



How can
aquaculture
contribute
to feeding
9 billion people
in 2050 in a
sustainable
way?

*feeding
the future*

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feeding the future

Aquaculture: bridging the gap

We addressed the challenge for agriculture of doubling food production while halving the footprint in our 2010 Feeding the Future booklet. Aquaculture has an equivalent challenge, though providing a far smaller proportion of the food needed by nine billion people in 2050 it still can be an important contributor. Seafood is widely appreciated as tasty and excellent nutrition. However, the ocean fisheries cannot increase yields without destroying the fish stocks on which they depend. Aquaculture must bridge the gap between sustainable fisheries and global demand. Having grown rapidly over the past four decades, aquaculture already provides a substantial proportion of the fish, crustaceans and molluscs we eat. As contributors to this booklet discuss, for continued growth we require greater sustainability.

Sustainability is in the nature of Nutreco. In 1994, when Nutreco was founded, we chose our name to reflect our activities and concerns, **nutrition**, **ecology** and **economy**. These concerns are central today as we face the global challenge. Companies now part of Nutreco were aquaculture pioneers. They introduced many technical advances such as extruded feeds. Operating today as Skretting, they are leading the way in reducing our



Wout Dekker,
CEO Nutreco

dependence on fishmeal and fish oil in feeds, an essential development for sustainable growth in aquaculture. Elsewhere, the industry is overcoming other challenges, for example using vaccines rather than antibiotics. Twenty years ago aquaculture was strongly criticised for its use of marine raw materials and antibiotics. The industry recognised the importance of addressing these issues to maintain its licence to operate. Stakeholders in the value chain worked together to resolve them. Simultaneously sustainability goals were aligned with the policies of the various governments regulating aquaculture.

Since 1996, Nutreco has organised the AquaVision business conferences. They provide a neutral forum for stakeholders, policy makers and issue groups to discuss issues and the sustainable growth of aquaculture. In 2000 we added an alternating Agri Vision conference. These conferences contribute to our strategy and have confirmed our belief that sustainability is fundamental to the future of Nutreco, to growth in aquaculture and agriculture, and to feeding the world in 2050.

A large crowd of people is gathered on a steep hillside, likely at a festival or event. The crowd is dense and diverse, with many people wearing traditional Japanese clothing. In the foreground, a blue banner with white text is overlaid. To the right, there are traditional Japanese buildings and a sign with a pedestrian symbol. The overall scene is vibrant and busy.

what are the challenges
of feeding the world in 2050?

The challenge of feeding the world in 2050

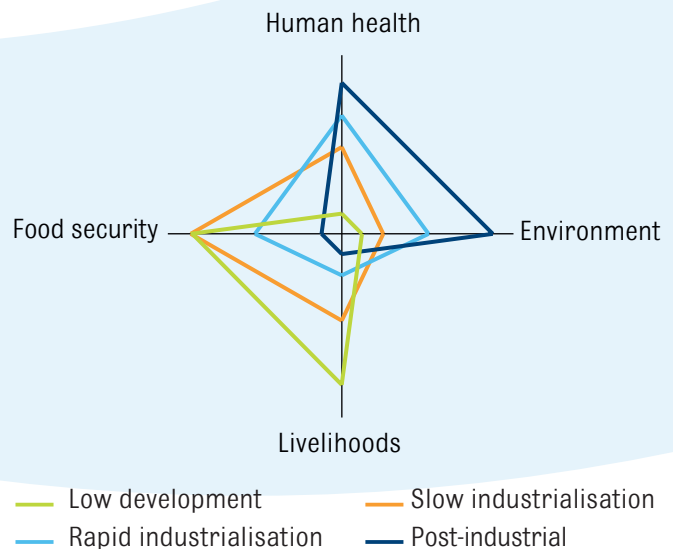
The trends of global demographics show us that the world population is growing and will continue to grow. It is around seven billion today and by 2050 it will reach nine billion: two billion more mouths to feed. Population growth is mainly in emerging economies such as China, India and Brazil. Their increasing wealth adds to the challenge as people are earning more and are increasingly urbanised. Rising incomes lead to a shift in dietary patterns as these new consumers choose to eat more protein-rich meals with meat and fish. Increased urbanisation leaves fewer people to produce more protein food to meet this demand, which means food production must become more efficient.

A third factor driving up the demand for fish is the spreading recognition of fish as excellent nutrition, providing highly digestible proteins, essential vitamins and minerals in an easily accessible form. In many species there is the additional benefit of health promoting omega-3 fatty acids.

On the supply side, however, the traditional source of fish from the wild catch cannot be increased above today's levels or we will deplete stocks. In fact we may need to reduce the catch further to be sustainable. The inevitable conclusion is that aquaculture must fulfil its potential as a means of supplying fish for consumers and fill the growing gap between supply and demand. And it must do so in a sustainable way, with sustainable feed raw materials and minimal environmental impact, and it must be recognised and accepted as a valid provider of excellent food.

The graph illustrates the balance of priorities, in the form of policy objectives, relating to livestock production in societies of differing status. Different countries and societies may prioritise objectives differently, depending on factors such as income levels, relative role of smallholders in the sector, importance of and prospects for exports, and degree of pressure on and degradation of natural resources. In general, the objectives will be prioritised differently according to the country's stage of economic development.

Balancing societal objectives



Source: FAO, 2009, The state of food and agriculture, 94 - 100.



Dr Jacques Diouf
*Director-General of the
Food and Agriculture
Organization of United
Nations (FAO)*

“ More food will have to be produced over the next decades than has been produced during the past 10,000 years combined

World population is expected to grow from the current 6.9 billion to more than 9 billion in 2050. About 90% of this growth will be in Asia and Africa. On average, those people will live longer. Life expectancy at birth is projected to rise from 68 years today to 76 years in 2045–2050. Today half of all people worldwide live in cities. About the same percentage is poor, living on less than US\$2 a day. In 2050, urbanisation will have increased to 70% of the world population, making more people dependent on fewer farmers for their food. At the same time, per capita incomes are projected to be a multiple of today's. With more money to spend, people tend to eat more animal products, notably when income goes above \$2 a day. Food follows the flow of mouths and money. Feeding more than 9 billion wealthier and longer-living mouths in 2050 would require raising overall food production by at least 70%, possibly doubling it. Globally, animal protein consumption is expected to double in the first half of this century, towards more than 465 million tons of meat and more than one billion tons of milk. The strongest growth is expected in the consumption of farmed fish and chicken. By convenient coincidence, these also seem to be the animal protein sources with the smallest carbon footprint.



“ More from less



Jason Clay
*Senior Vice President of
Markets Transformation*
WWF

We only have one planet. The math is simple. Population times consumption must relate to one planet. Currently, we are living at about 1.5 planets. Our global footprint exceeds the world's capacity to regenerate by about 50%. If we continue as we are today, we'll need the equivalent of two Earths by the 2030s but there are no extra planets. We need more from less and we need to restore this planet. We must care for it as if our lives depended on it... because they do!

Aquaculture is the fastest growing food production system. Today, aquaculture accounts for half of all seafood consumed directly by people. With many global fisheries fished at or beyond capacity, aquaculture will be the source of all additional seafood consumed per capita. Given the production efficiency of some aquaculture species it is predicted that “white fish” from aquaculture will equal chicken by 2050, then surpass it. In China, aquaculture production already equals poultry. However, aquaculture can have unacceptable impacts. We must identify the key impacts and work with producers to make performance levels acceptable. This is why WWF works with Nutreco and others to develop credible global standards for a dozen aquaculture species and the Aquaculture Stewardship Council (ASC) to hold those standards.

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what is
the role of aquaculture?

The role of aquaculture

Aquaculture is the rearing of fish, shrimps, other crustaceans and mollusks for consumption. It has been practised for centuries: the earliest known publication dates from 500 BC. Aquaculture ranges in scale from subsistence level to farms producing thousands of tonnes. The type of aquaculture depends on the quality, quantity and temperature of the water available combined with the technology applied, the management input, the infrastructure available, the productivity wanted and the species being produced.

On a global scale aquaculture is responsible annually for around 68 million tonnes of fin fish such as carp and Atlantic salmon, molluscs, aquatic plants and crustaceans such as shrimp. In total over 300 species are raised in aquaculture but only about 40 are economically significant. Output from these has risen substantially in the past 20 years. Manufactured feed is used in the production of around 29 million tonnes of fin fish and shrimp. China is the world's largest aquaculture country with an annual production of 22 million tonnes (excluding molluscs), of which 16 million tonnes is carp. In Europe, the Americas, Australia and New Zealand the main species are the salmonids: Atlantic and Chinook salmon and trout, both

freshwater and sea trout. Other important aquaculture species are tilapia, pangasius, barramundi, groupers, cobia and snapper in Asia and Africa and sea bream, sea bass and turbot in Europe.

World fishery production is relatively stable at around 90 million tonnes of which 70–80 million tonnes is currently used for human consumption. Most of the remainder is converted into fishmeal and fish oil, which are used in fish feeds for carnivorous species such as Atlantic salmon and shrimp. Fishmeal is also used in pig and poultry feeds. The sustainable harvest from fisheries cannot be increased from current levels. However, demand from the human population is greater and increasing. Aquaculture bridges the gap and must increase in scale as the gap widens. The 2008 State of World Fisheries and Aquaculture report of FAO estimated aquaculture provided 47% of the 16.7 kg per capita consumption globally. Aquaculture developments are likely to come in more sophisticated land-based production and larger sea sites further from the shore. The challenge is to bridge the gap sustainably.

“ Aquaculture is important to China



Mr Lin Yi
*Executive Vice Chairman
& President*
China Fishery Association
Ministry of Agriculture

In China aquaculture has an important role in developing more safe food products for the future.

Today, aquaculture production in China accounts for more than 10% of the total food output. China is also a major exporter of seafood, with a positive impact on China's trade balance. All fish species farmed today in China are considered important as they play different and important roles in various regions of our country. As the world's largest producer of farmed fish and seafood, we are all aware of the challenges the rapid growth of the world population represents in terms of providing sufficient quality food. The Chinese consumer market also is undergoing changes that will require increased production of seafood and the Chinese aquaculture industry will contribute importantly in this development.

Sustainable production of seafood is a priority for both the Chinese authorities and the industry itself. The aquaculture industry will develop in a sustainable manner based on market situation and demand from consumers. First of all production must generate a healthy product providing safe food for the market. Further vital steps include dealing with environmental issues in accordance with accepted standards and the industry's consequential emissions of CO₂ must be controlled.

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Maria Damanaki
*European Commissioner
for Maritime Affairs
and Fisheries*

“ Ensuring aquaculture can fill the gap

Aquaculture is a key alternative to capture fisheries and an important economic activity, with significant growth and job-creation potential in regions around Europe. It is dynamic and diversified with products including marine finfish, freshwater finfish and shellfish. But we need more to complement the fisheries. If aquaculture did not exist, we would have to invent it. The demand for fish and seafood is steadily rising and declining European fishery stocks cannot meet the demand. Aquaculture can offset the widening gap.

There is a challenge to ensure aquaculture is environmentally friendly. The major objectives of sustainability are achieved to a significant extent. Aquaculture in Europe has good environmental, and health protection, standards. It has access to good technologies and high-quality research. Animal welfare is being addressed. Even so, we face problems with competing economic activities in places where aquaculture is conducted. Maritime spatial planning is important to reconcile such conflicting interests. Much remains to be done. A key task is to secure information for consumers. We must give the facts and figures about aquaculture as its image is not as good as we would opt for if aquaculture is to fulfil its role as a source of fish and seafood.

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Aquaculture value chain

Running from feed raw materials, from land and sea, through to fish products for sale to consumers, the aquaculture value chain has several links. The texts here were provided by leading international representatives of each link.



TASA is privileged to fish in the world's richest and best monitored marine ecosystem. Peruvian anchoveta is the most abundant fish of the coastal ecosystems but is increasingly targeted by TASA and others for direct human consumption products. However, the Total Allowable Catch and current scientific evidence indicate we can supply fishmeal and oil to sustain aquaculture long into the future. TASA strongly supports fishery management by the Peruvian Sea Research Institute and Peruvian and international policies for sustainable fisheries. We continuously explore environmentally friendly technologies for fishing vessels and factories. In 2010 TASA obtained certification with the IFFO Global Standard for Responsible Supply and is committed to full MSC certification. It is our way to contribute to food security and business for tomorrow.

RAW MATERIAL PRODUCERS

FISH FEED

FISH



We are aware that Cargill's global reach in agricultural and food products creates expectations for leadership in responsible resource stewardship. Sustainability requires environmental innovations and using today's resources wisely. We work with seafood supply chain partners to minimise the environmental impacts of farmed seafood, leveraging our expertise and connectivity across many Cargill businesses to explore ways to reduce and replace fishmeal in aquaculture feed. We contribute knowledge, skills, financial and technical support to organisations around the world to build the world's capacity to feed itself sustainably. Ultimately, our success depends on the growth and health of the communities in which we operate.



Skretting is the world leader in fish feed, with products for over 50 species, including feed for shrimp. Skretting feeds provide balanced nutrition from hatchery to harvest. The nutrition is stable and concentrated, enabling fish and shrimp to feed efficiently and grow to their full potential. Many farmed fish are carnivorous, for example salmon, trout and sea bass. Fishmeal and fish oil are important components of their feeds. They are combined with ingredients such as vegetable proteins, cereal grains, vitamins and minerals. As aquaculture expands, Skretting is discovering ways to share the limited marine resources more widely while maintaining the nutritional value of the feed for farmed seafood and the eating quality and benefits of the end product for the consumer.



Lerøy Seafood Group covers the value chain from eggs to market. Consideration for the marine environment, fish health, fish welfare and social responsibility are key elements of our values. Our salmon and trout are produced by regional companies familiar with their local environmental challenges.

We believe that increasing production from aquaculture in harmony with nature is a best option in supplying a rapidly-growing population with healthy food. Success requires stringently sustainable solutions, raw materials and environmental measures that ensure efficient production with minimum impact. We will use our unique competence in aquaculture, processing, sales and distribution to help ensure continued growth in aquaculture and to create value for our local community, owners, customers and employees.



Morpol is the world leader in smoked salmon, supplying smoked and marinated salmon across Europe, the US and Japan. Sustainability is a constant theme in Morpol. Responsibly farmed Atlantic salmon from Norway and Scotland, often from Morpol farms, and Pacific salmon from MSC certified fisheries are processed at our plant in Poland. The plant is designed to achieve efficiency through scale, utilising every part of the fish while focusing on food safety and outstanding quality. Morpol products are for retail and food service, packaged under our own and retailer labels and ready-to-eat or ready-to-heat straight from the pack.

FARMING

FISH PROCESSING

RETAIL

PESCANOVA

Lo bueno sale bien

Pescanova is a major fishing company, an important fish farmer and a processor of fish into frozen food products.

Pescanova is developing environmentally compatible fish farming methods to offer high quality products with guaranteed traceability. Fish farming includes salmon in Chile, tilapia in Brazil, and sea bream, sea bass, sole and turbot in Spain and Portugal. Shrimps are farmed in Spain and several Latin American countries. Quality, food safety and sustainability are core concerns as Pescanova continuously builds productivity to meet the growing worldwide demand for fish products for today and tomorrow.



Auchan is present in 13 countries in Europe and Asia and is a major retailer of fish products; both fresh and further processed. The Group is committed to acting ethically, to operating according to environmentally-responsible principles and to encouraging customers to buy sustainably. Auchan requires its fish products to be sustainable, avoiding endangered species and inappropriate fishing practices. It requires guarantees of sustainability of feed raw materials used in farmed fish such as salmon and trout and of standards of animal welfare. In emerging economies Auchan encourages aquaculture practices with low ecological footprints and where producers are justly rewarded.



what are the challenges
for aquaculture in fulfilling its role?



The challenges for aquaculture in fulfilling its role

Aquaculture provides a substantial volume of fish for consumption but to feed the world of 2050 it must produce more, more efficiently and with far less impact than today. Manufactured feeds are important in commercial aquaculture, providing balanced nutrition in a stable form, enabling the fish to grow to their full potential. Many farmed fish are carnivorous. Fishmeal and fish oil are key components of their feeds, combined with ingredients such as vegetable proteins, vitamins and minerals. Fishmeal and fish oil are derived from the wild catch and the supply cannot increase. The sustainable supply must be shared across expanding production, supplemented with other sustainable raw materials to make aquaculture a net fish protein producer. This is far more efficient than using trash fish; that is fish caught and fed directly to larger species in aquaculture pens.

There are further challenges. Grouping animals together brings risks of disease and inevitably there is mutual exchange of infections between farmed and wild populations. High levels of biosecurity, integrated pest management and investment in vaccines are essential. Unlike land animals, nutrients from farmed fish in pens pass directly into the water, which means farm sites, stocking densities and feeding efficiency are all important. Farmed fish are bred to suit farm conditions. If they escape they can compete with and interbreed with wild populations. Equipment must be appropriate to prevent escapes and maintained correctly. Finally, as a relatively new means of producing food, aquaculture must demonstrate it operates responsibly, in accordance with regulations and the expectations of society.

“ Ensuring sustainability in marine raw materials

By reducing the fishmeal and fish oil needed in fish feed, research is enabling limited marine raw materials to be important contributors in an expanding aquaculture industry. Simultaneously IFFO is helping to ensure the supply is sustainable. In October 2009 IFFO introduced its Global Standard for Responsible Supply (RS), which covers sourcing the wild fish for marine raw materials and their purity and safety. Fishmeal producers, feed companies, fish farmers, fishmeal traders, the Global Aquaculture Alliance, major retailers, the Marine Conservation Society and WWF were involved in the Technical Advisory



Andrew Jackson
Technical Director
International
Fishmeal and Fish
Oil Organisation
(IFFO)

Committee that prepared the RS standard. Factories must source their wild fish from fisheries managed in line with the FAO Code of Conduct for Responsible Fisheries and there can be none from illegal, unreported or unregulated fishing. Applicant factories and their raw materials are audited by an independent accredited certification body. In the first 12 months 47 factories utilising six fisheries were certified, representing over 20% of global fishmeal and fish oil production. IFFO is also developing an Improvers Programme which will assist less developed parts of the industry achieve the RS standard through a process of measured improvement. In October 2010 the standard was extended to cover fishmeal and fish oil from the by-products of seafood processing from both wild and farmed sources. By-products now provide 25% of the global supply of marine raw materials thereby maximising the use of these valuable resources.

“ Making best use of marine resources

The objective of the European Union funded AQUAMAX project was to replace as much fishmeal and fish oil in fish feeds as possible with sustainable, contaminant free alternatives, while maintaining the health benefits of eating fish. Species investigated were

salmon, trout, sea bream and carp. Goals set were 12–16% fishmeal and 8–12% fish oil for salmon, 5% of both for trout, 15% fishmeal and 10% fish oil for sea bream and none of either for carp.

No impact on fish welfare or nutrient utilisation was reported for any of the species. However, some metabolic consequences were observed for some of the species at maximum combined replacement levels. Fish-in to fish-out ratios were significantly reduced. In the UK AQUAMAX assessed the health benefits in pregnant women and their newborn infants of salmon produced on modified feeds. Women who ate salmon twice per week received the omega-3 intake recommended by the health authorities. Thus the salmon was still a good source of these important fatty acids.



Professor Øyvind Lie
*Director, National
Institute of Nutrition
and Seafood Research
(NIFES), Norway*

““ Caring for both fish and the environment

The position as the world leader of farmed Atlantic salmon represents immense opportunities and extensive responsibilities.



Alf-Helge Aarskog
CEO
Marine Harvest

The health and welfare of our fish is based on sound farming and husbandry practices and policies, as well as proper health management. Our approach to fish management is to tend to our fish under conditions that satisfy their biological needs for food, clean water, space and habitat.

To ensure that our fish obtain the necessary nutrients

required for optimal health and performance, feed formulations are carefully balanced and delivered through efficient feed management systems which provide access to feed when the fish need it, without overfeeding. In some cases, functional feed has proven to be efficient in providing ingredients which support fish health and disease prevention.

The feed conversion ratio and feed utilisation is of great importance, both with regard to cost and maintaining a clean environment. By ensuring optimal utilisation of the feed, discharges to the environment can be minimised.



““ Balancing the ecology

Harvesting food from the oceans can make a significant contribution to feeding the world of 2050. As capture fisheries cannot be sustainably increased, marine aquaculture (mariculture) is destined to play a major role. Mariculture is growing and the rate doubled in the past ten years. Bottlenecks restricting further growth include adverse environmental impacts, which must be resolved, but a sense of proportion is important. These environmental costs are typically assessed by comparison with undisturbed control sites and rarely with the impacts of agriculture, which is the major driving force for coastal eutrophication. Mariculture has the potential to help correct these problems and produce positive effects for the environment.

With its contribution of around a third of marine food production, mariculture is potentially already reducing pressure on wild stocks. Moreover, macroalgal production can help remove excess nutrients and replenish oxygen in water while farming filter feeders can reduce excess plankton and alleviate the effects of eutrophication. In addition, as clean water is important for successful mariculture, responding to the threat from anthropogenic contaminants, the mariculture sector exerts political pressure to maintain good water quality to the benefit of all users of the marine environment.



Dr Kenneth Black
Ecology Department
Scottish Association
for Marine Science



“ Equipment can contribute to efficient, sustainable production

AKVA group is the leading supplier of technology for fish farming at sea and on land. Moving farms further offshore could be an option to improve sustainability. With advanced monitoring and feeding technology it is possible to maintain feed conversion ratios. Potentially, better water quality means better welfare and thus better feed utilisation. Higher flows mean feed residues are more widely spread. Fewer sites further apart would reduce cross contamination of infections. Larger sites reduce transport per kilogram produced.

In choosing sites good water quality is essential. Then, extremes are more important than averages; highest/lowest temperatures and lowest oxygen level. Factors such as wave height and wind determine equipment issues;

cages, nets etc. Automated solutions are being developed, reducing requirements for skilled staff. Improved net technology is providing cages that are virtually escape- and predator proof. Recyclable nets last 20 years. Easily cleaned hard surfaces resist marine fouling, avoiding antifouling paints. Semi-rigid structures maximise water flow and oxygen through the cages.

On land closed recirculation systems reduce the footprint per kilogram produced, improve welfare, reduce stress and eliminate disease invasion and escapes. Waste is a resource. Control over water and temperature improves feed utilisation, reducing resources consumed per kilogram produced. Location is less restricted. If close to a city, transport is significantly decreased.

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“ Creating a basis for sustainable aquaculture

There is nothing fundamentally unsustainable about aquaculture but, in common with other food production systems, there are negative environmental and social impacts that must be addressed if we are to realise the enormous potential of aquaculture to contribute to global food security. By promoting the adoption of voluntary standards, which focus on best environmental and social practices, we create the basis for significant transformation of aquaculture to a more sustainable basis. Retailers and food service companies will play a key role in this regard by incorporating and rewarding responsible aquaculture practice in their buying policies.



Philip Smith
Chief Executive Officer
Aquaculture
Stewardship Council

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Morten Nærland
Chief Financial Officer
and acting CEO
AKVA Group

“ Genomics: a potential to raise the sustainability of aquaculture

Genome sequencing opens a world of possibilities for aquaculture and food production. By uncovering an organism's genetic information, researchers are better equipped to investigate its growth, health, reproduction, nutritional value and role in the environment.

The field of genomics within aquaculture has grown in recent years. Governments and industry invest in sequencing the genomes of aquaculture species such as Atlantic salmon and cod.

Conservation of declining wild salmon populations is increasingly important. Solving potential conflicts between wild and farmed

salmon will rely mainly on increasing our understanding of the salmon and its pathogens. Sequencing the salmon genome can be an important contribution.

In addition, genome sequencing in a systems' biology setting will help us understand how farmed fish can utilise new raw materials in feed, lead to better fish health and bring a broader understanding of the species. This knowledge can also help minimise the potential negative environmental impacts of fish farming. ”



Photo by Haakon Sparre

Professor Stig W. Omholt
Centre for Integrative Genetics
Norwegian University of Life Sciences

“ Securing the trust of our customers

Our customers trust us, the world's leading food retailer, to sell to them high quality and safe fish from well managed sustainable farms with high welfare standards. To achieve this Tesco invests, in partnership with our suppliers, in supply chains that address all these issues in balance and audit them against the strict Tesco farming standards. Feed sustainability and traceability is addressed from the management of the fisheries that are harvested for feed, through to the environmental impact from the feeding systems on farms.

We also engage in the setting of global standards for certifying aquaculture and feed producers to bring independent scrutiny and transparency to our supply chains.

Tesco encourages investment in feed formulation and feeding technology to improve feed conversion ratios and allow the industry to grow sustainably, including alternative protein and oil sources to supplement sustainably harvested fish. Our customers see negative stories in the media about fish farming and it is essential to reassure them with the facts and to educate those that influence the media such as celebrity chefs. ”



Jodie Johnston
Technical/Aquaculture Manager,
Tesco Stores Ltd.
London, UK



what are the opportunities
for aquaculture?

The opportunities for aquaculture

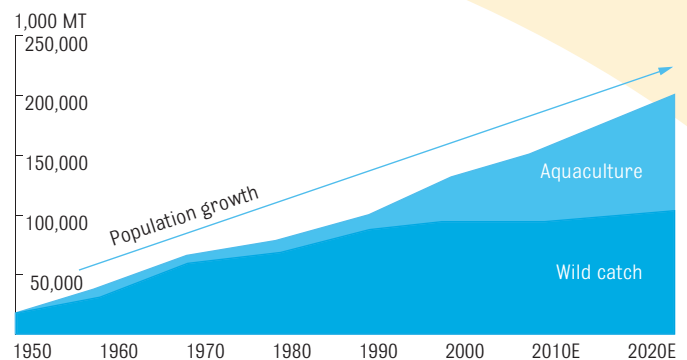
Increasing experience combined with advances through R&D is bringing commercial aquaculture towards being widely recognised as a sustainable, energy-efficient producer of fish protein for human consumption. The feed conversion ratio is diminishing as is the need for marine raw materials in the feed. Technical progress in feeding, recirculation and filtration is further reducing pollution of the aquatic environment. Advances in net pen equipment and farm management are minimising escapes. Better understanding of fish nutrition and raw material options mean faster development of feeds for more aquaculture species.

Fish are highly efficient converters of feed into body mass; mostly nutritious protein. Fish also provide many vitamins and minerals in easily assimilated forms. Oily fish such as Atlantic salmon additionally are rich in the polyunsaturated omega-3 fatty acids EPA and DHA (PUFAs) known to be beneficial for health. These come from marine raw materials, fishmeal and fish oil, in the diet of many aquaculture species. Recent research demonstrates PUFA levels in aquaculture fish can be maintained while using far less marine raw materials than originally thought. Supplementing with sustainable alternatives means a sustainable supply of marine raw materials can be shared

around expanding aquaculture production without loss of nutritional value. As a further consequence, fish farmers will be net producers of fish protein; producing more than is present in the feed consumed.

In a broader context, knowledge gained in commercial aquaculture can help people in poor rural communities produce excellent food through fish farming. Such ventures can be expanded to provide income and eventually products for export.

Global production of seafood 1950-2020E



Source: FAO/UN Population Division

“ Aquaculture drives livelihoods and economic development

About 1 billion people, often living in Least Developing Countries and belonging to the poorest parts of society, depend on seafood as their primary source of protein and minerals. Many of them live in the vicinity of their aquatic resources in rivers, lakes or coastal areas. Over-exploitation, water pollution and global climate change reduced these resources to critical levels. Farming fish and shellfish is then a suitable alternative to enhance food security in these areas, as is shown in Bangladesh where almost three quarters of the rural household families are involved in farming fish and/or prawns, providing thereby food for millions of the poorest families.



Prof Dr J.A.J. Verreth
Aquaculture & Fisheries
Wageningen University

Aquaculture also provides jobs, cash and wealth and stimulates the local economy. Farming shrimp nowadays produces almost two million metric tonnes, and provides livelihoods and household wealth for hundreds of thousands of people living in formerly remote rural areas along the Asian coasts. The challenge for aquaculture is continue on this path without harming the environment and the social structures in these areas. ”

“ Exploring options to extend choice in feed raw materials

Volatile prices and the limits to fishmeal and fish oil supplies led to a breakout from the restricted range of traditional feed raw materials. By comparison, vegetable proteins and oils are available in vast volumes. Research proved many to be suitable. Protein concentrates are nutrient dense and can meet the needs of carnivorous fish. Their use will be developed. Alternative sources of starches will augment the supply from wheat. By-products from animal rendering, widely used outside Europe, offer excellent nutrition. The biofuel industry is creating protein co-products that we must explore. Further ahead, algae and bioproteins from micro-organisms may become competitive in price, even providing long chain omega-3 fatty acids, as may genetically modified plants. To produce sufficient fish protein in aquaculture we must consider all options and conduct the research needed to asses them.



Alex Obach
Managing Director
Skretting Aquaculture
Research Centre





Philip Calder

*Professor of Nutritional
Immunology*

School of Medicine
University of Southampton

“ Fish provides high quality nutrition that can contribute to improved health

Fish provides many important nutrients. These include the minerals iodine and selenium, fat soluble vitamins such as vitamin D, and omega-3 fatty acids. Each is beneficial to human health. Iodine is essential to regulate metabolic rate and growth, selenium is involved in reducing oxidative stress and in the immune system, vitamin D ensures good bone formation, and omega-3 fatty acids promote heart health. Regular consumption of fish contributes significantly to the recommended intakes of these nutrients. Eating an oily fish like salmon twice a week provides more than the recommended minimum intake of marine omega-3 fatty acids. Research shows a strong association between eating fish and many aspects of human health. The best evidence is for cardiovascular health. Other evidence indicates benefits relating to allergic disease in children, some cancers, and mental decline with ageing. All in all fish is a highly nutritious food that is likely to improve a person's health and well-being.

Growth with sustainability opens oceans of opportunity

Aquaculture can deliver seafood that is healthy and delicious and has grown at close to 10 percent per year for the past 20 years. It is the only option we have to meet the growing demand for seafood while maintaining wild fishery harvests at sustainable levels. By ensuring we keep sustainability central in the growth of aquaculture we will open oceans of opportunity.

Sustainability includes the responsible use of raw materials, good animal health, minimising ecological impact and being socially beneficial. Agreeing best practices is complex and is being addressed through species-specific discussions where many stakeholders contribute. These debates highlight contentious aspects in aquaculture, universal and specific, that must be resolved. Ultimately they lead to international standards to which producers can become certified to demonstrate responsible practices and to protect the reputation of aquaculture: its licence to operate. Although progress is being made, it will take years before all the major aquaculture species have an associated standard, and the list of species is growing.



Knut Nesse

*Nutreco Executive Vice-President
Aquaculture*

Research and development are essential and have delivered significant progress, particularly in the past 20 years. Dependence on marine protein in the feed has diminished substantially as the graph shows. This has been made possible through effective alternative raw materials and concepts such as MicroBalance™ developed by Skretting Aquaculture Research Centre. Aquaculture in Norway has progressed from using 3.5 kg of fish protein in the feed for every kilogram of salmon produced in 1990 down to below 1.0 kg for the best performers in 2010. This means that salmon farmers have become net fish protein producers.

In the same period, new vaccines have virtually eliminated antibiotics from aquaculture in Norway, with usage per tonne falling by 99.3 percent from the peak in 1992 to close to zero for more than 10 years. Other regions are following the same path. Among the latest developments, feeds that promote health are emerging as an important advance.

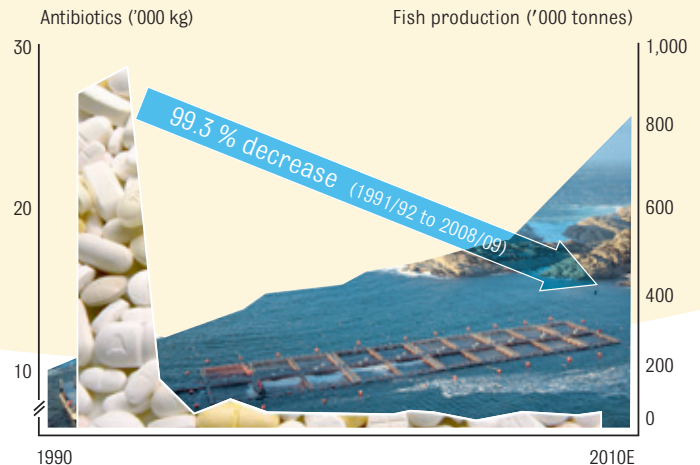
Fulfilling the Blue Revolution

There are issues still to be resolved but aquaculture will continue to expand, notably in Asia, where there is a huge potential to satisfy the growing population with its increasing spending power and liking for seafood. Skretting has set up companies in Asia and now operates in 15 countries worldwide. Together with other industry leaders, we can be facilitators in the expansion of responsible aquaculture, in Asia and other regions and with new species. Our contribution is to transfer technology and knowledge of nutrition and feeds across regions and species, bringing lessons learned while recognising and addressing the local issues. Sharing knowledge and proceeding together with care will enable us to fulfil the Blue Revolution in a sustainable manner.

MicroBalance™: enabling the future growth of aquaculture



Salmon farming Norway versus antibiotics usage



Insights at AquaVision 1996–2010

In the eight AquaVision conferences organised by Nutreco from 1996 sustainable growth for aquaculture is a consistent topic. The theme in 1998, for example, was 'Addressing the challenges to maintain a sustainable 10–20% annual growth of the aquaculture industry'. Sustaining growth to feed the world was again top of the agenda in 2010. Over those years the delegates heard from many informative, inspirational and perceptive speakers, some of the best are quoted here.

1998

**Lester Brown, President,
Worldwatch Institute**

Nothing but farmed seafood and to some extent poultry, have the capacity to meet the sure-to-come growing demand for food in a sustainable way.

2000

Rohana Subasinghe, FAO

Fish is recognised throughout the world as a highly nutritious food. As a result fish farming has a key role to play in any campaign to achieve sustainable improvements in conditions in developing countries.

2002

**Dr Simon Cripps;
Endangered Seas Programme, WWF**

Aquaculture potentially has an important role in a balanced future, in combination with sustainable fisheries, to provide an adequate supply of fish. However, if aquaculture is to take up this responsibility, it must first make changes of its own to ensure that it too is not the cause of declining wild fish stocks and damaged marine ecology.

AquaVision

2002

**Frederic Hauge,
Founder and President, Bellona**

For me as an environmentalist my main concern is how to feed and provide energy to the people of the world. This is our biggest challenge and therefore in principle we are in favour of fish farming. However, the harvest of wild fish stocks for feed must be sustainable. The feed industry should take responsibility for this and not trust local fisheries authorities.

2006

John Naisbitt, author and philosopher

The fish farming industry has a great story to tell and you are not telling it. It's the greatest food in the world and we are running out of it. Fish farming has the opportunity to bridge the gap but you must tell people about it.

2002

Patrick Dixon, Chairman, Global Change UK

An increasingly fussy consumer population is one of the realities the industry will have to face in future. The starving man is not worried about pigments used to colour farmed salmon—he will just eat it. But to a 75-year old pensioner with no money worries and for whom food is a real pleasure it can become very, very important... Wealthy people have an emotional connection with food that you do not see in a poor country in the same way.

Further reading

- Aquaculture Dialogues, World Wildlife Fund. Website: www.worldwildlife.org/what/globalmarkets/aquaculture/aquaculturedialogues.html
- AQUAMAX, Sustainable Aquafeeds to Maximise the Health Benefits of Farmed Fish for Consumers. Website: www.aquamaxip.eu
- Blonk et al. (November 2008) Greenhouse Gas Emissions of Meat – Methodological issues and establishment of an information structure (background document)
- Communication from the Commission to the European Parliament and the Council of 8 April 2009 – Building a sustainable future for aquaculture – A new impetus for the Strategy for the Sustainable Development of European Aquaculture [COM(2009) 162 final]
- EU Commissioner Maria Damanaki: http://ec.europa.eu/commission_2010-2014/damanaki/index_en.htm
- FAO, Rome. (12–13 October 2009) High-level Expert Forum on 'How to feed the world in 2050'. Global agriculture towards 2050. http://www.fao.org/fileadmin/templates/wsfs/docs/Issues_papers/HLEF2050_Global_Agriculture.pdf
- FAO, Rome. (12–13 October 2009) High-level Expert Forum on 'How to feed the world in 2050'. The Technology challenge. http://www.fao.org/fileadmin/templates/wsfs/docs/Issues_papers/HLEF2050_Technology.pdf
- Jackson, A.J., 2007. Challenges and opportunities for the fishmeal and fish oil industry. *Feed Technology Update* 2 (1) 9 pp
- Nesse K., 2010, Presentation at Capital Markets Day in Italy 6 October 2010, www.nutreco.com
- Population Reference Bureau. (2009) 2009 World population data sheet. www.prb.org
- Pretty, J. et al, 2010, The top 100 questions of importance to the future of global agriculture, *International Journal of Agricultural Sustainability*, 8(4), 219–236
- Tacon A.G.J and Metian M., 2008, Global overview on the use of fish meal and fish oil in industrially compounded aquafeeds: Trends and future prospects, *Aquaculture* 285, 146–158.
- The International Fishmeal and Fish Oil Organisation (IFFO), Global Standard and Certification Programme for the Responsible Supply of Fishmeal and Fish Oil, website: www.iffonet
- The State of World Fisheries and Aquaculture, 2008. FAO Fisheries and Aquaculture Department, Rome, 2009
- www.peopleandplanet.net (Feeding a world of 9 billion) and Megan Clark. (6 October 2009) The Science & Technology in Society Forum, Japan. Sustainable Agriculture – Feeding the world

Websites

- AKVA Group: www.akvagroup.com
- Aquaculture Stewardship Council (ASC): www.ascworldwide.org
- Auchan: www.groupe-auchan.com/index.jsp?lang=EN
- Cargill: www.cargill.com
- Centre for Integrative Genetics: www.cigene.no
- FAO. www.fao.org.
- Leroy: www.leroy.no/en/
- Marine Harvest: www.marineharvest.com
- Morpol: www.morpol.com
- Nutreco: www.nutreco.com
- Pescanova aquaculture: www.pescanova.com
- Scottish Association for Marine Sciences: www.smi.ac.uk
- Skretting: www.skretting.com
- TASA: www.tasa.com.pe
- Tesco: www.tescopl.com
- University of Southampton: www.soton.ac.uk
- www.panda.org

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