

Creating value

Project year 2015



32 examples of useful research



Norwegian Institute of Food, Fisheries and Aquaculture



CtrlAQUA – innovation in closed-containment aquaculture

CtrlAQUA is a centre for research-based innovation (SFI) that is hosted by Nofima in close collaboration with 18 national and international R&D providers and companies.

Innovations in closed-containment aquaculture systems, where fish are isolated from the outside environment, will be important for further development of sustainable aquaculture.

CtrlAQUA
Centre for Closed-Containment Aquaculture

Website: ctrlaqua.no

Closer contact with trade and industry



Eight years have passed since Nofima was established. In this time we have developed a robust and industry-oriented research institution that fulfils its mission. Nofima delivers research-based knowledge that improves the competitive strength of food-producing industries.

Our clients and their needs are always of the utmost importance, thus our goal of having insight and excellent understanding of the industry's need for knowledge is extremely important. Our disciplinary strategies are therefore refined in close interaction with industry and in line with the priorities of our clients and the public funding system's.

In order to strengthen this work, we have also established a platform for industrial internship for our scientists. The internship has proved that there is real value to be gained, both for the hosting client and our researchers. Nofima has decided to extend the scheme. The scheme reinforces us as an attractive partner in both small and large projects and positions Nofima as a solution oriented research institution and contributor. We will strengthen our work on implementation of research results to solutions and this year's edition of *Creating value* shows that we make a difference.

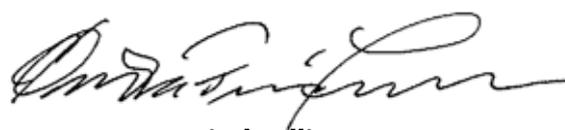
At Nofima we believe that competitive strength is developed through insight, research and implementation. To achieve this we have to emphasize the importance of insight largely, and we are confident that this is an important strategic choice.

2015 was a good year for Nofima. In professional terms we have delivered, which is also demonstrated through the award of a Centre for research-driven innovation (SFI) called CtrlAQUA. This is a large and important project for fish farming in closed and semi-closed contained systems and will last for eight years. The SFI is located at Sunndalsøra. We were also awarded infrastructure funds from the Research Council of Norway to upgrade the feed technology centre in Kjerreidviken. The centre will, in cooperation with our partners, be a national centre for developing new feed raw materials for the aquaculture industry. In 2015 we opened an office in Alta, which we consider valuable in order to come closer to the fish farming industries and gain better insight in the Northers part of Norway.

In the course of the eight years of Nofima, we have worked for a strong common culture that has one purpose: Our research-based knowledge must contribute to increased competitiveness and profitable and sustainable production and value creation with our clients, and processing of food.

This year's edition of *Creating value* shows that research is useful and contributes to added value.

Enjoy the read.



Øyvind Fylling-Jensen
Managing Director

32 examples of useful research

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Mobilizing for snow crab

Snow crab is estimated to represent billions in export value. Nofima is mobilizing the full range of its research expertise for the newcomer.



PHOTO: JON-ARE BERG-JAKOBSEN © NOFIMA

It looks somewhat grim, but it's taste is exquisite. Snow crab is assumed to represent billions in future export value. This is Gørild Voldnes and Sten Siikavuopio.

In recent years the snow crab has migrated into the Barents Sea. The Norwegian catch of the delicacy has significantly increased, and prices are good. However, knowledge on catching, shelf-life, storage, transport and total exploitation is still lacking. The Nofima food research institute is now in full swing remedying this.

Most of the snow crab caught by Norwegian vessels is cooked and frozen just after catching, but the market is willing to pay a higher price for live crab. The solution is to store the snow crab alive in "crab hotels" and sell it when the market is ready for it.

Nofima researchers were, in late summer 2015, as the first in Norway granted permission to keep snow crab captive for research purposes. The project is called "Optimisation of environmental conditions during live storage of snow crab – to ensure survivability, quality and the best possible animal welfare".

Sustainable development and an industry that is based on renewable resources is the goal of the work.

"In this work it is important to involve the entire value chain: Catching, live storage, processing, exploitation of

residual raw materials and market. At Nofima we have the range of knowledge and expertise that allows us to efficiently coordinate this work," says research manager Ragnhild Dragøy Whitaker.

Results from the research will in the course of 2016 be compiled in a manual for both producers and buyers, where they will find information on best practice for live catching and intermediary storage of the crab.

The snow crab is similar in appearance to the king crab, but lives in deeper water, where it thrives in the lower temperatures.

"When we started in 1994, few people believed that the king crab could be kept alive. Now as many as 70 per cent of the king crabs caught are kept alive. Norwegian king crab has an excellent reputation, thanks to the quality it maintains in hotels," senior scientist Sten Siikavuopio says.

The scientists are now looking forward to acquiring similar knowledge on snow crab.



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Better control of bacteria

New packaging methods that inhibit bacteria maintain the quality of salmon fillets longer.



PHOTO: JON-ARE BERG-JAKOBSEN © NOFIMA

New packaging methods that inhibit bacteria contribute to keeping salmon fresh longer.

Hygiene, cleaning and storage conditions are decisive factors that affect product quality. Additionally, the choice of packaging method is important for shelf life. Requirements to packaging and storage will vary, and must also be tailored to different fish species and products.

The goal of this research project has been gain control of the raw material quality of pre-rigor filleted salmon. The first step was to identify which bacteria contribute to reducing quality and shelf life.

So far, the major part of the fish delivered from fish farmers to processing in Norway or abroad has been whole fish – this is because there is a widespread perception that the quality of whole fish is better than that of filleted fish. However, trials show that the bacteria content is approximately the same for pre-rigor filleted salmon as for whole fish after nine days of storage at 2°C. Nevertheless, it cannot be concluded that filleted fish in general is of the same quality as whole fish as several aspects are affecting the quality.

Based on the knowledge of which bacteria exist and dominate in various stages of production, on both

raw material and product, Nofima's researchers have investigated different packaging methods for different products.

The removal of oxygen can reduce the growth of bacteria that require oxygen to grow. Vacuum packaging accomplishes this. On the other hand, the growth of some bacteria are inhibited when CO₂ is present. The use of CO₂ therefore leads to reduced growth of some spoilage bacteria.

It is possible to achieve a 20 day of microbiological shelf life for fillet packed with CO₂ and stored at 2°C.

"We have also studied at the requirement to oxygen barrier in the packaging material for different products and packaging methods. The use of plastic material with a good oxygen barrier can have a positive effect on product quality. The better the barrier, the less oxygen and the fewer bacteria", explains senior scientist Marit K. Pettersen.



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Optimal feed reduced mortality

Research during natural outbreaks of the salmon diseases PD and HSMB shows that mortality can be halved through the optimum use of feed.



PHOTO: HELGE SKODVIN © NOFIMA

Nofima's research and development licences in Hordaland shows that the diet has a major influence on mortality rates in salmon co-infected with the diseases PD and HSMB.

Pancreas Disease (PD) and Heart and Skeletal Muscle Inflammation (HSMB) are two of the most widespread and common diseases in the Norwegian salmon farming industry, and often occur simultaneously. According to estimates from the Institute of Marine Research, PD alone costs the Norwegian fish farming industry more than 1 billion NOK annually.

Nofima holds several R&D licences in collocation with commercial fish farmers along the Norwegian coast, whereof two are co-located with Blom Fiskeoppdrett at one site outside of Bergen. In the beginning of June 2015, a simultaneous infection of both PD and HSMB were detected at the site.

Scientists Jens-Erik Dessen and Kjell-Arne Rørvik noted that salmon that had been fed lean, protein-rich test feed had a mortality rate of 4 per cent. Salmon fed normal control feed with a higher fat content had a mortality rate of 9 per cent. The group fed the lean test feed also had higher feed intake and growth.

The statistical analysis also confirmed that there was lower mortality in large fish, and in fish that were less stressed during handling. Stress, the size of the fish and the diet explain 99 per cent of the variation in acute mortality. Further research is needed in order to elucidate the specific mechanisms contributing to the positive effects on fish survival.

“Outbreaks of PD and HSMB have a tendency to occur during the spring and autumn. Therefore, diets with a relatively high protein/lipid ratio may be used not only during and after an outbreak, but also before, this might exert a beneficial effect in terms of maintaining growth and minimizing the mortality. At the same time the fish should be as large as possible before these critical periods” Dessen says.

The R&D licences Nofima holds with three Norwegian farming companies in the south, middle and north of Norway are an invaluable tool in order to carry out research that can benefit the industry.



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Quality beats origin

Comprehensive consumer studies show that Norwegian consumers are more concerned with the quality of food than its Norwegian origin.



PHOTO: JON-ARE BERG-JAKOBSEN © NOFIMA

Norwegian consumers have great confidence in Norwegian raw materials, but this doesn't mean it's important to them to buy Norwegian food.

Norwegian raw materials are competing with foreign raw materials for the favour of consumers. A group of researchers have investigated what it means to consumers that food is labelled as Norwegian. With support from the Research Council of Norway, they will find out whether there is perceived added value if the consumer is aware that the food originates in Norway, and which actions that may be taken to increase the value of different food products.

In addition to a comprehensive survey, researchers have conducted in-depth interviews and have spoken to consumers in six cities and small towns in Norway, just after they had done their shopping. They were questioned on which type of Norwegian products they had bought, and why they had chosen a Norwegian product instead of a foreign one if they had done so.

"Many hadn't given any thought to where the food was from. The exceptions were milk and fish, where people deduced that they couldn't have travelled far due to shelf life," says scientist Aase Vorre Skuland at Nofima.

Consumers have great confidence in Norwegian raw materials, but this doesn't mean it's important to them to buy Norwegian food. It was more important to consumers that the food had the desired properties, and that quality was high.

The interviews were conducted both in shops with a relatively small selection, shops with a large selection of products and in specialist shops. Quality was important to customers in all shop segments, but the specialist shop customers are somewhat more conscious of the origin of the food than customers in supermarkets with a limited selection. Fish buyers in specialist shops were most concerned that the fish should be Norwegian.

"Our advice to producers is to highlight the properties of the product and its quality, and to demonstrate how it stands out from the crowd. Consumers are often willing to pay more for better quality," Skuland says.

She is well under way with the next stage of the project, where researchers and businesses will apply the new knowledge in the process of creating new concepts or products. The final report is due in 2016.



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Optimism for marine species

Hard and purposeful work at Nofima's Centre for Marine Aquaculture has led to success in farming of marine species.



PHOTO: JON-ARE BERG-JACOBSEN © NOFIMA

The farming of marine species is gaining success at Nofima. Systematic improvements in all areas of husbandry are responsible.

Systematic improvements in all areas of husbandry have resulted in increased survival of cod juveniles.

“In certain tanks we had a 100 per cent survival rate 80 days after hatching. Even though the average survival rate for all 200 tanks is of 33 per cent, this is a vast improvement from about one per cent when production started in 2003,” says Atle Mortensen, who heads the cod breeding programme.

“We have a unique expertise with extensive experience in production of marine fish species. With regard to cod breeding, we optimise everything we possibly can; temperature, environmental change, feed, feeding regimes, water quality, quality sorting of eggs and so on,” says head of research for production biology, Hilde Toften.

Compared to salmon, cod larvae are very small and vulnerable before becoming juveniles. “Cod have a high mortality rate in early stages of life, but when we do

everything right, we see an aquaculture potential,” Hilde Toften says.

The stable cod juvenile production at the Centre for Marine Aquaculture makes the facility well suited for research in other areas. In collaboration with three German research institutions, groundbreaking research has been carried out that shows that the expected temperature increase and higher acidity levels in the sea may have a negative impact on reproduction and later life stages in cod.

The cod breeding programme will continue under the auspices of Nofima in 2016. The Nofima researchers' expertise is also being used to improve production methods for lumpfish. A survey of lumpfish environmental requirements and basic genetics with an aim to breed them is currently undertaken at the Centre for Marine Aquaculture.



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A grain of truth about public health

Nofima conducts several ongoing research projects to exploit the healthy components of grains. Optifiber and OatMet are two such projects.



PHOTO: JON-ARE BERG-JAKOBSEN © NOFIMA

The healthy nutrients in grain are subject to several research projects headed by Nofima.

The fibre in whole grain products are affected differently during processing. It is not certain that the fibres retain their special health properties after baking, for example. This particularly applies to beta glucans.

During raising the enzymes, which occur naturally in grain, start to break down the beta glucan chain. This is a problem, because the larger the beta glucan molecules are, the better their healthy properties. This is why researchers are attempting to deactivate these enzymes.

The next step is to investigate how beta glucans work in the body. These fibres affect viscosity, i.e. the flow rate of the content of the stomach and small intestine, and inhibit reabsorption of cholesterol and biliary acids, which reduces the level of cholesterol in the blood, among other things. They will also affect absorption of glucose.

“It is the size and solubility of the beta glucans that determine how effective they are,” says senior scientist Svein Halvor Knutsen.

The researchers use a model for mouth, stomach and small intestine, and take samples of how different

components in the food are affected during digestion. The researchers have also developed another model that simulates the large intestine. Here they study how fibre is decomposed and exploited by the gut flora.

Oats contain several components that can affect the sensation of fullness and thus our food intake. By combining them in the right way, it may be possible to tailor foods with an extra fullness effect.

“In OatMet we are investigating which components and physiological mechanisms make us feel full and eat less for our next meal,” says senior scientist Bente Kirkhus.

Among other things, results from the project show that trial persons feel more full after eating porridge made from oat flour than oatmeal. The next stage in the study is that researchers at the “Institute of Food Research” in the UK use MRI to investigate what takes place in the stomach and small intestine when trial persons eat porridge with the same nutritional content, but with different structure.



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See
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website



Nutrition for your gut flora

You're only ten per cent human. The remaining 90 per cent are bacteria in your gut that digest your food and are important for your health.



PHOTO: JON-ARE BERG-JAKOBSEN © NOFIMA

Ida Rud and colleagues at Nofima are using human gut models and animal and human trials to test the effect of food on the gut flora.

Nofima has established a scientific platform to understand the effect of food on health, where the gut flora – i.e. gut bacteria – play an important role. Through several different projects the researchers are mapping the food's effect on the gut flora – and thus on health.

“An intake of healthy and varied food is important in order to maintain a favourable gut flora. The lifestyle in the western world, including the consumption of a lot of unhealthy food, can cause the gut flora to become imbalanced through a reduction in the diversity of bacteria. Evidence is increasingly showing that this imbalance in the gut flora may lead to diseases such as cancer, diabetes, allergies and bowel inflammation,” says Nofima scientist Ida Rud.

It is particularly food that is rich in fibre that provides nutrition to the gut bacteria, as this cannot be digested by our own digestive system, but enters the large intestine after passing unchanged through the mouth,

stomach and small intestine. Undigested proteins, starch and fat can also affect the gut flora. Nofima is studying the effect of cereals, vegetables, red meat, fish and fibre components on the gut flora.

Researchers are using both human gut models and animal and human trials to test the effect of food on the gut flora. The project “The healthy meal” showed that barley, broccoli and salmon affect different gut bacteria. Barley consist mainly of the fibres beta-glucan and arabinoxylan, while broccoli contains high amounts of pectin. These different fibres stimulate different bacteria in the gut with different properties for fibre decomposition and contribute to the creation of favourable metabolites in the gut.

Through research into various foods, food components and meals, we can help raise awareness of how Norwegian food products and meal solutions can contribute to a healthy gut flora and good health.



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Northern salmon hot down south

In South Africa Norwegian salmon has a market share of 90 per cent, and South Africans emphasize the salmon's Norwegian origin.



PHOTO: MORTEN HEIDE © NOFIMA

With its high purchasing power, South Africa is an interesting market for the Norwegian salmon industry. Here salmon fillet is being packed at Checkers in Cape Town.

With its high purchasing power, South Africa is an interesting market for the Norwegian salmon industry. Demand for Norwegian salmon has grown in line with positive economic developments. In 2014 Norwegian companies exported around 4,290 tons of salmon to South Africa at a value of NOK 181 million.

On behalf of the Fishery and Aquaculture Industry Research Fund, Nofima has analysed the market situation for Norwegian salmon in South Africa. The results show that Norwegian salmon is gaining in popularity on the South African market. The trade agreement between EFTA and the South African Customs Union made Norwegian salmon exempt of duty from 2015, while competing countries such as Scotland and Chile still have 25 per cent duty. This made Norwegian salmon cheaper than salmon from other countries, and led to an increase in Norwegian exports to South Africa.

A large proportion of the salmon is fresh and is used for sushi in restaurants. There are many different salmon products in grocery stores, and new ones are constantly being brought to market. Salmon often has a preferen-

tial position on the shelves, which indicates that this is an important product for the supermarket chains. One also tends to emphasize its origin.

“Up to 80 per cent of all seafood used for sushi in South Africa is salmon. Most emphasize that the salmon is Norwegian, both in supermarkets and restaurants in Cape Town, so Norwegian salmon has a strong position,” says senior scientist Geir Sogn-Grundvåg.

However, the purchasing price of salmon has risen, and along with a weaker local currency and costly air freight, fresh salmon has become expensive. The market reacted by increasing prices in shops and restaurants, but at the same time frozen salmon has replaced fresh salmon where possible.

The researchers hope the analyses may help Norwegian salmon producers and exporters in their marketing work.

“Detailed market knowledge also strengthens the position of Norwegian exporters in negotiations with importers, in that they are perceived as competent partners,” Sogn-Grundvåg points out.



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Report



Fish market opportunities

Angola is a more and more important market for Norwegian dried and salted saithe, and developments indicate increased demand.



PHOTO: SAGACI RESEARCH

Demand for Norwegian dried and salted fish is increasing in Angola. Through efforts and presence there is room for an increase in this market of opportunities.

This is an opportunity that must be grasped by the Norwegian industry.

On behalf of the Fishery and Aquaculture Industry Research Fund, Nofima's market researchers have gathered knowledge on the dried and salted fish markets in Angola. The purpose of the work has been to provide Norwegian companies with basic knowledge of the market in Angola, so that they may make strategic decisions based on current research information.

Dried and salted saithe is primarily consumed by the Bakongo people who comprise around 13 per cent of Angola's 25 million inhabitants. The Bakongo often call dried and salted saithe "makayabu". Despite "makayabu" being a familiar term, Norwegian players report that knowledge of the product and naming varies throughout the value chain.

"The Norwegian industry should therefore obtain a better understanding of which terms are used for salted and dried saithe, and where the terms are used in the different market segments, Nofima scientist Ingelinn Eskildsen Pleym believes.

"Bacalhau" is the Portuguese term for salted and dried cod. The former Portuguese colony Angola is the biggest market for bacalhau in Africa.

The country has very high population growth. It's difficult to estimate the potential for growth – but a doubling of the current export volume of both cod (135 tons from Norway in 2014) and saithe (6115 tons from Norway in 2014) may be possible over the course of a decade.

Currently, the market for dried and salted cod is dominated by the Portuguese. This makes it difficult to penetrate the market, but if Norwegian companies are capable of taking market shares from the Portuguese, exports will quickly expand. This will however require a greater presence in the country.

Because dried and salted cod and saithe are different products that are sold through different channels, it would be appropriate to apply different strategies to sell more of these products. This requires further investments in the market, both by individual companies and jointly by the industry.



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Reduced feed loss

Researchers have developed a processing aid that act as a nutrient and binder in extruded fish feed.



PHOTO: TERJE AAMODT © NOFIMA

Nofima in Bergen and partners are currently developing the Aquafeed Technology Centre, where the result will be even more knowledge on feed processing of raw materials.

This can contribute to reducing feed loss in the aquaculture industry and make feed production more energy-efficient. The processing aid is a protein-based solution that can be produced from marine raw materials or plant protein.

In his doctoral thesis Tor Andreas Samuelsen at Nofimas Feed Technology Centre in Bergen studied how loss in feeding systems can be reduced by taking action during feed processing. Nofima has estimated that the loss in feeding systems constitutes a yearly additional expense of around NOK 40 to 200 million. To reduce loss, the feed must have uniform and high physical quality.

The main objective of the doctoral project was to divide fishmeal into components, identify which of these influences the extruder, and determine their significance for the physical properties of the final fish feed.

The components with a positive effect on the extrusion process are water-soluble low molecular weight

proteins (small peptides and amino acids). These proteins are pressed out together with water during production of fish meal and have a high nutritional value. Such proteins will make processing from raw material to pellet easier and also act as a binding agent. Researchers have shown how the processing aid works during production of fish feed and which type of proteins that have the desired effect on physical feed quality.

"This allows us to exploit water-soluble low molecular weight proteins better, both to ease processing from raw material to pellet, and as a binding agent and nutritional component," Samuelsen says.

The processing aid has several of the same properties as water, and can thus reduce energy consumption in the feed process.

Knowledge from the doctoral project may also contribute to reduced reprocessing of feed and fewer customer claims due to poor physical feed quality.



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MORE INFO:



Developed nitrogen gauge

Nofima has taken part in developing a fully automatic sensor that continuously measures nitrogen compounds in aquaculture.



PHOTO: TERJE AAMODT © NOFIMA

Dag Egil Bundgaard and colleague Kristin Skei Nerdal tested the functional model of the new sensor at Nofima in Sunndalsøra.

This is the first sensor that has been developed specifically with the sensitivity required for aquaculture systems. Until now, technology has been acquired from the water treatment industry, and has not been tailored for aquaculture.

This technology is becoming more and more relevant as contained facilities are being tested and developed. In contained facilities on land, recirculating aquaculture systems are used, and in such systems good water quality monitoring is essential to ensure good welfare of the fish and optimal operation of the systems.

“We have to provide fish with the water quality they require to thrive and grow optimally – as considerations toward welfare are the first priority. Having in mind the regulations and the requirements for water quality for salmon production, we have tailored the technology to fit the salmon’s biology,” says scientist Jelena Kolarevic. Along with colleague Bjørn-Steinar Sæther, she has headed Nofima’s work, as a part of the FP7 EU project AQUALity.

In AQUALity the goal was to develop an open, standardized technology platform for monitoring water

quality in the process line. Use of this technology can reduce costs and requirements for expertise among fish farmers, and provide reliable measurements of potentially toxic nitrogen compounds in aquaculture. The sensor Nofima has contributed to develop in cooperation with Philips, is one of the products of this project.

Nofima tested and refined the functional model of the sensor in the laboratory and at Nofima Centre for Recirculation in Aquaculture in Sunndalsøra, where innovative lab engineers played a decisive role.

The nitrogen sensor is designed to be a part of a measuring apparatus that continuously measures eight water quality parameters in recirculating water. The farmer is provided with continuous online measurements of nitrite, total ammonia nitrogen and its compounds, pH, salinity, oxygen, carbon dioxide, total gas saturation and temperature, and levels can be viewed on a monitor.

The company OxyGuard will continue to develop the prototype for future commercialisation and sale to aquaculture industry.



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Rested cod best

Consumers want cod that is good enough, the industry is looking for enough cod. Nofima seek to know whether the cod welfare is good enough.



PHOTO: LIDUNN MOSAKER BOGE © NOFIMA

Ph.D. stipendiary Ragnhild Svalheim has used Nofimas "trawl simulator" – swimming tunnel – in trials related to the quality of newly caught fish.

The conclusion so far is that stressed and exhausted newly caught trawl fish can be rested to achieve good quality in the course of six hours.

Ph.D. stipendiary Ragnhild Aven Svalheim has carried out several different trials using a custom-built swimming tunnel at the Aquaculture Station in Tromsø.

The work has dealt with experimental simulation of the conditions that arise during commercial trawl fishing, and investigations into how these conditions affect the fish's physiology and which impact this has on the quality of the raw material.

The different phases of trawl fishing are physical exhaustion as the fish try to avoid the mouth of the net, crowding when they are gathered in the trawl and lifted out of the water, and major changes in pressure from different depths and up to the surface.

"The swimming tunnel is basically a trawl simulator where we can imitate the different stages of trawl fishing," Svalheim says.

During high activity swimming, fish are unable to provide their muscles with enough oxygen. The lack of

oxygen and use of energy causes the muscle to sour and accumulate lactic acid. In order to tackle the change in pH and obtain new energy, blood is redistributed to the muscle causing a reddening in the musculature for a few hours while it is resting.

When the white muscles of white fish become red, quality is considered to be deteriorated.

The amount of blood in white muscle increases for 2–4 hours after exertion, before returning to the resting level.

The project Ragnhild Svalheim is working on is a part of CRISP – a centre for research-driven innovation in sustainable fishery.

The results are relevant in connection with trials carried out on trawlers, where one has tested pumping live fish from the net with a subsequent resting period in containers filled with water.

"Fish that are stored alive on board have higher quality than fish that die in reception bins without water. The interesting thing to look at now is how to bring the fish efficiently and carefully onto the vessel. Rested cod maintain the best quality," the researcher concludes.



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MORE INFO:

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Can produce stockfish indoors

It takes around four months to produce stockfish outdoors on racks. Now, high quality stockfish can be produced indoors – in less than a month.



PHOTO: REIDUN LILLEHOLT KRAUGERUD © NOFIMA

Senior scientist John-Erik Haugen has developed an indoor drying process that provides good quality stockfish and efficient drying – throughout the year.

Exporter Nordahl Anthonisen from Athena Seafoods AS in Bergen sought stable quality in stockfish, and had an idea for a new drying process where the result is not dependent on the outdoor weather and temperature. Senior scientist John-Erik Haugen at Nofima developed his original idea. The stockfish has been approved by sensory assessors in Italy.

“My dream was to be able to control the conditions in which the fish was dried, so that we can sell exclusively good prima quality stockfish to Europe,” says Anthonisen.

That dream seems about to come true with the aid of Nofima. The stockfish exporter linked relevant SME companies and research institutions in Europe with the Nofima researcher in an EU project.

In his lab at Ås, John-Erik Haugen has developed an indoor drying process that provides high quality stockfish and efficient drying. In addition to using the traditional raw material, his starting point was optimal weather conditions for traditional outdoor drying.

The Italian gastronomy company Il Ceppo has 80

years of experience with stockfish. They have assessed the look and smell of the indoor-dried fish. Il Ceppo has also carried out local consumer surveys in Italy where indoor and outdoor produced stockfish have been subjected to blind tests, based on traditional Italian dishes.

“These first tests indicate that the pilot product maintains high quality,” says Haugen.

A patent has been filed for the method.

The purpose of this type of EU project is to stimulate innovation in small and medium-sized businesses, as well as collaboration with research institutions in order for innovations to be realized both domestically and in other countries. The EU thus provided full economic support for this R&D project. The SME in the EU project contributed labour and had their expenses covered.

Now Nofima and Athena Seafoods are working together to develop the concept with an aim of commercialization and industrial scaling and implementation.

Top quality throughout the year is one of the ambitions.



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MORE INFO:

See video



Strengthened PD findings

In cooperation with R&D partners, Nofima has identified and validated genetic markers for resistance to PD in Atlantic salmon.



PHOTO: JON-ARE BERG-JACOBSEN © NOFIMA

The mystery of PD resistance lies within the salmon's genes, which Matthew and breeding researchers can reveal.

The genetic markers they were looking for are linked to functional genes that determine how likely the salmon is to die after infection with Pancreas Disease (PD). PD is one of the most widespread diseases among Norwegian farmed salmon.

The markers Nofima found through this project are an interesting example of how international research and collaboration can strengthen research findings and validate these markers an effective tool to breed for increased PD resistance.

While Norwegian researchers had found the markers for PD in post-smolt from SalmoBreed's population, scientist Matthew Baranski at Nofima became aware that the Roslin Institute in Scotland was carrying out a similar study on fry for Marine Harvest. Both research institutes were given permission by their industrial partners to collaborate on the publication of their findings.

In both studies, genetic markers linked to PD resistance were found on the same chromosome and in the same area. This represents a strong validation of these results, something of great importance for both practical application and publishing.

"It's also interesting that we have shown that it probably is the same genes that affect mortality in both fry and post-smolt," Baranski says.

The methodologies for performing disease challenge tests were also different, and proves that there are several routes to reliable research results.

SalmoBreed are now using these markers to counter PD through marker-assisted and genomic selection. This method provides significantly higher breeding accuracy for this trait than traditional breeding alone.

Nofima is continuing work with both SalmoBreed's and Marine Harvest on this important topic:

"We have collected a lot of data in several projects, and will use the material to identify the gene or genes behind PD. We want to find out whether these genes are involved in the immune system and perhaps have an influence on other diseases. This could provide knowledge that makes it possible to breed more efficiently for health overall," Baranski concludes.



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SalmoBreed AS (Nofima's part of the project)

MORE INFO:



Organic for large households

The Storting has a goal of 15 per cent organic production and consumption within 2020.



PHOTO: JON-ARE BERG-JACOBSEN © NOFIMA

In order for organic food to make its way into institutional kitchens, products need to be adapted accordingly.

If Norway is to achieve this goal, public and private large households must increase organic food and ingredients in their menu and serving.

In order to increase the diversity of organic food and give the large households the opportunity to increase their share, both large, medium and small food process companies must produce organic food. Nofima has received funding from the Norwegian Agriculture Agency since 2001 to assist companies in developing and producing good organic products. A large number of the producers who supply organic products have used the service.

Rørosmeieriet, Røroskjøtt and Toten Eggpakkeri are good examples of companies who process organic products and who have growth and the ambitions to serve a larger market.

In 2015 Nofima has been responsible for eight different specialist courses in organic food for large households. The courses have taken place at different locations across the country include baking courses, vegetarian courses and fruits and berries.

In three different surveys Nofima has queried large households chefs on the greatest obstacles preventing

increased use of organic food.

“Our enquiries show that the supply of organic products to large households is characterized by lack of adaptation to these customers needs. Those who cook several hundred to more than a thousand portions every day need organic products that are tailored to their needs. They demand products that have a higher degree of processed, chopped, ready to use products,” says project manager Isabell Lien.

And the price? It remains too high, according to many large households chefs – up to 50 per cent higher for some organic products compared to conventional products.

The large households chefs would like to see dairy products in easy-to-use packaging, in large enough volumes and available all over the country. Processed vegetables are also high on the wish-list. Organic meat and meat products are considered virtually unavailable, partly due to very small supply, partly due to price.

It appears that a better coordination of specifying – and ordering – products would document the overall volume required to the suppliers. Such documentation will likely also have an impact on the price.



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High cost in salmon production

Costs in salmon farming have increased significantly in recent years. Higher feed prices and sea lice are mostly to blame.



PHOTO: JON-ARE BERG-JACOBSEN © NOFIMA

Øystein Hermansen and Audun Iversen maintain that sea lice and feed are significant reasons for the increase in costs for producing salmon.

From 2012 to 2014 production costs increased by five kroner a kilo. In 2014 one kilo of slaughtered salmon cost approx. NOK 28.50 to produce.

Nofima and Kontali have studied the cost drivers in salmon farming on behalf of the Fishery and Aquaculture Industry Research Fund (FHF). All costs are increasing, but costs are mainly increasing due to increased feed costs and costs for the prevention and treatment of sea lice problems.

The feed price has increased due to a weaker currency and higher raw material prices. The economic feed conversion ratio has also increased, due to increased mortality and the increased size of dead fish.

The costs for controlling sea lice levels and prevention have increased, but the greatest cost is incurred when fish have to be treated for sea lice. In recent years the industry, due to resistance towards certain sea lice treatments, has had to return to hydrogen peroxide for delousing. This method is far more expensive due to more costly materials and more labour-intensive operations. Treatment-related mortality in large fish is also an important factor in increased costs.

“We estimate that the sea lice problem has cost the industry NOK 3–4 billion in 2014. In addition there are costs as a result of lost growth and a poorer feed conversion ratio,” says scientist Audun Iversen with Nofima.

The industry wants to depart from costly treatment, and focus on prevention is increasing.

Wage costs are also increasing, both because work input for control and own operations are increasing, but not least because hired labour for sea lice treatment, cleaning nets and other specialized services are increasing. With a production that no longer is growing, wage costs are also increasing due to general wage increases.

The project also discusses the significance of cost-driving regulations and how costs and regulations impact the future competition situation for the industry. The project discusses the use of resources in terms of administration, application processes, environmental surveys and certification, and in particular costs, advantages and disadvantage of the stringent sea lice policy.



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Top quality on the agenda

Cermaq came to Nofima to learn how they could become even better at ensuring that salmon maintains high quality throughout its shelf life.



PHOTO: LARS ÅKE ANDERSEN © NOFIMA

Using QIM – the “Quality Index Method” - Nofima is putting top quality on the agenda in the seafood industry.

The standardized method the Cermaq employees were trained in is called QIM – the “Quality Index Method”. The method has been developed by Nofima’s researchers in cooperation with researchers from a number of European countries.

The standardized method is available for a number of species, including cod, haddock, herring, saithe, redfish and shrimps.

Cermaq is the world’s third largest producer of salmon and trout, with operations in Norway, Canada and Chile. Nofima has cooperated with Cermaq for a number of years to measure the quality of their salmon. The scientists have taken measurements, and the company’s employees have conducted assessments in consultation with Nofima.

However, not all properties are equally easy to assess, and the method requires that the person performing the assessment is well trained.

“The course in question was tailored for Cermaq. However, we have created a training scheme that would be useful for the seafood industry in general,” scientist Torbjørn Tobiassen explains.

Among the topics covered by the course are shelf life, instrument measurements and the slaughter process. The participants are given both theoretical and practical exercises where they practice assessing the salmon.

Quality manager with Cermaq, Kristin Dahlen, says the course contributes to solving challenges for the company.

“We have slaughterhouses in several places and a large number of controllers. In order to compare data, we are dependent on using the same methodology and on having a common understanding of the various parameters we have to consider. The method we learn on the course is a good tool for ensuring this,” Dahlen says.

“We also learn how to communicate with customers with regard to freshness. Several of our customers use the same parameters to assess freshness, and it is a great benefit that we speak the same language,” she says.

Nofima organizes a number of courses, seminars and topical days on subjects that concern fisheries, aquaculture and the food industries.

Are you interested in a similar course? Get in touch!



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Major advances in modern breeding

R&D departments at Ås and industry stakeholders have employed the salmon's reference genome to create new efficient selection tools.

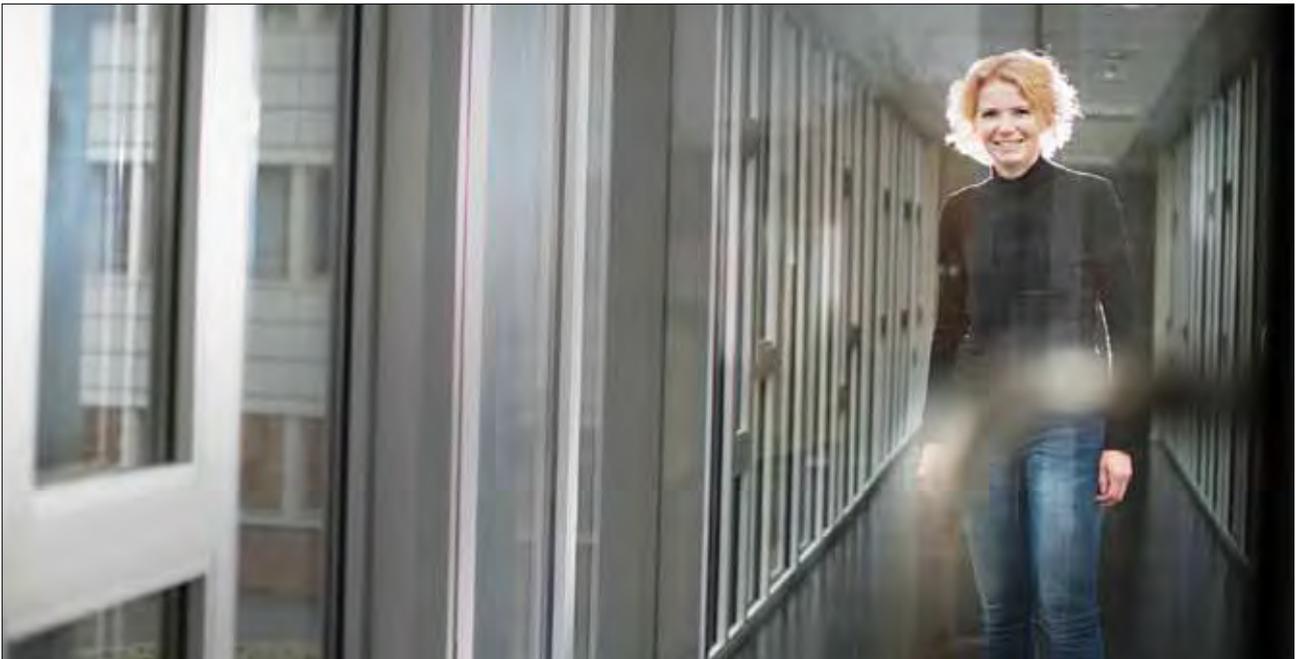


PHOTO: JON-ARE BERG-JACOBSEN © NOFIMA

Senior scientist Anna Sonesson believes it has been of great benefit to progress that the three breeding companies have collaborated in the research project.

In 2014, the reference genome was completed, which maps the complete DNA code of Atlantic salmon. The reference genome is a tool that helps researchers understand the link between the DNA codes of the and the salmon's phenotypes.

In a recently-concluded Innovation Project for the Industrial Sector of the Norwegian Research Council, the three industry partners SalMar, SalmoBreed and Marine Harvest have recorded data on lice, growth and PD (Pancreas Disease) in their fish. Nofima has used this data to develop two selection tools, and the Norwegian University of Life Sciences (NMBU) has developed software to apply them. These innovations will lead to significantly more accurate breeding, and they will make it easier and cheaper through genomic selection:

"In traditional breeding we estimate the breeding value of broodstock based on information on their siblings. With these tools we can use genomic selection to estimate breeding values of each individual broodfish, and this more than doubles the accuracy of selection," says senior scientist Anna Sonesson at Nofima.

Higher accuracy of selection will make farmed salmon more resistant to disease and better suited to handle different environmental conditions.

In order to know which fish have which gene variant, the fish must be genotyped (DNA-tested). Using a tissue sample, breeding companies can test genetic markers across the entire genome. This information is used to select parents for the next generation.

This project focused on reducing the costs of genotyping. The new selection tools' accuracy is on a par with earlier and far more costly tools. The technology will now be tested on a larger scale at Nofima at Ås for the industry.

Vidar Lund from SalMar headed the project, and he is optimistic:

"This is a major advance in modern breeding. Use of the tool for genomic selection will become the industry standard," Lund says.



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FINANCED BY:

The Research Council
of Norway

Omega-3 requirement for salmon

150 grams of farmed salmon a week is sufficient to meet the needs for omega-3 fatty acids in humans. But what is sufficient for the salmon?



PHOTO: JON-ARE BERG-JAKOBSEN © NOFIMA

Marine omega-3 is a globally limited resource shared between food for humans and animals. Bente Ruyter is researching how much farmed salmon need.

Salmon require the long marine omega-3-fatty acids EPA and DHA in the diet to maintain good health. These fatty acids are known to have a role in developing eye and brain function and for good growth, and they are probably also essential for the immune system.

Nofima's research has previously shown that salmon have a natural but limited ability to transform a short omega-3 fatty acid from plants to marine omega-3. This ability is greatest when the level of marine omega-3 in feed is low. Research has also shown that the ability varies between fish with different genetic backgrounds.

So how little marine omega-3 can farmed fish get by on? Nofima is approaching an answer by studying fat metabolism throughout the salmon's life, where they have given salmon from 0 to 2 per cent EPA and DHA in the feed, from initial feeding to slaughter at 4 kilos. They have analyzed the fish regularly, and found which level of EPA and DHA in the feed that results in the maximum own production of marine omega-3 in salmon.

In terms of the most efficient utilisation of resources, it pays to have 1 per cent or less of marine omega-3 in the feed, as the salmon's own production peaks.

However, 1 per cent is too low for the fish to maintain good health in a demanding environment, says Bente Ruyter, senior scientist with Nofima. In trials in the sea she has seen that salmon on a omega-3 diet deficient showed higher mortalities than salmon on a high omega-3 diet. This salmon was treated for sea lice repeatedly and the sea temperature was high.

"In order to secure a robust salmon in the sea that can withstand the handling and environmental stressors it faces in practice, farmed salmon seem to need more than 1 per cent marine omega-3 in the diet to maintain good health. However, if one succeeds with closed technology and control of environmental factors, the salmon can probably cope with less omega-3 in the diet. At the same time, it's possible to exploit the genetic potential the fish have in transforming plant fat to marine fat," Ruyter says.

The content in current feed varies, but all are well above 1 per cent.



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Round steak prevent osteoporosis

Tenderloin and round steak is good food, not least for preventing osteoporosis.



PHOTO: RUNE RØDBOTTEN © NOFIMA

Meat is a good, natural source of vitamin K₂, which prevents osteoporosis. Round steak and tenderloin have the highest content of the healthy vitamin.

The vitamin has several biological effects. It is well-documented that vitamin K₂ is important for bone structure and can protect against osteoporosis. It has been indicated that the high occurrence of osteoporosis in Norway may be linked to a low intake of vitamin K.

As the first group in the world, researchers at Nofima have investigated whether the content of vitamin K₂ varies between cattle breeds and muscle groups in cattle. Results show that there is more vitamin K₂ in round steak than in tenderloin and in the meat from Jersey cattle compared to NRF (Norwegian Red).

“It seems like muscles active in body movement contain more vitamin K₂ than relaxing muscles. There was most K₂ in the round steak, followed by sirloin, while the lowest concentration was found in tenderloin. However, all three muscles and both cattle breeds provide good contributions of vitamin K₂,” scientist Rune Rødbotten of Nofima emphasizes.

The investigation showed no connection between intra-muscular fat and the share of vitamin K₂, nor between the animal’s age and vitamin K₂.

The researchers have been thorough in their investigations. Trials started when the animals were 1–2 months old and lasted until they were slaughtered at 18 to 24 months age. During the study all animals were given the same feed. They grazed at Jæren in the summer, and during winter they were given roughage and a small proportion of concentrate (which was not enriched with vitamin K).

“Vitamin K is fat-soluble vitamins, which comes in different forms. Vitamin K₁ is primarily found in plants, while K₂ is found in animal products such as meat, liver and cheese,” Rune Rødbotten says.

“In Norway meat is an important food source for vitamin K, because bioabsorbtion is high,” senior scientist Bente Kirkhus of Nofima says. Bioabsorbtion indicates to which degree nutrients are absorbed by the body.

In the United States authorities recommend a daily intake of approximately 100 micrograms of vitamin K. In Norway and the EU there are currently no vitamin K recommendations.



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The Foundation for Research Levy on Agricultural Products (FFL) and the Research Council of Norway

Much to gain from better handling

If all cod catches were without major injuries, the fishing industry could increase its profits by hundreds of millions every year.



PHOTO: SJURDUR JOENSEN © NOFIMA

A reduction in catch injuries and better handling of the fish can provide significantly increased income in the fishing industry.

A reduction of catch injuries and better handling of the fish may enable the fishing industry to achieve better returns from cod.

On assignment from the Fishery and Aquaculture Industry Research Fund (FHF) scientist Marianne Svorken and her colleagues at Nofima have estimated the potential value of higher quality fish based on the export value of cod in 2013. The estimates have been made for the fillets, salted fish, salted and dried fish and fresh fish.

Despite the fact that the authorities, organizations and research have had a strong focus on quality in recent years, Nofima's research shows that a relatively large share of cod catches in 2014 arrived at shore with reduced quality. A report in December established that the share of fish with poor quality is at the same level or worse, compared to catches in 2004.

Line and jig caught cod are best, and the share of fish in the categories "good", "reduced" and "poor" has remained stable since 2004. Trawl and seine caught cod result in the highest share of poor fish, and the trend is negative for seine net.

"The main problem is that the catches are too large, not the type of gear used. We have seen that seine nets are best suited for storing live cod, which proves that we can achieve very high quality from seine nets," says senior scientist Sjurdur Joensen.

"Keep the catches smaller and preserve quality," is his advice.

The quality of cod can be degraded at several stages, both during catching, handling on board, slaughter and bleeding, during further processing on land, through storage and during transport. The researchers call for more comprehensive understanding and responsibility for quality throughout the value chain.

"Analyses show that it is possible to extract greater value from cod by ensuring that the raw material has a consistently high quality," says Marianne Svorken.

The researchers believe it is reasonable to assume that if the quality was predictable and at a stable high level, it would also be possible to increase prices.



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The Norwegian Seafood
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Learn to taste yourself

Small and large food producers now have the opportunity to employ a quick method to determine which products should make it to market.

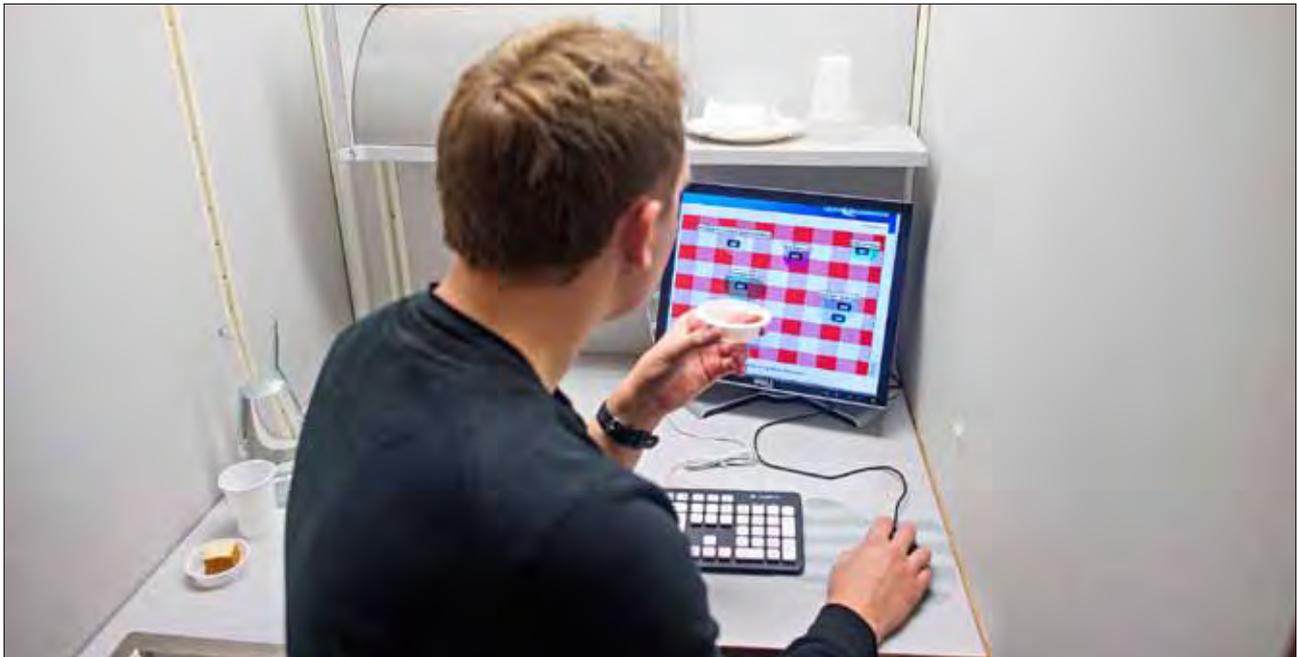


PHOTO: JON-ARE BERG-JAKOBSEN © NOFIMA

In the "RapidCheck" project Nofima is developing methods that enable the food producers themselves to perform sensory assessments of their products.

Which cocoa drink should we put on the market – the one with extra milk, the one with extra sugar, or the one with vanilla? These are the type of questions food producers ask themselves when considering putting new products on the shelves. Now there exist new opportunities to find the answer.

"Professional tasters, such as those in Nofima's sensory panel, can provide the most accurate answers. But now there's also a simpler option," says senior scientist Paula Varela Tomasco.

In the "RapidCheck" project Nofima is developing methods that enable the food producers themselves to perform sensory assessments of their products – through taste, smell, visual impression and texture. One of the methods is called PSP – "Polarized Sensory Positioning".

The method is particularly useful during the initial and final stages of product development. Anyone can use it, and it is a four-stage process. First the test product is compared to reference samples – for example competing products one wants to resemble or distinguish one-

self from, or own products. How similar or different are they? When the degree of similarity is established, one uses words to describe what characterizes the product.

The words are entered into a computerized system. Here the frequency of words is tabulated. The data is subjected to multivariate data analysis – statistical analysis with several simultaneous variables – and a product map is generated. When this is combined with surveys of what consumers like, one has a good basis for choosing which prototypes to introduce to market.

"For food companies checking quality or working on product development, this is both a simpler, faster and cheaper way of assessing products," says senior scientist Tormod Næs, who heads the statistics part of the project.

Research is being carried out in close cooperation with major industry players. Nofima also offers courses to companies wishing to employ sensory methods, so that they may ensure that they are used correctly and that the results are correctly interpreted.



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The Research council of
Norway and the Foundation
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More from the same type of fish

While Iceland's filleting industry is viewed as profitable, the Norwegian industry is described with terms such as crisis and closures.



PHOTO: JABBI, WIKIMEDIA COMMONS

Fillet production at fish processor HB Grandi in Reykjavik, Iceland.

This despite both Norway and Iceland producing and exporting relatively similar products of cod, haddock and saithe to the same global markets.

An Icelandic master student was tasked with analysing accounts, landing data and export figures from 2003-2012 to determine whether the Icelandic filleting industry has developed permanent competitive advantages, and if so, which advantages and whether they may be copied by Norwegian industry.

The analysis shows that the filleting industry in Iceland is more profitable than in Norway. An important cause is how the businesses are organized.

In Iceland there are more large companies that control the entire value chain – from catch to export. In Norway this is unusual due to statutory limitations. The greater the control of the value chain by the Icelandic companies, the more profitable they were.

Norway has an advantage in terms of the volume of white fish. However, Iceland has an advantage in terms of the migratory patterns of the fish. Icelandic vessels

can catch fish the year round close to shore, thus the industry has good access to fresh raw material throughout the year. In Norway the cod season is short and hectic, because the cod is far out to sea for most of the year. If Norway succeeds with catch-based aquaculture, this could compensate for this.

Icelandic businesses are more market-oriented than Norwegian counterparts. They export a larger share of fresh fillets, and they catch a lot with hook gear that yields very high quality.

“We can't do much about biological and geographical issues, but we can try to copy Iceland's advantage through the design of management. For example by making greater allowances in terms of financial organization, the design of catch regulations and greater opportunities to transfer quotas between vessels, says research manager Bent Dreyer of Nofima.

Dreyer was a supervisor for David Bragi Björgvins-son, who wrote the master's thesis at Norway's Arctic University in Tromsø.



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programmet

MORE INFO:
Read the
thesis



Good advice from sausage maker

Hadeland Viltslakteri and Ask are neighbours on Randsfjord lake. Both produce meat products and are grateful towards Nofima's sausage maker.



PHOTO: JON-ARE BERG-JAKOBSEN © NOFIMA

Hadeland Viltslakteri and Ask produce meat products. They greatly appreciate useful advice from Nofima's sausage maker Tom Chr. Johannessen.

The two local food producers have benefited from the Competence Network for local food in eastern Norway, which is administered by Nofima. It is particularly the expertise of Nofima's sausage maker Tom Johannessen they have benefited from through courses and access to a visitation scheme.

"Tom is an important partner in discussions. If I am to take any major decisions, such as purchasing equipment or altering the recipe, I always consult him," says Tor Egil Torp at Hadeland Viltslakteri.

Husband and wife Tor Egil Torp and Ramona Narvesen both work full-time producing smoked sausages, grilling sausages and meat patties.

"I started the game slaughterhouse with no training. There was quite a bit of trial and error, so I soon saw a need for more knowledge. It's more than 15 years since I attended my first course with Tom. Then I learned about starter cultures, and after that errors dropped radically," Tor Egil says.

Kristoffer and Anne Marte Evang at Ask Gård are artists, but now the days are mainly dedicated to producing organic smoked sausages and cured leg of mutton.

Kristoffer works full time as a producer of cured meats. Anne Marte works part time.

The profit from cured meat has been used to upgrade the production facility – which was bought on Tom's recommendation.

"In addition to providing advice on which equipment is most suitable for us, Tom also has good contacts and knows whether other manufacturers have equipment for sale and whether it's suitable for us. We have made great savings," Kristoffer says. He has used several of the courses from the Competence Network, and has also taken part in a course in sensory assessment – tasting.

Taste has always been key. Other aspects that have been important for Anne Marte and Kristoffer are that the food is pure and genuine, and that the design is attractive and suits the products.

Anne Marte also believes they timed the organic wave well too.

Soon they are initiating a new product development project in cooperation with Nofima. This time the goal is to develop organic and tasty fresh sausages.



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HSMI: More pieces in place

Slowly but surely, researchers are putting together the pieces in the puzzle of knowledge on how to best prevent disease in salmon.



PHOTO: JON-ARE BERG-JAKOBSEN © NOFIMA

There is still no miracle cure for HSMB in salmon, but scientist Lill-Heidi Johansen is constantly finding new pieces in the puzzle.

A three-year project with different research approaches to the virus disease HSMI (Heart and Skeletal Muscle Inflammation) has come to an end. According to scientist and project leader Lill-Heidi Johansen, there is still no miracle cure that prevents and cures the disease in salmon, but a few more pieces of the puzzle are in place.

Micro-organisms, environmental factors, farming conditions and malnutrition. The factors that contribute to the disease's development are numerous. This makes it difficult to both prevent and treat. Among other things, this research project has compared the diseases HSMI and PD (Pancreas Disease) and the consequences they have for salmon.

"Increased knowledge on which immune response the different diseases result in allows for better vaccines that can prevent outbreak of disease. There is currently a vaccine for PD, but not for HSMI. Our results show that the salmon's response to the two diseases is somewhat different. Innate immune response is strongest in the

case of PD, while adaptive response is strongest in the case of HSMI", Johansen says.

The vast majority of farmed salmon in Norway are healthy and fit until they reach slaughter weight. However, in cases where disease afflicts aquaculture facilities, it impacts profitability in several ways: Fish die of the disease, one experiences slower growth than normal both during and after disease outbreaks, and one can lose income as a result of downgrading to poorer quality for fish that have been subject to disease. Early diagnosis is therefore of great interest to the industry.

"The earlier one knows, the greater the chance of implementing necessary measures to prevent infection from developing into disease. Our results may contribute to new methodology for early and more disease-specific diagnosis," Lill-Heidi Johansen concludes.

"We know far more than we did at the project's outset, but we still don't have all the pieces of the puzzle."



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Progress based on knowledge

FindIT is a new tool for storage and analysis of aquaculture production data: Understand the past, control the present and predict the future.



PHOTO: LIDUNN MOSAKER BOGE © NOFIMA

Ranita Styve Aarvik (Bolaks), Synnøve Helland (Nofima) and Julia Fossberg (Lerøy Belsvik) presented FindIT at Aqua Nor 2015.

In FindIT production data is stored in a format that enables active use of the figures, which include environmental data, various incidents in the life of the fish and measures for productivity.

“The tool collects and structures data. The analyses show what are limiting and what are positive factors in production. One can thus implement improvements in the next production cycle based on knowledge rather than assumptions,” say Nofima scientists Grete Bæverfjord and Synnøve Helland. They have taken part in the development of the application and are currently working on implementing the tool in Norwegian fish farming.

FindIT has initially been developed for fresh water production, but the goal is to include sea production and broodstock too.

Temperatures, water quality, vaccinations, disease, checks, weight, unforeseen incidents. Everything that affects the life of farmed fish is already recorded. Currently much of the knowledge is inside the heads of those who at all times work with the fish, while the data is concealed in files and binders.

The goal of the FindIT data tool is to use these records strategically, and to ensure that knowledge is not lost.

Data mining, which is FindIT’s methodology, is based on large amounts of data, and uses computing power to find patterns in the data that the human brain is incapable of. The system relies on large datasets, and the value of FindIT will increase with the number of participants and time. All participants may see and work with their own data, while information from others contribute in the analyses. Knowledge is developed jointly, without individual producers having to show their hand.

“In this way one may generate knowledge in order to optimise production in upcoming production cycles,” Synnøve Helland says.

“We are working on optimising data transfer from current production management systems, such that the fish farmers avoid doing the same work twice. FindIT is not an alternative to these systems, rather a supplementary tool,” Grete Bæverfjord concludes.



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EU

Mutton has large potential

You may make lamb and cabbage stew using mutton instead of lamb. Many people won't be able to taste the difference.



ILLUSTRATION: NOFIMA

Consumers described the mutton roast with the words lean, juicy, mild, beef and tender among others.

In a research project where the goal is to develop tasteful products from mutton and lamb, tests have been carried out both with Nofima's sensory panel – professional sensory assessors – and among regular consumers. The main conclusion is that the use of mutton has a large potential.

“We believe that we only like lamb, but our tests show that consumers in most cases think mutton tastes just as good. “The results from our tests show that in a blind test many of us can't tell the difference between meat from a nine month-old lamb and a four year-old sheep,” says project leader Kristine S. Myhrer of Nofima.

The purpose of the ongoing project is to study the potential for mutton on the market. The study is a part of a larger NFR project where Nortura is the owner, and Animalia, NMBU and Nofima are partners. The project-goal is better exploitation of raw materials and increased added value.

The test was carried out in March 2015 with 90 consumers who were served three samples of mutton and

three samples of lamb. All samples were taken from the animals' legs.

The consumers were presented a total of 36 descriptive terms to choose from. Their responses can be seen in the “word cloud” illustrating this article.

Finally, the consumers were asked to complete a questionnaire on their consumption of lamb and mutton, and their perceptions of the two types of meat.

“When consumers are asked to choose what they would serve for Easter dinner or for the autumn's traditional lamb and cabbage stew, the vast majority choose lamb rather than mutton. However, the truth is that consumers don't perceive large differences between lamb and mutton when they don't know what they're eating. Some of the consumers in the study also mixed lamb with pork, and mutton with beef,” Myhrer says.

None of the samples registered a woollen flavour, which mutton sometimes has a reputation for.



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Regulating for further growth?

Is the Norwegian governance regime suitable for growth in the production of farmed fish?



PHOTO: FRANK GREGERSEN © NOFIMA

Is the Norwegian management regime suitable for future growth in aquaculture? Nofima researchers are trying to find the answer.

Management and regulations constitute important framework conditions for the aquaculture industry when it comes to facilitating further industrial development. Researchers from Nofima, the University of Tromsø, the University of Stavanger and NTNU have assessed this framework.

There is no doubt that the current regulatory regime has been successful in many ways, and has made a positive contribution to the development of a new and important coastal industry. However, the researchers have focused on challenges and areas for improvement:

“The fragmented management structure is one of the main challenges. The current regime entails “piece by piece” planning, which makes it difficult to achieve an integrated aquaculture management” says senior scientist and project manager Roy Robertsen

“The current requirements toward sustainable growth in the aquaculture industry is largely directed toward envi-

ronmental sustainability, based on a few parameters. This should be extended to also include social and economic sustainability, in order to achieve overall sustainable development,” says senior scientist Kine Mari Karlsen.

“A too narrow approach to sustainability may cause a negative distortion of competition toward other food and resource industries. There is therefore a need to clarify the prerequisites and prospects for more industry-neutral sustainability principles,” says senior scientist Otto Andreassen.

“In the next stage of the project we will take a closer look at how the regulations are enforced and practiced, and which conditions that are challenging, in order to identify more specific areas of improvement in management and regulations,” scientist Ann-Magnhild Solås says.



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Broccoli – climate and storage

Where is the healthiest and tastiest broccoli produced? And how is the quality best preserved after harvest?



PHOTO: JON-ARE BERG-JACOBSEN © NOFIMA

How can wholesale and retail in Norway best preserve the quality of healthy broccoli? Nofima has found some of the answers.

For three years Nofima researchers and their partners conducted extensive trials to find out how different light and temperature conditions from field to table affect the quality of the healthy, green vegetable.

Broccoli has been grown in greenhouses simulating different climate zones in Norway, as well as outdoors in four test fields from 43 to 69 degrees north.

“Different growing conditions can result in broccoli with different sensory and health-related quality,” says project manager and recently retired senior scientist Gunnar Bengtsson. An interesting finding, particularly for us in Norway, was that a cold period before harvest resulted in a higher level of vitamin C.

Complex storage trials that simulated the wholesale and retail stages in Norway have given researchers knowledge on how quality best may be preserved all the way to the consumer.

“Temperature has the greatest impact on the keepability of broccoli and thus the quality at the time of purchase,” says postdoctoral fellow Sidsel Fiskaa Hagen.

The lower the temperature, the better – both in wholesale and in stores. Light conditions are far less important, but different types of light may be used to optimise the content of health-related constituents, including vitamin C, glucosinolates and polyphenols.

Nofima’s researchers have used different methods to find out what is going on in the plants. In addition to monitoring selected phytochemicals and nutrients, they have used so-called ‘omics’ techniques for a more holistic picture of how the broccoli’s internal machinery is affected by external stimuli. In these analyses they have studied thousands of plant compounds and broccoli genes – simultaneously.

The project has carefully documented effects of temperature and light on health-related compounds in broccoli throughout the value chain. This allows for better optimisation of the quality of broccoli both during growth and in distribution.

The knowledge generated in the project forms a basis for increased value and greater consumption of broccoli.



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FINANCED BY:

The Research Council of Norway, Nofima and partners

Profitable colour gauging

Salmon farmers are now using Photofish in quality analyses. Nofima wishes them the best of luck with the tool, which emerged 13 years ago.



PHOTO: JON-ARNE BERG-JACOBSEN © NOFIMA

Scientist Thomas Larsson and professor Kjell-Arne Rørvik are happy to share knowledge on how the quality of the fillet can be managed throughout production.

“When we started developing this tool, we saw the need to quickly and impartially measure the colour, pigment and fat content of each individual salmon,” says Kjell-Arne Rørvik of Nofima, one of the three founders.

The backdrop was that there are requirements toward the visual colour of fillets in the Norwegian industry standard, but no available analysis that directly measures the colour while remaining impartial. The alternative is chemical analysis of pigment from the fillet, and this takes time. There was thus a need for the tool Rørvik had developed. Using it, colour could be continuously measured throughout production, and quality could be managed up to slaughter. However, the technology had to become easier to use.

Technology vendor AKVA group had great interest in the innovation, and created a new, portable device that could perform measurements on location.

Now the company is producing and selling Photofish devices. Method, statistics and calculations have been verified by Nofima. Nofima also quality-assures each individual device before it is deployed to the fish farmer.

Nofima has used Photofish continuously in its research since the prototype was launched in 2003.

“We are pleased to see that AKVA group has been able to develop our research and implement this quick analysis tool in the industry,” Rørvik says.

Einar Helsø is Product Manager of AKVA group, and he believes that they as a technology vendor are dependent on good collaboration with expert communities:

“It was decisive to have Nofima on board when commercializing Photofish,” Helsø says.

Nofima also assists farmers who need advice on quality management:

“Through years of research and experience in the field we know a lot about methods for optimum colouring. For example, we have data that shows that when the fish are stressed, pigment (which is an antioxidant) is consumed, and the colour turns less red. By imparting such knowledge to the farmers, they will enjoy the full effect of the photo device. We are only happy to share this knowledge!” Rørvik concludes.



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AKVA group and Regionale

Forskningsfond Vestlandet

(RFFVEST)

Low drip loss for salmon

Fish is sold by the kilo. But when stored, fish loses weight. The money literally drips off the fish.



PHOTO: JON-ARE BERG-JACOBSEN © NOFIMA

Norwegian seafood industry already does what can be done to prevent drip loss in salmon.

However, research concludes that the seafood industry already does what is best to prevent drip loss in salmon.

How much loss can one expect, and what affects fluid loss in salmon? Can anything be done to minimize drip loss? These issues have now been thoroughly documented by researchers at the Nofima food research institute, in collaboration with Sør-Trøndelag University College and Marine Harvest's slaughterhouses at Hjelmeland and Hitra.

Each percentage of weight lost means a lower sale value. When sellers and buyers of large consignments of fish agree on the price, the so-called drip loss is an important factor to take into account.

A number of variables were tested in order to document what results in the least fluid loss. Researchers have compared whole fish with fillets, fish from farms in the north with fish from farms in the south, fish slaughtered during the spring with fish slaughtered in the autumn, and fish that was filleted pre-rigor and fish filleted post-rigor.

"One has to take into account a loss of 1–2 per cent. But when all is said and done, it is the storage time which is decisive. The shorter the storage time, the less fluid loss," says Nofima scientist Bjørn Tore Rotabakk, who headed the research experiments.

Fillets lose the least fluid at cooler temperatures, and it is thus best to store fillets on ice, if the weight is to be maintained as high as possible.

Pre-rigor fillets have a higher drip loss than post-rigor fillets, but this is because post-rigor fillets are filleted at a later stage and that whole fish have far less drip loss than fillet. On the other hand, post-rigor fillets have other challenges with splitting and texture.

"The best results coincide with fish that have undergone what is common practice in the seafood industry. We can therefore say that much of what is currently done is done in the best way," Rotabakk says.



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Breaking new ground in brewing

Beer has become cool, and microbreweries a new growth industry. Nofima is taking part in the process of breaking new ground in brewing.



PHOTO: JON-ARE BERG-JACOBSEN © NOFIMA

Microbreweries have become a new growth industry. At Lindheim Gård in Telemark Eivin Eilertsen – in cooperation with Nofima – is breaking new ground in the art of brewing.

Beer and fruit. The combination is uncommon. However, at the fruit farm and brewery at Lindheim Gård in Telemark, one is investigating brewing beer with fruit using a different method than the traditional one: Instead of adding yeast to the wort, it is cooled in large vats and spontaneously ferments based on the micro-organisms in the air and the general environment.

The “beer farmers” Eivin Eilertsen and Ingeborg Lindheim found the inspiration for their new beer project in Belgian Lambic beer. It is here the method of spontaneously fermented beer has been developed. Eivin started up in 2014 – and was soon left with a series of questions on the process and optimisation that he was unable to resolve himself – and was unable to find information on. The idea of a research project thus arose.

“The micro-organisms that provide the desired fermentation in spontaneously fermented beer normally reside on fruit, among other places. Our role is to take numerous samples of the air, fruit, cooling vats and the finished product and then analyse these. Using modern

DNA-based methods, we can analyse entire microbe communities with greater accuracy than ever. This method – which only a few professional communities in Norway are capable of carrying out – in combination with general fermentation expertise, make us particularly well-suited to identify the conditions for spontaneous fermentation,” says senior scientist Lars Axelsson at Nofima.

In the context of research projects, the Lindheim beer project is a small one. However, the researcher is positive towards using Nofima’s experts to develop niche products too. In the past 14 years more than 50 microbreweries have been established in Norway. The research at Lindheim will thus in all likelihood be relevant for others in the brewing community.

The result of the beer brewer’s work and enthusiasm is already so good that the Lindheim beer was named one of the world’s best new beers in 2015. Albeit not the spontaneously fermented type, which is still at an experimental stage.



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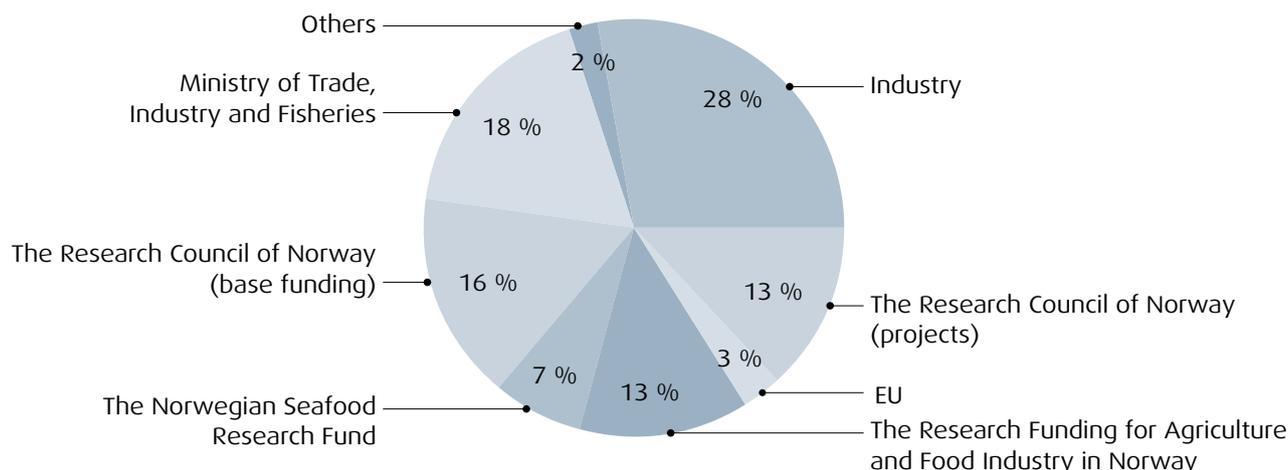
Lindheim Gård and
Tel-Tek

FINANCED BY:

Oslofjordfondet

Facts and figures

In 2015 Nofima's 355 employees delivered research and services worth NOK 550 million to approx. 250 different clients in Norway and abroad.



The following are our largest funding providers:

RESEARCH COUNCIL OF NORWAY is a strategic organ that identifies priority areas and project/programme managers, allocates research funding and evaluates the research that is carried out.

THE MINISTRY OF TRADE, INDUSTRY AND FISHERIES is responsible for the fishery and aquaculture industry, fish health, fish welfare, seafood safety and quality and more.

THE NORWEGIAN SEAFOOD RESEARCH FUND (FHF) shall create added value for the seafood industry through industry-oriented research and development. Financed through a levy on all seafood exports.

THE RESEARCH FUNDING FOR AGRICULTURE AND FOOD INDUSTRY IN NORWAY (FJM) shall secure an economic basis for research connected to agricultural products that are utilized to produce food and stimulants, as well as feed grain for animals. Financed through a research levy on agricultural products.

THE INDUSTRY – Nofima's R & D work is oriented primarily towards the aquaculture, fishery and food processing industries.

THE EUROPEAN UNION finances several research projects that Nofima either participates in or has project responsibility for.

Nofima's mission

Our mission is outstanding research, development and innovation for the food of tomorrow.

This means that

- our research shall be relevant and of high quality and utility value
- we shall be innovative, responsible, committed and inclusive
- we shall think carrying out, competence development and implementation

Our strategy is based on the vision "Creating value together" – and in collaboration with our clients we deliver internationally recognized research and solutions that provide a competitive edge throughout the entire value chain.





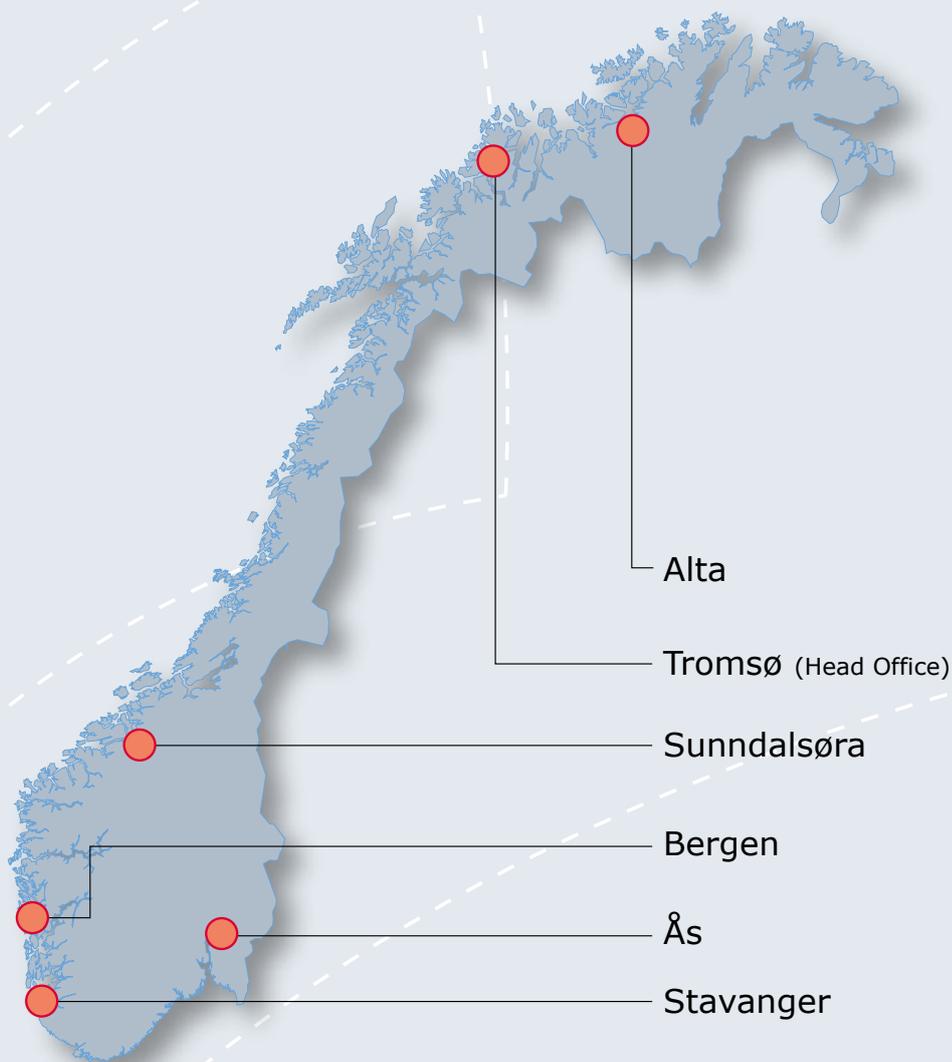
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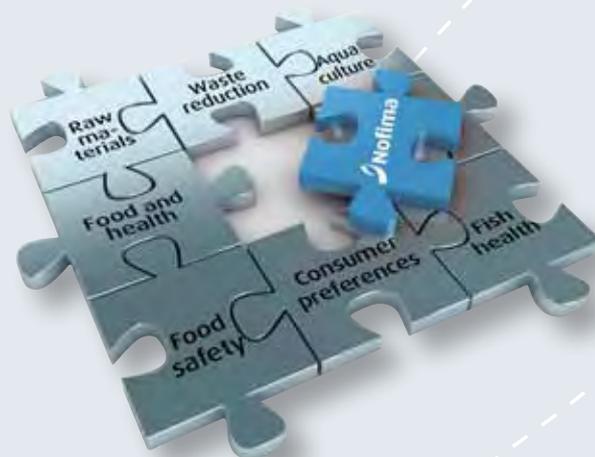
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