function is that the pellet mill reacts much more forgiving on the warm meal, which results that the nominal capacity can be reached within minutes from start. This improves the pelleting line efficiency importantly especially when frequent product change overs are required.



After the product is heated it needs to be kept for a certain set time at the required temperature. A hygieniser is used to keep the product (first in first out) usually between two-to-six minutes. Special precautions are made to prevent heat losses and excellent self-cleaning characteristics.

For high fibre formulations more retention time (>6 minutes) is required for the material to absorb added liquids.

Liquids and some steam is added in the first mixer. After that the material is kept for a long time (>6 minutes) in a retention bin so that liquids can be absorbed.

Before pelleting additional steam is added in a second mixer. Adding too much steam in the first conditioner will result in large amount of un-processable material in the retention bin.

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## Pellet mill requirements

Generally speaking, a pellet mill is selected based upon its perceived ability to reliably produce pellets of a certain quality at a certain capacity. But there is more; in a sustainable environment energy efficiency is becoming more and more essential, which is also true for the pellet mill selection.

Using gear drive machines driven by a highly efficient motor is a step towards reducing the carbon footprint and reducing operational costs on top of that. Figure 2 includes information that relates to the use of energy in the pelleting process.

Thermal energy is added in the form of steam in the conditioner, whilst mechanical energy is added in the pellet mill die. However, the optimal amount of mechanical energy varies with the processed formulation.

It is therefore required to be able to adjust the amount of mechanical energy. This can be done with the CPM Lineator remote roll gap adjustment. With increasing distance between the die and rolls more electrical energy is consumed by the pellet mill and pellet quality is increased.

If pellet quality allows it, then the roll gap can be decreased leading to saved energy (see Figure 3). The remote control of the roll gap provides an increased safety level, which also reduces downtime.

What is also important to realise is that during the starting up of the pellet mill, roll distance can only be limited to prevent roll slippage but once running the gap can then be increased. This reduces steel to steel contact between die and roll and saves importantly on die life. And since the die stays longer in shape it also saves energy and gains capacity.

To find the maximum allowable roll gap is always a challenge. The roll slip will increase with the distance until a pellet mill choke occurs. In an effort to remedy this issue, CPM have introduced a roll slip measurement system.

Figure 4 illustrates that with increasing temperature of the product coming into the pellet mill, the roll slip is increasing till a choke occurs at in this case 80°C, whilst Figure 5 shows that the slip can be controlled by varying the roll distance.

In this way the pellet mill is operating exactly on its optimal working point. But that is not all the system prevents pellet mill chokes, reduces downtime which increases effective production capacity.

It can also determine the exact zero position of the rollers and with that prevent steel to steel contact with the die, which will result in reduced wear costs.

## Reducing mechanical energy

In the case that even with an optimal thermal conditioning system and large roll gap you can't get enough mechanical energy into the pelleting process the retention time of the die can play an additional role.

This figure shows that a higher retention time of the product in the die increases the energy consumption and with that increases the pellet quality.

Basically, it means that for ensuring both pellet quality and pellet mill capacity the most flexible choice is selecting a larger pellet mill with a relatively thin die and adjusting the energy input by varying the distance between the rollers and the die.

If pellet quality still is a challenge while using relative thick dies (ratio 1:20). What means, less steam addition (lower pelleting temperature), reduced pelleting capacity, higher wear and energy costs and increased production costs.

Apart from that, thick dies are sensitive for surface wear and many other curses. In this instance, a next step can be considered.

## If at first you don't succeed...

Something that we consider to be a quite simple solution is double pelleting. If it is hard to do it in one big step, then do it in two smaller steps! Back to thinner dies, increased flexibility, low cost raw materials and lower production costs.

This pelleting principle is extremely successful on high fibre (ruminant) formulations, in areas where low cost raw materials have replaced grains and soya.

When compared to the energy input by the use of the lineator roll adjustment, the mechanical energy input is increased further by the use of the additional pellet mill, or alternatively other pre-compactors.

With the increasing amount of fat, a higher amount of thermal and mechanical energy is required to still get a good quality pellet.

That said, you should always be very mindful that the first step to quality improvement of high fat formulations is post pelleting fat coating.

## Expander pelleting

An expander is a tube with cantilevered shaft fitted with proportioning, mixing and kneading elements. The hydraulically adjustable cone at the outlet together with the outlet ring forms the annular gap. By means of adjusting the cone, the pressure, the intensity of kneading, the product heating, and the energy consumption can be controlled.

Figure 7 shows three different formulations that have been produced. The odd tests are single pelleting tests and the even test numbers are produced on an expander pelleting set up.

At high fat and liquid formulations, where it is hard to get energy in, the expander improves pellet quality. But running the expander on lower fat and liquid formulations results in higher energy and wear costs, as well as a less user friendly and controllable process.

## There is no 'one size fits all' solution

Going over the characteristics of the different conditioning systems we can conclude that there is no one size fits all solution. The selection is depending on process parameters like the binding properties of raw material, and desired pellet quality. What works for him doesn't necessarily work for her and an incorrect selection may result in a very costly machine which have a negative impact on the production process.

What may be the safest conclusion to arrive at is that the key to the art of conditioning is to fully understand the science.

### About the author: Arthur vom Hofe - CPM Europe BV

Arthur vom Hofe is working as Segment Manager - Feed & Oilseed at CPM Europe BV, a California Pellet Mill subsidiary in Zaandam - the Netherlands, where he has worked for more than 30 years.

Mr vom Hofe has been involved in the front line since the early nineties, when representing the company for pelleting and particle size reduction equipment. Throughout this time, he has gained valuable experience of feed production processes across the world.





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# FISH FARMING TECHNOLOGY



## Tech update

### Humane smolt stunner helps hatcheries to target new markets

By converting waste into a natural, healthy and safe ingredient for petfood products and fish oils, a recently unveiled humane smolt stunner can help the aquaculture sector further reduce its carbon footprint.

Using Ace Aquatec's in-water Humane Stunner Universal (HSU) technology, the Humane Culling System (HCS) stuns smolt and juveniles without using chemicals, thus transforming a costly by-product into a sustainable fish source, whilst it has further possible applications for salmon broodstock and across fishery by-catches.

Fish due to be culled for quality reasons are typically treated with a chemical anaesthesia, rendering them unsuitable for consumption. They are then incinerated and end up either in landfill or in ensilage bins.

By removing the need for chemicals, the smolt stunner provides a more ethical way of disposing of excess smolts at hatchery facilities, as well as producing an omega rich protein that can be harnessed for new revenue streams.





**Image:** Basin at the Il Vigneto site, with multiple aerators in operation.

# Precision Fish Farming

## Digital twins for inland aquafarms

by Adriano  
Lima, Hydraulic  
Engineer, Ca'  
Foscari University  
of Venice, Italy

**Under the emerging Precision Fish Farming approach, which brings control-engineering principles to fish production, the Ca' Foscari University of Venice is implementing Digital Twins in land-based aquafarms in Italy.**

**The Precision Fish Farming methods rely on sensors, Big Data, Internet of Things, predictive mathematical models and mechanisation, with the aim of supporting producers in optimising feeding practices, oxygen supply and fish cohort transfers in light of fish growth performances, fish welfare and environmental loads.**

### The emerging framework of Digital Twins

Industry 4.0 and sustainable farming are gaining prominence in the aquaculture sector and are key factors for advancing aquaculture production and to respond to the growth vision of the EU aquaculture industry of reaching the provision of 4.5 million tons of sustainable food annually by 2030.

Currently, the reduction in the cost of monitoring devices and the increase in computation power has been revolutionising the management of aquaculture farms. Generally speaking, Digital Twins are virtual, digital representations which mirror and are connected to real objects, and which rely on real-time acquisition and processing of large data sets.

A fully implemented system ultimately enables real-time and remote management, where operators are decoupled from the physical controls, as well as the reproduction of real and forecasted scenarios.

The Ca' Foscari University of Venice is setting up Digital Twins which mirror commercial land-based fish farms, employing an approach based on the quantitative processing of environmental data and bio-responses that makes it possible to optimise the feeding, oxygen supply, water quality and fish biomass transfers and to provide short-term response capabilities.

These Twins rely on integrated mathematical models which simulate several dynamic processes, based on data from in-situ sensors and from external sources, thus allowing the estimation of key outputs concerning fish requirements, such as - oxygen and feed demand, and environmental loads (nitrogen excretion).

### The physical and the digital object

The Digital Twin mirrors the grow-out phase of fish production, from fingerlings to harvest. In parallel, the physical objects mirrored by the Digital Twins are the recirculating aquaculture systems along with their complimentary systems (oxygen and feed deploy systems, sluice gates etc.), sensors, and the contents of the water basin, like water itself, fish biomass, feed, dissolved





oxygen and other chemical species.

Compared to most industrial applications, including agriculture and livestock farming, aquaculture is characterised by a higher dependency on the ambient conditions. Most aquaculture operations, such as feeding, are typically targeted at the entire stocked population, rather than on individuals or small groups.

Furthermore, fish metabolism is highly dependent on water temperature. In the case of unfavourable ambient conditions such as temperature extremes, anoxia, presence of contaminants and pathogens, the entire population can be affected.

On account of this, quantifying relationships between 'environmental variables' and 'animal variables' is a fundamental feature of the mathematical model that translates these variables into present and future descriptions of the digital object.

The most important environmental variable is water temperature, since it acts as a forcing factor for several processes, such as fish respiration rate, fish metabolic rates (anabolic and catabolic), and oxygen saturation rate.

Other typical environmental variables include concentration of oxygen, ammonia and pH. Animal variables include fish weight or size, mortalities, and several non-observable variables (e.g., fish respiration, fish metabolic rates).

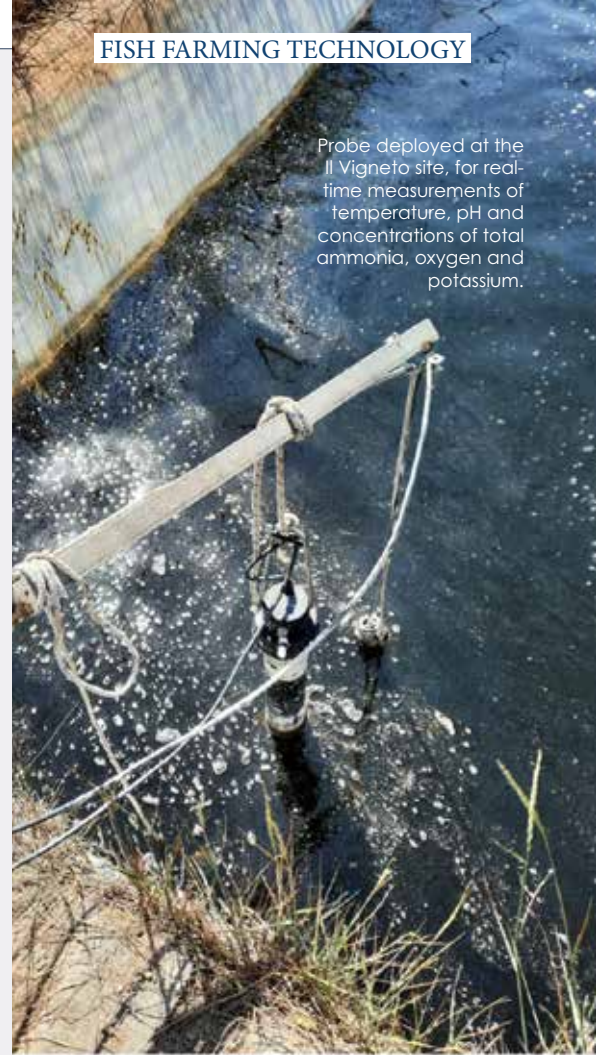
Parallel to environmental and animal variables, the digital representations are then organised into two components: water and fish, respectively.

### The pilot implementations

The Digital Twins are being set up in two land-based aquafarms in Italy. The first is a trout (*Oncorhynchus mykiss*) farm run by Troiticoltura Fratelli Leonardi, located in the Alps in the Trentino Alto-Adige region.

The developments in this pilot site were part of the H2020 GAIN Project ([www.unive.it/pag/33897/](http://www.unive.it/pag/33897/)), coordinated by Ca' Foscari, which has just ended in October 2021. The second pilot site is located in the Tuscany region, close to the Orbetello Lagoon. This site is run by Il Vigneto Società Agricola, who, along with Ca' Foscari, is a partner of the ongoing H2020 NewTechAqua Project ([www.newtechaqua.eu](http://www.newtechaqua.eu)). In this pilot case, the twin is targeted at European seabass (*Dicentrarchus labrax*) and

Probe deployed at the Il Vigneto site, for real-time measurements of temperature, pH and concentrations of total ammonia, oxygen and potassium.



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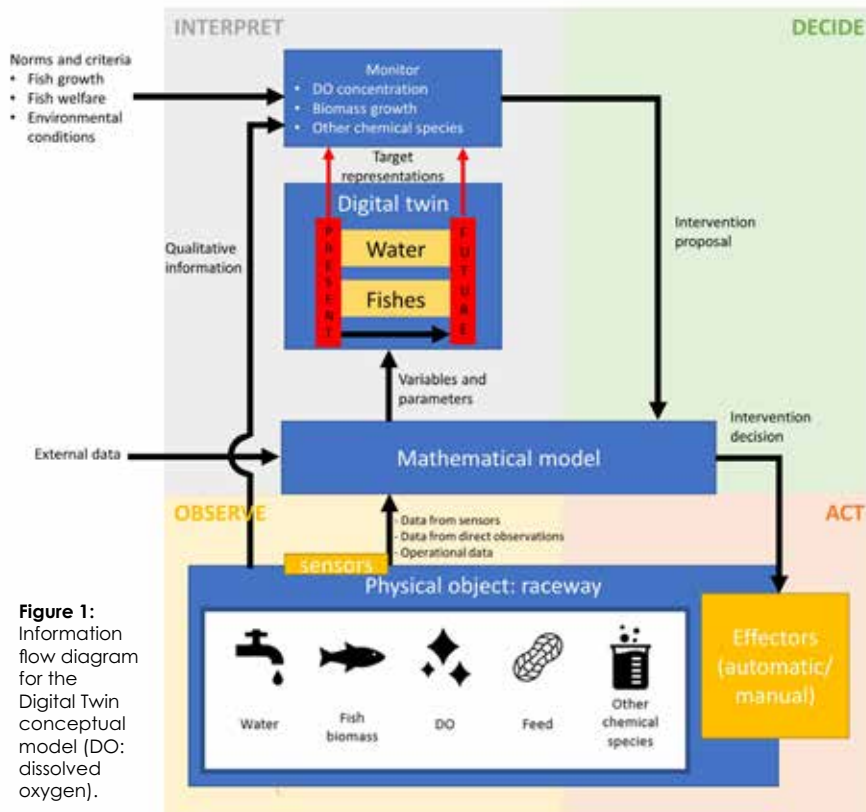



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Mechanised portable feed silo at the Tricoltura Fratelli Leonardi site.

fish weight 1) by direct weighting, 2) using a submerged frame equipped with sensors which scans fishes as they swim through it and 3) using the mathematical bioenergetic model; or the determination of dissolved oxygen concentration from 1) the measuring probes and 2) the mathematical model for dissolved oxygen transport.

By combining observations and model predictions, Data Assimilation (DA) schemes update the accuracy of forecasts with observations using model-data filtering approaches which are

gilthead seabream (*Sparus aurata*).

The farms are equipped with sensors for real-time monitoring of water temperature, pH and concentrations of oxygen, ammonia. The water in the basins receive point sources of oxygen that are supplied from stocks in liquified form and with discharge regulated through manual valves.

The basins at Il Vigneto are also equipped with mechanical aerators. The feed is manually deployed into the basins, though the transport of feed within the plants makes use of mechanised devices such as a moving gantry in the first site, and mechanised portable silos.

These pilot sites are representative of the typical technology level found in inland finfish farms in Italy and thus constitute adequate, conventional use cases to design state-of the art Digital Twin strategies in land-based systems that can support farmers in their day-to-day decisions.

### The control structure of the Digital Twin

The information flow scheme of the cyclic control structure of the Digital Twin is shown in Figure 1, with control functions and information flows distributed along the four phases of farm management, i.e., observing, interpreting, deciding and acting.

This structure was developed to reflect producers' needs and to reflect the disparate levels of autonomy of the different processes. At the current implementation stage, the Digital Twin translates data- and model-based outputs into suggestions that can be executed along an ongoing fish rearing cycle, allowing operators to optimise feeding, oxygen supply and flow rates, and to enhance the control on released nitrogen in wastewaters.

In the observing phase, quantitative and qualitative information is extracted via direct observations and data acquisition tools. Different methods may be utilised for the acquisition of data corresponding to the same state variable.

Examples in the present applications include the estimation of

integrated with the Digital Twin.

Qualitative characterisation may include observation of fish behaviour, water colour, transparency and odour, and may be used in the interpreting phase, e.g., unusual fish behaviour may indicate diseases, particularly if high mortalities are observed, and may require adaptations in the feed table.

It is envisaged that as the Digital Twin concept evolves further, qualitative information that currently flows without being used as an input into mathematical model, will take the form of quantitative datasets to be incorporated into the model-based transformations. This may include for example the use of underwater cameras or sensors along with algorithms that identify diseases or parasites.

A core component of the Digital Twin control system is the mathematical model which unifies disparate data streams and provides real-time and forecasted pictures of the state of the physical object. In the present applications, the mathematical model is composed by two modules, specifically a bioenergetic model and a dissolved oxygen dynamic model.

The bioenergetic module simulates the fish growth, at both individual and population levels, as desired by the user, based on input data characterising the forcing variables – water temperature, and food quality and quantity –, species-specific parameters, population source terms (fishes in and out) and population dispersion indicators. Apart from predicting fish growth, the bioenergetic model predicts the release of organic waste and estimates fish metabolic indexes.

The predictive capabilities of the Digital Twin anticipate alternative future states based on intervention proposals such as daily updated feed tables and alternative schedules or quantities of biomass transfers among basins. These future states can take the form of real-time actionable suggestions, which in a fully autonomous twin would be executed autonomously without human intervention, such as the regulation of oxygen by manual valves or feed deployment by automated silos.

# Remote monitoring in shellfish farming

Using big data and unsupervised learning to better forecast productivity and ecosystem impacts

by Camilla Bertolini, Ca' Foscari University, Venice, Italy

**Shellfish farming, with its reduced ecological footprint, net removal of organic material, and low food-web nutritional requirements, is one of the best examples of nature-based intensification for blue growth. Shellfish are, in fact, filter feeders, able to filter large quantity of water (circa 2-2.5 L hour<sup>-1</sup>).**

Valves opening and closing, known as gaping activity, represents a behaviour that is required for two key physiological functions: food intake and respiration. These are processes strictly linked to the growth of the individuals, and, in the end, they affect both productivity, as well as the provision of the ecosystem services linked to nutrient cycling.

Linking valve-gaping behaviour to environmental drivers can greatly improve our understanding and modelling of these processes. These models, usually based on the theories of 'Scope For Growth of Dynamic Energy Budget,' which are important when estimating biomass yield and nutrient fluxes.

These figures can then be used for maritime spatial planning and can be useful tools for maximising sustainability by optimising initial resource (bivalve seeds) utilisation to obtain the maximum returns.

Currently, these models incorporate a general temperature relationship for both clearance rate (feeding) and respiration rate, but do not consider effects of other environmental parameters such as food quantity. It is also still unclear whether acute environmental changes can cause abrupt behavioural shifts.

## Farm management strategies

Since opening and closing of valves has an energetic cost (that is also still not accounted for in modelling, but estimated to be up to 38 percent of daily expenditure) any new findings related

to this behaviour and the relationship with environmental drivers can be useful to inform farm management strategies, allowing growth rates to be predicted for the often dynamically changing on farm conditions

Precision aquaculture, which is also relevant shellfish aquaculture, applies control-engineering principles to production, thereby improving the farmer's ability to monitor, control and document biological processes (Føre et al., 2018). This involves monitoring a biological response to stress, usually a behaviour that can be monitored with various technologies grouped under the term of 'biotelemetry' (Cooke et al., 2004). To measure gaping it is possible to use sensors to detect at high frequency the distance between valves: these can rely on various technology, with the most common ones being 'hall' sensors using magnetism.

Biophys sensors (Figure 1) that were used for this work have been developed at the Royal Netherlands Institute for Sea Research (NIOZ) as long-term standalone data logging instrument that can be used for measuring valve-gaping, air/water pressure and temperature.

All sensors are located in the head of the Biophys, and they can be vacuum locked so they can withstand deployment underwater for long periods (depending on battery and settings).

## Cultivated for commercial purposes

These sensors allow one to collect large data sets on gaping activity, but interpretation is difficult due to the large numbers of environmental drivers and the intra-individual variability. To move past this obstacle, we used an unsupervised machine learning model based on k-means clustering analysis.

K-means clustering is a method that aims to partition



observations into  $k$  clusters in which each observation belongs to the cluster with the nearest mean (cluster centres or cluster centroid), serving as a prototype of the cluster.

Two congener species of mussels, *Mytilus galloprovincialis* and *Mytilus edulis*, the former in the Venice lagoon and the latter in the Dutch Wadden Sea, were studied in areas where mussels are currently cultivated for commercial purposes. Six sensors were deployed in Venice at three sites for one year (July 2019-June 2020) and eighteen sensors were deployed in the Wadden Sea in two areas for one month (September 2020). The clustering helped identifying some consistent patterns for both species.

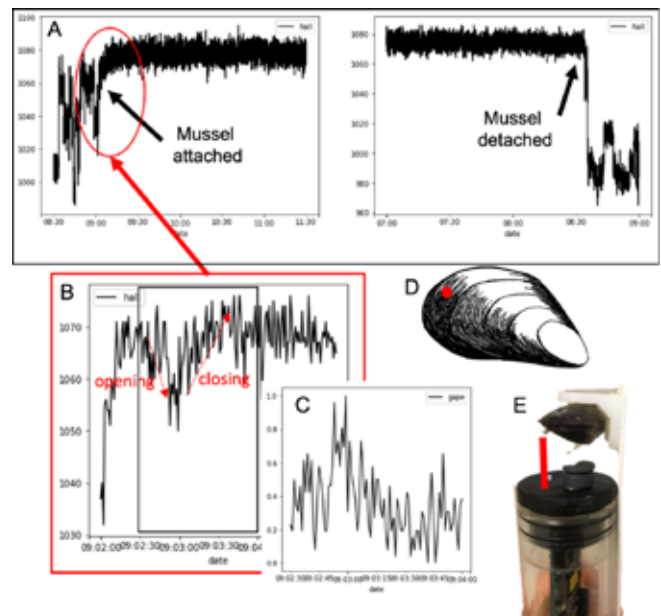
Firstly, we found evidence for a ‘large scale’ difference expressed in terms of mean opening, where mussels had a narrower aperture in some day compared to other days when they were overall open more widely (see Figure 2).

Using this first result, daily means of gaping were clustered together with daily means of environmental variables measured at the two sites (water temperature, oxygen concentration, expressed as percentage saturation, turbidity and chlorophyll for the Venice Lagoon; temperature, turbidity and chlorophyll for the Wadden Sea).

### Linked with food availability

The width of aperture was found to be linked primarily with food availability, with mussels being more widely opened at higher chlorophyll concentrations. In Venice where the study lasted one year, there was also a link with temperature, with mussels open wide in warmer days and narrow in cold days.

Once the time series were detrended by removing the daily means, and the algorithm was reapplied, we found evidence



**Figure 1:** Processing methods for the gaping data. (A) identification of the moment where mussel was attached to the sensor, jumping occurs because of the presence of the magnet attached to the shell and located directly above the sensor (D, E). Red line in (E) shows the distance being measured to quantify gaping. (B) and (C) represent data series processing described in methodology.

for a ‘fine-scale’ behaviour, which showed two main clusters expressing as being more or less ‘oscillatory’ (see Figure 3). These were not linked to specific environmental variables per se, but appeared to be site specific, in particular in the Venice Lagoon.

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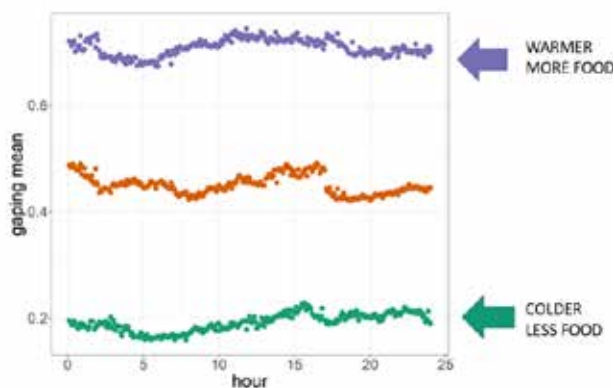
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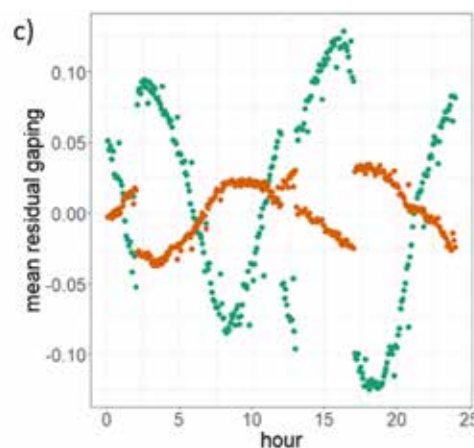
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**Figure 3:** Plotted values of the centroids of the two clusters identified, showing the two patterns of valve gaping aperture oscillation from the detrended series (y axis: proportion of aperture relative to the daily mean (0)).



**Figure 2:** Plotted values of the centroids of the three clusters identified, showing the three patterns of daily valve gaping aperture (y axis: 0 – closed, 1 – fully open).

These oscillations were conducive to the results from a first study which, using wavelets analyses, found a cyclical behaviour of gaping, a circadian rhythm linked to the tidal cycle and a site specificity of this behaviour linked to the tidal amplitudes.

This can be an important consideration when planning locations, as mussels may have different energetic expenditures if they move their valves in a more pronounced way.

Data on the energetic expenditures linked to valve gaping however are still needed, but, given the results of our work, would clearly represent a useful addition for a more optimal site selection in aquaculture.

Given the availability of sensors and the fast development of technology, collecting continuous data on valve gaping from a few sentinel organisms together with temperature and chlorophyll, is becoming more and more feasible these days.

Having such big-data should improve predictions on productivity and be a major aid for aquaculture decision support especially in the context of 'precision shellfish farming.'

The next challenges will be to include the gaping effects within the respiration and clearance terms of the models and to include these in a simple platform that can be utilised by farmers to obtain specific site predictions.

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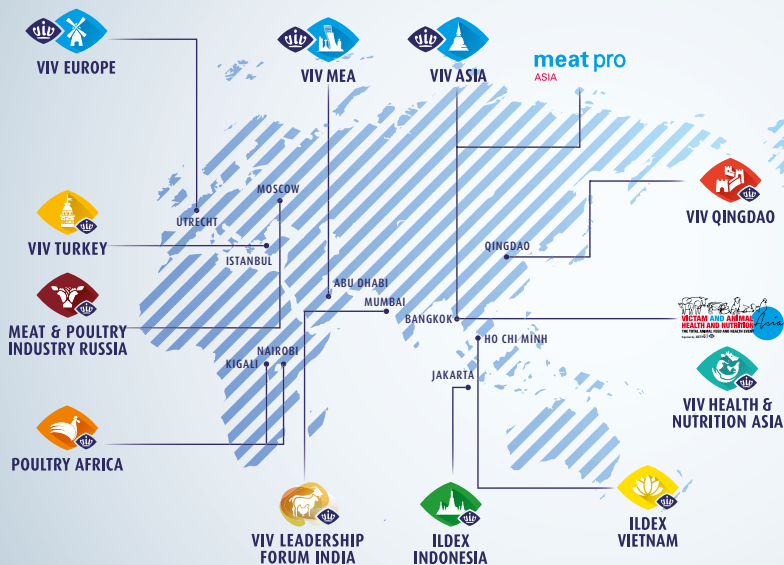
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KIGALI | SEPTEMBER 1-2

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#### VIV MEA 2021

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# Assessing & monitoring fish welfare

Developing software to help farmers to navigate the complicated network of causes & correlations

by Dr Linda Tschirren, Research Associate, Zurich University of Applied Sciences, Switzerland

**Fish welfare has become a trending topic in aquaculture, or to put more frankly - everyone knows fish welfare is important, but nobody is quite sure how to handle it yet.**

So, what is fish welfare and what can you do with it?

Fish health and welfare are not the same and both are important. Health focuses on the physiological function, where a well-functioning body means good health. Welfare goes beyond that and includes aspects of pain and perception. This makes welfare more complicated to define, measure and provide. Yet, the effort is worth it.

In aquaculture, healthy and well fish are better - environmentally, economically and ethically. Healthy and well fish have lower mortality, better feed conversion ratios and higher robustness. This results in less losses and better growth and hence makes the farming of well fish more sustainable and more profitable.

Additionally, providing best possible health and welfare to the animals in our husbandry is our responsibility. The question is how well is well enough?

## **Welfare standards & how to measure them**

A standard on how to measure welfare is needed and science has begun to shed light on the state of 'being well' in fish. In doing so, it has uncovered a complicated and multidimensional network of causes and correlations.

With our increasing understanding of the prerequisites for welfare (parameters such as water temperature or oxygen saturation) and its corresponding signs (indicators such as fin condition or feeding behaviour), we can now propose how to measure and evaluate them.

Because welfare is complex, a common understanding and a shared definition of it are particularly important. To this end, methods were developed on how to define, measure and assess fish welfare, mostly in the form of unifying indices. However,

developed methods also need to be used on-farm.

## **Applying a welfare assessment**

Standardised methods to assess welfare must be user-friendly. Whereas methods to assess health and welfare exist in the laboratory, similar provision to carry out assessments in industrial settings is still mostly lacking.

A main reason why the implementation of welfare assessment protocols in the industry has failed so far is poor applicability. In an industrial environment, there are limits for resources such as time and money as well as constraints of possibilities such as equipment and training.

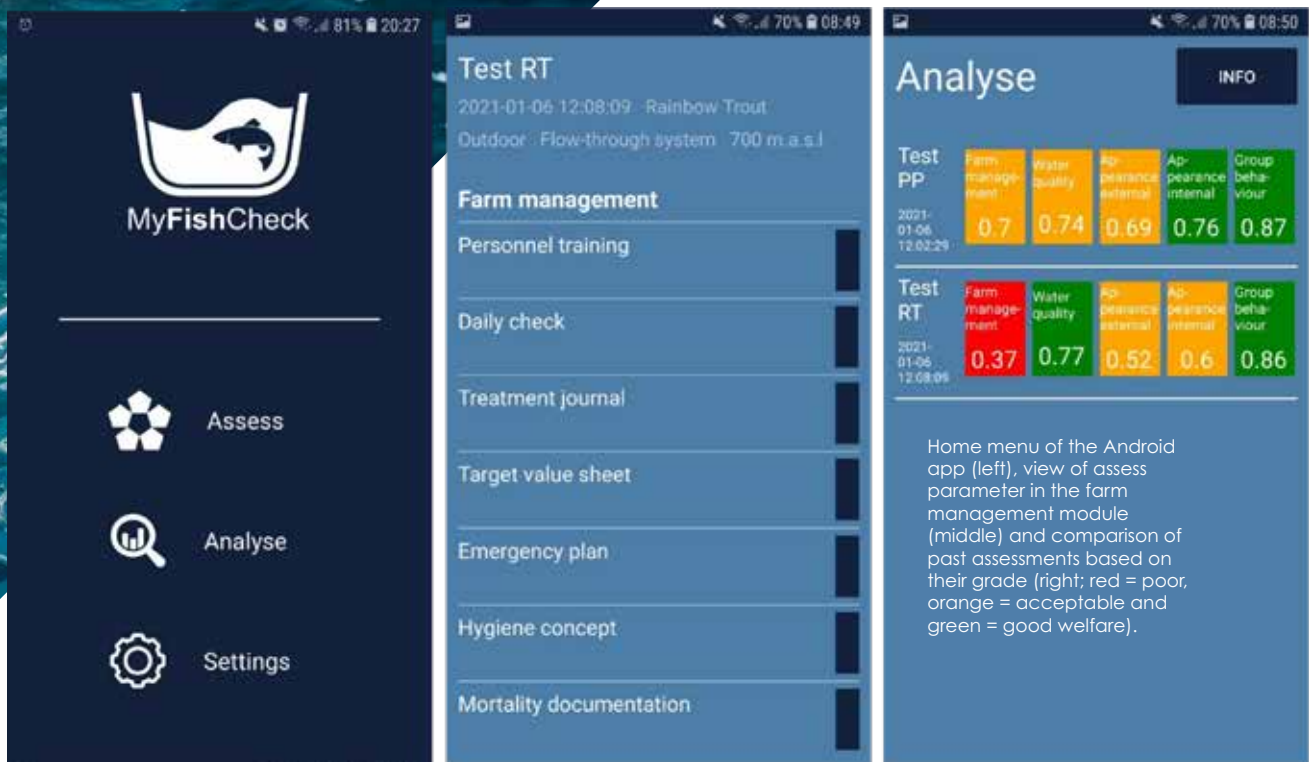
Additionally, results should be robust and clear in order to result in meaningful impacts and changes. Hence, the requirements for such an applicable method are high: low-cost, fast, intuitive and with clear insights.

## **Developing a standardised method**

The research group for Aquaculture Systems of the Zurich University of Applied Sciences (ZHAW) developed such an assessment method in five steps:

1. A digital network of information was created to link needs (fundamental requirements of a fish) with parameters (quantifiable parameters and indicators).
2. From this network, parameters that were relevant, practicable and reliable were selected and grouped into five modules: farm management, water quality, fish group behaviour, fish external and internal appearance.
3. Each parameter was scored and weighted in a transparent and repeatable manner to account for relevance and severity of stress.
4. An equation was developed to account for the accumulation of stress and to calculate an individual grade per module, which categorises welfare from critical, to poor, to acceptable, and good.





5. And finally, to facilitate the use of the model, a Microsoft Excel version and an Android app were developed.

The resulting model, called MyFishCheck, has three key features. Firstly, it is comprehensive, as parameters of health as well as welfare are included. The assessment is done in five modules covering fish, water and farm. And at least ten

parameters and indicators are used per module.

Secondly, it is applicable, as all parameters and indicators have proven relevance for welfare with a practicable measuring protocol that delivers reliable results. The model functions with only a subset of the modules or parameters. And farmers can profit from free and user-friendly versions of the model.

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Finally, the software is developable, as all parameters can be adapted to specific fish species, production systems or local regulations.

### Pinpointing areas for improvement

The model assesses fish health and welfare in five modules as this makes the assessment easier (similar parameters are measured together) and helps to pinpoint areas with potential for improvement.

1. Farm management: aspects like personnel education, hygiene concepts and emergency protocols are evaluated. These aspects are crucial to safeguard the security of the fish.
2. Water quality: parameters like water temperature, dissolved oxygen and water velocity are assessed. The quality of the system water has imminent effects on the health and welfare of the fish. Some parameters, such as the nitrogen values, are system specific and only assessed in recirculating systems.
3. Fish group behaviour: aspects like feeding activity, ventilation rates and fin position are assessed as an average of the whole tank. Observing the fish's behaviour is a vital part of detecting any changes in the system early on, from the onset of a parasite problem to the malfunction of a feeder.
4. Fish external appearance: parameters like fin condition, skin injuries and eye status are assessed on a few individuals. This examination reveals the health of the fish as a representative of the whole group and helps to plan handlings (eg: earlier sorting due to increasing aggression-based fin damage) or judge measures - such as the confirmation of degassing based on less bulging eyes.
5. Fish internal appearance: parameters like gill pathogens, body cavity and intestines are assessed on a few individuals as a representation of the whole group. Dissections give insight into the health of the fish and help to react to short-term issues (such as swallowed biochips hinting at a leak in the biofilter) and to make long-term decisions, like changing feed due to fatty livers.

Together these five modules give an overview of the health and welfare of the fish and help to anticipate problems and implement improvements.

### How to use it

The app allows the user to carry out assessments conveniently as well as to store and compare past assessments. Currently rainbow trout and pikeperch each for flow-through and

recirculating systems are included in the app, which is available in English and German. Here, for each assessment the user is lead through the process with detailed information on how to measure and score each parameter.

The Excel version, on the other hand, allows for more customisation but requires some flair for excel and equations.

Here, the parameters can be adapted, and modules can be incorporated fully or partly into existing farm protocols. Both versions, app and excel, facilitate the documentation of on-farm welfare standards, the tracking of improvements and the tracing of problems.

In general, the comprehensiveness of the model shall not impede its applicability, in other words, no need to dig daily through all the parameters. The module farm management might be evaluated quarterly, while the topic water quality can be assessed weekly or daily depending on the farm system.

Similarly, not all parameters per module need to be assessed every time. If carbon dioxide is not measured because it's a flow-through system or there is no probe or the probe ran out of batteries, the model still works. But of course, the more parameters are assessed, the better the module grade will represent the true welfare status of the fish.

Small fish farms need free access to helpful tools. Funded by the Swiss government the Excel file and the Android app are freely available under [www.myaquaculturefarm.ch](http://www.myaquaculturefarm.ch). It is our goal to develop the app further by adding more fish species and languages and improve the model over the next years according to what is learned from its application. Feedback from farmers that are using the app or have implemented the Excel files in their daily routines is crucial for any development and is therefore most welcome.

Larger fish farms, on the other hand, need a comprehensive methodology. For this purpose, the Zurich University of Applied Sciences ZHAW collaborates directly with the industry. The software company Urban Blue offers land-based aquaculture farms a software solution, which allows them to monitor key farm aspects and manage, analyse and visualise data to enable a better system operation.

Together ZHAW and Urban Blue launched the project "Animal Welfare Assessment and Control System for Fish Farms – AWACS", an innovation project funded by Innosuisse. Here the MyFishCheck list of welfare parameters is subject to yet another criterion: automatability.

The goal of the AWACS project is to implement fish welfare assessment in the available software. A constant measurement and automated evaluation of welfare is developed using image processing, descriptive analysis and predictive modelling.

This use of the digital revolution allows aquaculture to give fish welfare the ethical, environmental and economic weight it deserves.



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## Innovations this month

January 2022

For this month's Product Showcase we take a look back through the last 12 months, revisiting a selection of particularly notable products that showed innovative solutions in the aquaculture sector.

The choices that we have made incorporate a range of technologies that are designed to match the needs of fish farmers - from feed monitoring equipment to shrimp storing systems.

If you would like your product or service to appear in this section in a future edition of International Aquafeed and Fish Farming Technology magazine, then please contact us at [editorial@perendale.co.uk](mailto:editorial@perendale.co.uk)

### Offshore Feeding Canon from Fish Farm Feeder

An individual feeding system for on-growing in fish farms at sea or in large land areas, Fish Farm Feeder's offshore feeding cannon is easy to use, affordable and without automation. Built from stainless steel, it runs on a Honda 6.5HP gasoline engine and has the capacity for feed sizes of up to 10mm weighing 200 kilograms.

The Offshore Feeding Canon from Fish Farm Feeder offers those who purchase it numerous advantages when compared to alternative products or methods including a noticeable reduction in terms of feed conversion ratio, an increase in raw material savings, faster rates of fish growth, as well as affording potential savings in labour costs too.

Fish Farm Feeder manufacture feeding systems for aquaculture specifically, for all stages of the life of the fish and shrimp.

[www.fishfarmfeeder.com](http://www.fishfarmfeeder.com)  
[aqfeed.info/e/1215](mailto:aqfeed.info/e/1215)



### Optilice 4 by Optimar

Described as a thermic, non-medical and sustainable treatment for removing sea lice, Optilice 4 can be used with marine species salmon, trout and lumpfish.

The method it uses doesn't require the use of chemicals or medicals and has a success rate of removing 98 percent of all sea lice up to 36°C.

In the process, the fish is pumped from the cage to the treatment using Optimar's SQ 16 pumping system. The fish are counted and bathed in temperature-controlled water. After they are treated, they are delivered back to the cage where the sea lice are filtered out and destroyed.

Optilice 4 comes with an open construction for easy access, control and cleaning, and the flow of fresh seawater in the outfeed-chute/pipe.

Its improvements from previous technologies include a new lice filter, a minimised change for fish damage due to improvements on the treatment-tanks, and the control system Optimar Commander.

<https://optimar.no>



### ROV Aegir 25 from Ocean Robotics

The ROV Aegir 25 is a compact observation ROV system designed for demanding tasks within inshore, coastal and offshore operations. It is easily carried and operated by one person and can be used for inspection or intervention tasks.

The system can be delivered in all-copper and fibre versions depending on the requirements of a customer and tool packages available.

The protective frame shape gives the ROV a small, projected diameter which is well-suited to small space exploration. The ROV is supplied by DC power from the surface, and the power network itself is constantly monitored for isolation faults to ensure advance warning to the pilot when something is wrong, which is used to control all aspects of the operation.

Additionally, it can automatically shut down when in hazardous conditions to ensure the system can be safely recovered.

<https://ocean-robotics.com>





## SmartSpreader from ScaleAQ

The SmartSpreader is a motorised spreader designed to spread feed in improved ways. The operator of this piece of tech can select a pre-defined throwing length or allow the spreader to follow a specific pattern ensuring an even distribution of the entire pen surface. Controlling and making adjustments of the spreader at pen level is enabled by the FeedStation software, which makes recommendations in order to support the operator during feeding. The SmartSpreader is well suited for feeding during the start-up phase. By spreading the feed where the fish are located rather than having the fish seek out the feed, will result in benefits such as smoother and faster growth across stock.

However, it also suits large fish as they are inclined to swim closer to the edge of the pen to which the feeder can be adjusted accordingly.

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## DataForcis by Smalle Technologies

Described as a meteorological and oceanographic buoy, DataForcis is designed and made by Smalle Technologies. By using this product, the fish farmer is able to monitor different environmental parameters and can avoid a concentration of waste, for example, that will poorly impact fish health and growth, as well as the sustainability of the farm. DataForcis is able to accommodate any serial and analogue sensor depending on the requirements of the customer. Its key features include a high mechanical performance, easy transportation and deployment, simple mooring and minimum maintenance thanks to the marine-grade aluminum it is made out of. Its sensors monitor acoustic doppler current profiler (ADCP), dissolved oxygen (DO), turbidity, conductivity and the weather station. The buoy weighs 160kg and has a buoyancy of 500kg. Smalle Technologies develops monitoring solutions to improve upon the sustainability and productivity of fish farms.

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# Prawn & shrimp in Bangladesh

## Recent study sheds new light on the country's industry

by University of Stirling, Scotland

A new, large-scale study into prawn and shrimp production in southwest Bangladesh has found that the industry is crucial to public health and prosperity, whilst being climate-resilient, contrary to its reputation.

The University of Stirling's Institute of Aquaculture and partners conducted the study over four years, collecting quantitative and qualitative data from 240 households and 160 shrimp-prawn farms in four different communities.

Contrary to criticism in recent years of the impact of export-driven prawn and shrimp farming on communities and the environment in Bangladesh, the study found that a relatively small amount was exported, providing important income for communities, and other fish production had a low impact on the environment, whilst providing crucial nutrition.

### Safeguarding household nutrition & income

The researchers found that only 20-40 percent of all the fish produced – the shrimp and prawn – was destined for export, with a high diversity of other fish being produced, sold and consumed locally in mainly small-scale enterprises.

PhD researcher Abdullah-Al Mamun, lead author of a paper presenting the findings says, "There has been very little research into the detail of what's happening on the ground in Bangladesh, to counterbalance global discourse about food security and trade liberalisation. There has been criticism of the effect of prawn and shrimp export on communities and the environment.

"This study is important, because it shows that the family-driven, polyculture system currently in operation in southwest Bangladesh actually safeguards household nutrition and income, whilst requiring far fewer inputs than the intensive systems in operation in other places, making it better for the environment."

### Very few inputs were needed

The researchers used an interdisciplinary approach to gather data at household level. Four areas of gher dikes (where rice, fish and vegetables are grown together) were studied: high saline (coastal), medium saline, low saline, and freshwater (inland). Forty households farming fish from each area were chosen at random, and underwater biodiversity was measured.

"As well as prawn and shrimp, we found 52 other fish species growing in the water across the four areas, which is surprisingly diverse, as well as a range of vegetables," says Dr Mamun.

"The prawn and shrimp for export brought in the highest price for households. The other 52 fish species and the vegetables were consumed and sold locally.

"We found 60 percent of households were farming fish and the other 40 percent were indirectly linked – either employed by farms or along the supply chain – so aquaculture is incredibly important to people in southwest Bangladesh."

The study also found that very few inputs were needed to grow the fish, making the impact on the environment low.

### Coastal fish is more nutritious

"90 percent of these farms were extensive, i.e. with a low stocking density and relying on food produced naturally in the pond rather than on artificial feed, irrigation, energy or





electricity,” says Dr Mamun. “In the freshwater area, hatcheries were being used to produce finfish, but in the saline areas, the finfish grew naturally.”

The researchers studied 60 households from each of the four areas, asking local leaders to place families on a scale from rich to ultra-poor. Better off and poorer households that had at least one adolescent girl present were then sampled.

“Women, adolescent girls and infants are the most vulnerable in terms of getting their proper share of food, says Dr Mamun. “We measured how much food each family member got from the pot, in terms of protein, energy and food group.

“We calculated how much food each should receive, depending on their energy expenditure, and found that adolescent girls were still receiving ten percent less food than they should be.

“We also mapped the nutritional profile of what they ate, analysing biomarkers from a finger prick test. Interestingly, the girls in the high saline areas showed a higher level of a crucial fatty acid – EPA and DHA – showing that the coastal fish that they could access is more nutritious.

“While the prawns and shrimp were exported, they actually had lower nutritional value than the finfish retained for local consumption. But the exported catch gave financial strength to households.”

### A data-set of extremely high quality

The study was overseen by Professor Dave Little at the Institute of Aquaculture. “The data-set in this study was of an extremely high quality,” he says.

“The results send a clear message that consumers can safely eat Bangladeshi shrimp, knowing they are also supporting local people being able to eat more nutritionally valuable seafood.”

The study involved two nutritionists – Professor Baukje de

In the extensive shrimp polyculture ponds the marginal poorer people got chance to collect fish after final harvest by the farm owners. The team from the University of Stirling observed dozens of poorer men and women collecting fish, with each of them getting at least 1 kg of fish including tiger shrimp, with the boy pictured here collecting some high priced shrimp.

Roos from the Rowett Institute at the University of Aberdeen and Nanna Roos, associate professor at the Department of Nutrition Exercise and Sports (NEXS) at the University of Copenhagen.

It was funded by the Commonwealth Scholarship Council, UK, and the EU Sustaining Ethical Aquaculture Trade (SEAT) research project, supported by UK Aid’s Innovative Methods and Metrics for Agriculture and Nutrition Actions (IMMANA) programme.

“The UK Government is pleased to be supporting this Scottish research, bringing new insights into how prawn and shrimp fishing benefits communities and can combat climate change,” says Minister of State for South Asia and the Commonwealth, Lord Ahmad.

“This high-quality study will have a major impact in how we approach future development work by challenging long-held assumptions about smallholder fish farming, as opposed to more intensive commercial farming.

“University of Stirling’s work will enable us to look at ways to protect a vital part of Bangladesh’s economy, which offers climate-resistant livelihoods and highly nutritious food security to more than 38million people.”

The paper ‘Export-Driven, Extensive Coastal Aquaculture Can Benefit Nutritionally Vulnerable People’ is published in the journal, *Frontiers in Sustainable Food Systems*.



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2022 February



**16-17**  
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[www.aquafarm.show](http://www.aquafarm.show)



**28-4**  
**Aquaculture 2022**  
San Diego, CA, USA  
[www.was.org/meeting/code/AQ2022](http://www.was.org/meeting/code/AQ2022)

2022 March



**8-10**  
**AFIA Purchasing and Ingredient Suppliers Conference 2022**  
San Francisco, California, USA  
[www.afia.org](http://www.afia.org)



**24-26**  
**Aquafuture Spain 2022**  
Santiago De Compostela, Spain  
<http://en.aquafuturespain.com>



**25-28**  
**Aquaculture Africa 2022**  
Alexandria, Egypt  
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**30-31**  
**RASTECH 2022**  
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2022 April



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**24-27**  
**World Aquaculture 2021**  
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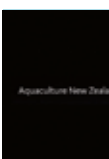


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# AQUA EXPO

In the Premier League of 2021 events

Despite Covid-19, the event managed to exceed the expectations of the attendees

by Clarissa Garza de Yta, International Aquafeed magazine

Making an analysis of the aquaculture events that were held last year at an international level, which could be carried out in person, despite the date changes; restrictions on flights, the requirements of several countries, the decrease in sponsors; the lack of vaccination and the economy pressing the companies that asked to see the light ...

Without doubt, Aqua Expo 2021 was the most relevant and attended Latin American event by the sector, leaving a great sense of satisfaction with the participants who gathered at the event in Guayaquil, Ecuador.

With more than 5000 people registered during the four days of the event, AQUA EXPO was a commercial exhibition with more than 150 national and foreign companies in approximately 6000 square metres. That's without forgetting that more than 30 international and Ecuadorian speakers of the congress also participated.

Those who attended also found themselves in the prime location to update their knowledge about the new trends applied to the industry, nutrition and feeding strategies, the management of aquaculture health in farming systems, sustainability, genetic improvement, production and management of crops, and the situation of the shrimp market.

## Because one event is not enough...

What stands out the most about Aqua Expo is that it is not just one event, but rather a series of events presented throughout the year. Comprised of four in total, they are all held at different venues including Santa Elena, Manabí, El Oro and Guayaquil.

Initially, Guayaquil was the first of the Aqua Expo, it is the largest and most international of the four and it is why it joins the Premier League of international aquaculture events, last year it generated more than US\$10 million in business appointments.

Santa Elena focuses on all the needs of the Ecuadorian larva production segment. Manabí is focused on sustainable production techniques and strategies to improve productivity in practical field management tools.

And finally, El Oro is a strategic point in shrimp production since the first shrimp farms were established in the area, they have been producing for about 50 years, improving the level of production and maintaining sustainability criteria. For more than two decades the National Chamber of Aquaculture CNA has been the organising this particular entity of the event.

Moving towards a sustainable sector is a necessary path. Far

from being a topic only mentioned at commercial exhibitions, is it a topic that is addressed daily. The invitation for producers and entrepreneurs to take the path of sustainability in the sector. In the congress, it was a topic that was tackled by several lecturers who describe the necessary actions and the benefits that walking with a vision towards the future represents.

In the same way, the CNA has been a strong promoter to have a shrimp farming sector with increasingly smaller environmental footprint, which has positioned the Ecuadorian shrimp as the best in the world.

Underlining that this task has been facilitated since the producer has been raising awareness until they have developed voluntary initiatives such as the zero use of antibiotics, working as a team with the Sustainable Partnership and striving to have a first-rate product for all markets.

## A great example of Latin American planning & development

We agree that when we see so many international companies in the aquaculture sector, so well known, establish themselves in Ecuador, develop research and investment projects; It means that things are being done well, that we have to turn to see them and learn from the integral teamwork undertaken by the Ecuadorian shrimp sector.

The growth and positioning of Aqua Expo at an international level is another confirmation of the good results that perseverance and the vision of where you want to go.

We congratulate all who have achieved this positioning and invite our readers to be aware of the Aqua Expo 2022, the next one is Santa Elena on February 9 and 10, followed by Manabí on April 6 and 7, then El Oro from July 19 to 21, to conclude with Guayaquil from October 17 to 20, believe me, you will not regret it.

See you in Ecuador!





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## Aqua Event by Adisseo

### Working towards a more climate-resilient, sustainable aquaculture

by Caitlin Gittins, International Aquafeed magazine

In a one day conference hosted by Adisseo on November 23, the Aqua Event was held under the theme 'The New Blue is Green'.

Covering an extensive number of topics around 'greening' the aquaculture sector, which all demonstrate the impact of global warming and what can be done to address this.

This list of challenges included the implementation of insect proteins in shrimp feed formulations, the potential impact of feed additives on the life cycle assessment of aquaculture, thermal stress on aquafeed formulation, amongst others.

Beginning the first of the three conferences, Gorjan Nikolik presented on the developments in the insect protein sector. The long-existing use of fishmeal and fish oil is limited to the production of fish stocks and has been substituted with vegetable-based proteins such as soymeal.

Insect proteins are likely to be driven by aquaculture and pet food, as pet food in particular is a huge market and is expected to grow. Insect proteins could be marketed as hypoallergenic, for pets that are allergic to fishmeal (and can be allergic to insect proteins but are in far smaller numbers).

The second conference titled 'The potential impact of feed additives', sees Bjorn Kok present on the increasing demand from consumers for sustainability, in awareness of the fact that food production has a considerable environmental impact – such as the production of greenhouse gas emissions, land use and water use. This has resulted in both eco labelling and leading initiatives, but also misleading claims – coined 'greenwashing'. For companies that make these green claims, they can be substantiated with standardised methodology, the life cycle assessment (LCA), states Bjorn Kok.

#### Relevance of thermal stress on formulation

Skilfully moderated by Peter Coutteau, Business Unit Director of Aquaculture at Adisseo, this conference followed five speakers, as they delivered on their range of topics. Professor Chris Carter's presentation was especially interesting, in exploring the impact rising ocean temperatures on thermal stress as a consequence of global warming.

First acknowledging that aqua feed ingredients are frequently driven by seafood consumers – such as the desire for natural pigments and sustainably sourced ingredients – Professor Carter then addressed temperature as the most important abiotic factor influencing aquatic ectotherms. Fish are able to perform at sub-optimum temperatures, but the feed they are given needs to be formulated to support these scenarios.

Professor Carter later explained that if the thermal stress on the fish is significant, the advice is to stop feeding them altogether depending on the stage at which you are in the timeline.

The Aqua Event came to a close after an enriching panel discussion, which touched on what the speakers had already spoken about, such as insect protein versus single-cell protein and the types of feed ingredients likely to have the greatest impact.

"All of us have great opportunities to contribute to reach the COP26 goals by working towards a more climate-resilient, sustainable aquaculture," remarks Peter Coutteau in his closing statement.





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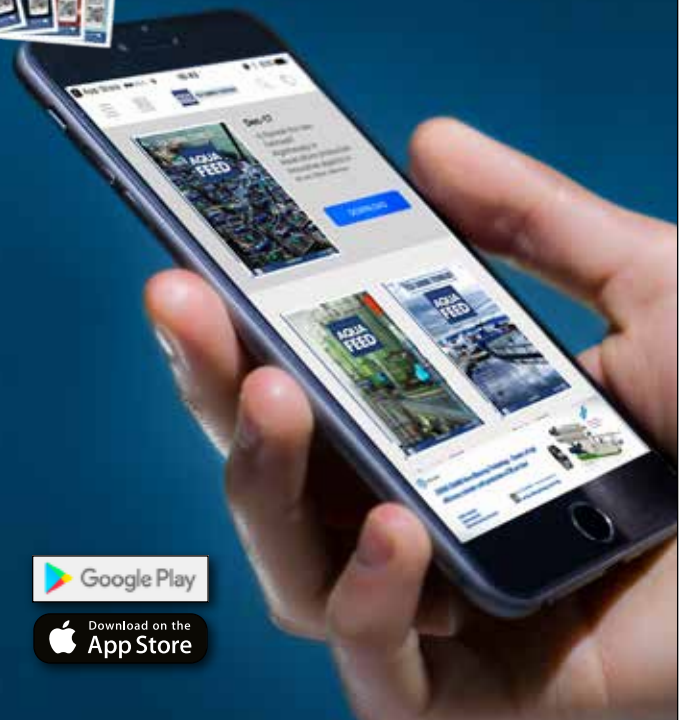
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## Aquaneo by Techna

### Outlining WFS as an important disease for consideration in shrimp farming

Broadcast on December 2, 2021, Techna's recently hosted webinar, Aquaneo, focused on the topic of white faeces syndrome (WFS) in shrimp.

Lasting 45 minutes, the online event was split into three parts: a presentation on latest understanding, preventive measures, followed by a Q&A at the end.

Presenters Sophie Reys and Pierre Fortin both delivered their detailed, informative presentations on WFS. Sophie Reys began her presentation on latest understanding by outlining WFS as an important disease for consideration in shrimp farming, due to the devastation it causes – both in high mortality rates and the cost of production losses.

Although the origin of WFS is unknown, Ms Reys explained, it has been associated with gregarine worms, vibriosis, microsporidan EHP, aggregated transformed microvilli structures, candidatus bacteria, and sudden changes in water quality. Many studies have proven that environmental impacts and stressful conditions can lead to 'opportunistic pathogens', which infect the shrimp.

The balance of the microbiota population within the shrimp is crucial, and an imbalance can lead to disease. Ms Reys went into further detail on possible causes of WFS, but emphasised that water quality is especially important as it often takes part in WFS outbreaks, and prove more difficult in areas experiencing high temperature levels. Low oxygen levels and alkalinity have reportedly led to high mortality rates in farmed shrimp population.

Pierre Fortin followed, with a presentation on preventive measures and began by discussing pathogens. Pathogens have not been identified as the cause of WFS, he explained, but still play an important role.

In order to maintain the microbiota, which Ms Feys had already touched upon as a crucial factor, there are several options available: using probiotics to insert beneficial microorganisms in the shrimp's digestive tract, using probiotics to promote the growth of beneficial microorganisms already in the tract, or using specific ingredients to prevent the pathogens from multiplying – such as essential oils and organic acids.

#### Anticipation as a preventive measure

One area to target in preventing the introduction of WFS in the first place is

the hepatopancreas. There is also proper farm management which includes pond preparation, proper biosecurity, stocking density, water quality and feeding. Particular parameters need to be monitored, such as water quality (as mentioned by Ms Feys) incorporating alkalinity, oxygen, nitrogen and carbon dioxide.

Dissolved oxygen conditions need to be considered in the context of an environment, for example, if there is a light or heavy plankton bloom; eight to 10 percent of oxygen is acceptable in the first instance but insufficient in the second. Mr Fortin suggested 'anticipation' as a means of approaching preventive measures, to ensure consistent production of shrimp and profitability.

Concluding their webinar, Ms Reys and Mr Fortin participated in a Q&A session. Several questions were covered, including the faeces of WFS affected shrimp – which is coloured white, rather than a healthy brown.

Further questions included whether the condition can be reversed using immunostimulants and probiotics – the advice for which is that these treatments should act as preventative measures, the same for which can be applied in the case of high-quality feed.



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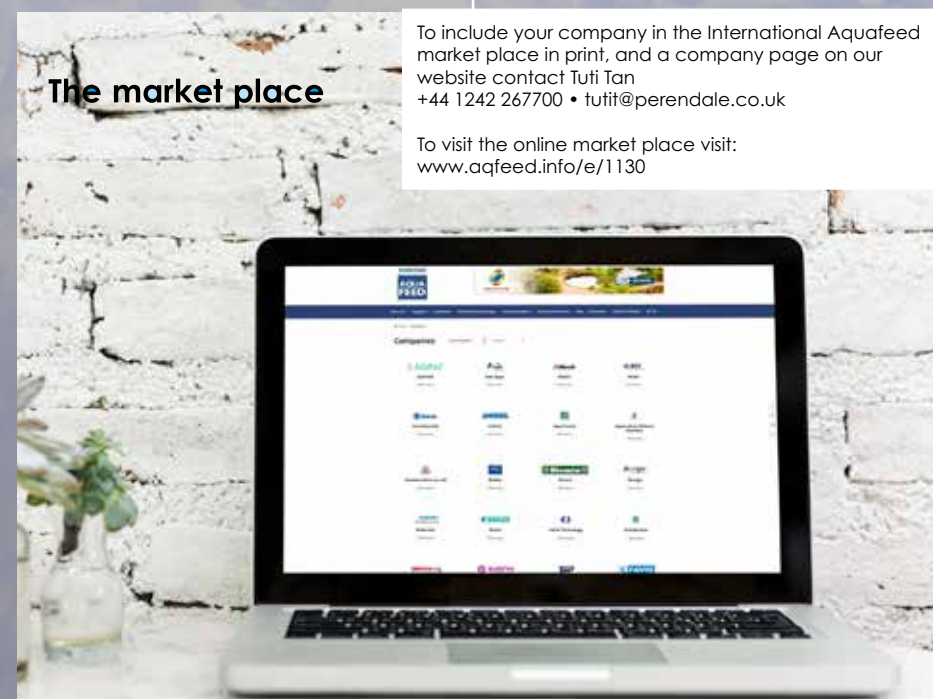


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# the interview

*Dr Philip Lyons, Global Manager of Aquaculture, Alltech, Ireland*

Dr Philip Lyons is the Global Manager of Aquaculture Research for Alltech. He holds a BSc in Applied Freshwater and Marine Biology from Galway-Mayo Institute of Technology in Ireland in addition to an MSc and PhD in Fish Nutrition from the University of Stirling in Scotland. Dr Lyons' PhD was focused on the impact of dietary factors on the structure and function of the intestinal microbiome of farmed salmonids. Upon completing his PhD in 2016, Dr Lyons moved to The Netherlands to join the R&D team of Alltech Coppens as a nutritional researcher and in 2018 he took on the role of Global Manager of Aquaculture Research for Alltech. His role within Alltech is to develop, execute and coordinate the company's global aquaculture research program. He is currently based at Alltech's European Headquarters in Dunboyne, Ireland.

## **How did it come that you chose to work in aquaculture and aquaculture nutrition?**

Growing up in Ireland, I had the opportunity to spend a lot of time in the outdoors, and it was on the lakes of the midlands and west of Ireland that I developed a passion for aquatic science. I learned to fly fish and scuba dive from a very young age and that really sparked a keen interest in fish biology, which I then went on to study at undergraduate level in Ireland and then at postgraduate level in Scotland at the University of Stirling.

My studies and postgraduate research really taught me the extent to which nutrition underpins all aspects of animal biology and reading the work of some of the greats of our industry like Dr Ron Hardy, Dr Albert Tacon, Dr Simon Davies, Dr Johan Schrama and Dr Brett Glencross really inspired me in this. I therefore made the decision to pursue a career in the field of fish nutrition as I saw it as an opportunity to link my passion for research and science with the opportunity to make an appreciable difference in how we produce healthy farmed fish to ensure food security for future generations.

Within the field of fish nutrition, I feel that we are only still scratching the surface in terms of applied and fundamental research and development topics, especially when we compare fish to monogastric and ruminant nutrition for example. There are so many different fish species, each with different physiologies, nutritional requirements and production systems and that diversity is precisely what makes research and development so exciting in this field. We are constantly on the edge of new knowledge and translating that new knowledge to applied solutions for our customers is immensely rewarding.

## **How has Alltech developed as a company within the aquaculture and fish feed industry over the past years?**

Although traditionally our focus has been on monogastric and ruminant nutrition, Alltech has developed at a tremendously fast pace within the aquaculture industry in recent years.

Our core competency is in yeast fermentation, and the additive technologies that we have developed through this process, such as Biomos, Actigen and Bioplex organic minerals have resulted in the application of products that have brought about huge benefits to fish health within our global customer base.

In 2016 and 2017, we entered the fish feed industry with the acquisition of two fish feed companies, Coppens International in The Netherlands and Guabi in Brazil. This was a fundamental game changer for us as it opened up new and exciting opportunities within aquaculture. Through what is now Alltech Coppens, for example, we have a world class research facility in The Netherlands, with eight separate state-of-the-art systems for conducting applied fish nutritional research that keeps us at the forefront of developing novel technologies.

At our headquarters in Lexington, USA we also have our Bioscience Centre that is specifically dedicated to nutrigenomics, promoting our understanding of how our additives promote animal health at the gene level. The ability that we therefore have to combine applied and fundamental elements of animal nutrition across our business is a huge strength of our company.

Alltech has therefore evolved within the aquaculture industry, from a company with a solely additive based focus to a company with a complete nutrition focus and the research

model that we have developed to reflect this evolution represents an unparalleled platform to produce applied nutritional solutions that address the most pressing challenges that the industry faces.

## **What are three key aspects of fish nutrition that you would like to see addressed and why?**

It is a bit difficult to pick just three! There are so many variables in fish nutrition that I think we need to prioritize somewhat.

However, first I think our knowledge on energy metabolism can still take a big step forward for multiple fish species. We have recently developed a Net Energy model for trout that was a first for the industry and this fundamentally changes how we address feed formulation for that species.

I believe such a model can be applied in other fish species and so that is one topic that will be addressed further in the future, following the knowledge that has been developed in monogastric animal nutrition.

The development of such models takes on a new level of importance when we consider how flexible we will have to be in the future when it comes to making responsible choices in raw materials to be used in fish feeds as the availability of those raw materials changes.

Second, I think the whole area of palatability and the factors that govern feed intake in different fish species is a massively understudied and misunderstood area of fish nutrition, which is surprising given how fundamental a role feed intake plays in animal performance. The development of further knowledge of the impact of different additives or raw materials on feed intake would represent a big step forward for the industry in terms of how we use such ingredients to improve feed efficiency and on-farm performance.

Finally, I would say that as an industry we still have a lot to learn about how we quantify and manage waste production in aquaculture systems. The ability to accurately quantify faeces quality characteristics and the links between indigestible nutrient loss and the effects on biofiltration apparatus and thus fish health in fish production systems will bring about appreciable gains in farm efficiency and so I also see that as a key area where further knowledge will be developed.

## **The environmental impact of aquaculture and the sustainability of the industry is a trending topic in recent times. What are you as a company doing to address this?**

Our company was built on the ACE vision by Dr Pearce Lyons, 40 years ago. The ACE principle is based on a vision that our products should improve the health of the Animal, Consumer and the Environment and so the topic of sustainability has always been at the heart of our company.

Today this vision has evolved into the 'Planet of Plenty', which guides all aspects of our business through the adoption of improved and sustainable farm management practices across the entire animal nutrition industry.

Within Alltech, we are constantly seeking partners that share this vision and have we have developed strong collaborations with a number of different companies to further this concept. Specifically focusing on the aquaculture division, we recently developed a program to not only talk about the whole topic of sustainability, but to actually accurately quantify how sustainable our raw materials and finished feed products are.

Therefore, within Alltech Coppens we developed a system





that ranks all of our feeds based on measurable sustainability indices. We do this based on the data generated through life cycle assessments of different raw materials from several databases such as that of the Global Feed LCA Institute (GFLI) along with several other internal and external databases that correct for the specific characteristics of our business.

Each feed that we produce is also corrected for its expected FCR, which adds another dimension to the scoring system and makes it applicable to our customers on-farm. We will continue to improve this scoring system as we continue to generate further data through detailed LCA of different ingredients that we use alongside the data that we generate from our bioscience centres, production facilities and through collaborations with our customers and suppliers.

**Is recirculation farming likely to gain consumer support over pond, river and coastal fish farming? Do we have the technology to sustain recirculation systems indefinitely?**

I think this is very much a regional market and species-specific question.

There is no doubt that RAS confers huge advantages over other systems in many cases in terms of the amount of control that can be exerted over water quality and fish health.

We are firm believers in the further development of RAS technology for the farming of a wide variety of fish species such as Salmon, Trout, African catfish and Sturgeon and we have developed a very detailed knowledge base on producing tailored RAS diets for these species within our feed division.

I firmly believe that RAS will continue to grow, but that growth will likely go hand in hand with more traditional forms of fish production that fit the specific geographical and market conditions within each region worldwide.

The industry is still learning about the optimal way to conduct RAS in large scale, and it is very exciting to see this technology continuously improve and be applied to an ever-expanding number of species.

I also believe that the adoption and application of big data analytics and improved on-farm camera and sensor monitoring will become more and more important in the further growth of RAS worldwide.

# People

## THE INDUSTRY FACES



### Ex Mowi CEO appointed as the new Bio Marine chairperson

**F**ormer Mowi Chief Executive Officer Alf-Helge Aarskog has been appointed as the new chairperson of Bio Marine.

The company, which is headquartered in Surnadal, Norway provides oxygen systems for aquaculture and offers a variety of other solutions for environmental control of pens.

Mr Aarskog served as CEO of Mowi since 2010. Prior to this position, he was the CEO and Executive Vice President at Lerøy Seafood Group ASA.

The news of Mr Aarskog's appointment was announced shortly after the disclosure that seafood investor Bluefront Equity has invested an undisclosed amount in Bio Marine AS.

"A number of investors have contacted us in the past few years, but we have decided to team up with Bluefront Equity because we share both the same market view and values," comments Martin Gausen, managing director of Bio Marine.



### Experienced operator joins Blue Ocean Technology as its new Mechanical engineer

**B**lue Ocean Technology AS, are growing strongly with the addition of increasing numbers of projects, both on land and at sea, at home and abroad.

In order for this expansion to go as smoothly as possible, the company is bringing in new key personnel.

Martin Solbakken has been hired as Mechanical engineer. He comes from a similar position at JL Bruvik – and also has a background as sheet metal worker and as a travel fitter.

"Martin's background is perfect for us, with his combination of hands-on experience from the field and a specialisation in technical drawing and superb AutoCad/Solidworks skills and experience," says Hans Runshaug, CEO in Blue Ocean Technology.

Mr Solbakken will be responsible for designing and constructing the Blue Ocean Technology systems, as well as ensuring quality before and after delivery.



### Lead Scientist joins Benchmark Genetics

**A** well-known personality in the aquaculture genetics and animal breeding communities, Professor Ross Houston joins Benchmark Genetics (BG) on March 1st, 2022, as Director of Innovation, Genetics.

In the role of Director of Innovation, Ross will lead BG's strategic development of innovation and R&D to support business growth and secure the company's competitive advantages.

"I am convinced that having Ross to lead our strategic development of innovation and R&D will place Benchmark in the forefront of this progress," says Dr Morten Rye, Director of Genetics in Benchmark.

Mr Houston has authored and co-authored over 100 peer-reviewed publications and has received several awards for his contributions to the scientific community. He is excited about the new position and adds: "I have been collaborating with Benchmark scientists for several years, and I am impressed about how the genetics business area has developed during this time."



### Former Cermaq, Pharmaq CFO elected to board of salmon farmer Nordlaks

**F**ormer Cermaq and Pharmaq CFO Tore Valderhaug has been elected to the board of Norwegian salmon farmer Nordlaks. The vastly experienced executive is already a board member of Salmenes Camanchaca, Lingalaks, Lumarine and ACD Pharmaceuticals.

Mr Valderhaug is also currently serving as a board member of Salmenes Camanchaca, Lingalaks, Lumarine and ACD Pharmaceuticals.

In 2014 Mr Valderhaug was appointed CFO at Norwegian vaccine manufacturer Pharmaq, after announcing his departure from Norwegian salmon farmer Cermaq, where he was CFO from 2009.

Nordlaks is a family-owned aquaculture group that strives to create value of all the resources in the value chain, from roe to table, in a sustainable manner.

The company's new board now consists of chairman Bjordal and Deputy Chairman Inge Berg, together with board members Therese Steinum Berg, Robin Harald Berg and Mr Valderhaug.



# Vertical Vacuum Spraying Machine

## SZPL Series



Particle Diameter		Model
1~30mm		SZPL 2000, 3000, 5000
Liquid Addition	Spray Uniformity	Residual rate
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