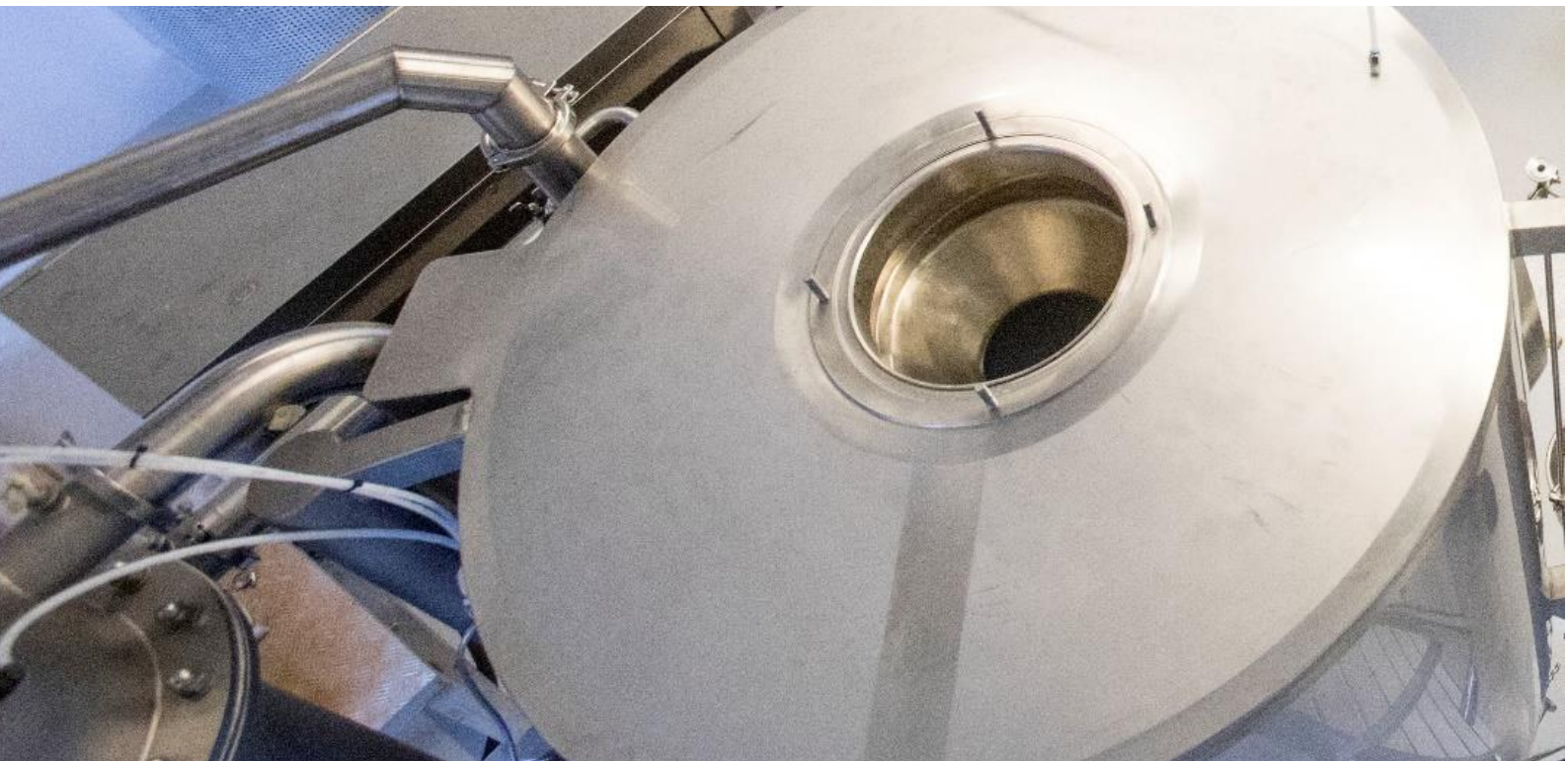
FOODS OF NORWAY

Annual Report 2016



Contents

Centre for Research-based Innovation
The Research Council of Norway

The Research Council of Norway

Norwegian University of Life Sciences

Foods of Norway is funded by the Research Council of Norway (grant no. 237841/O30), its partners and its host institution, the Norwegian University of Life Sciences.

Summary of the year 2016

Foods of Norway focuses on research and innovation to develop novel feed ingredients from natural bioresources, and on improving feed utilization through industrial exploitation of cutting-edge research on processing and (bio)technology, nutrition, health, genetics and food quality.
This summary will take you through the highlights of 2016, which was the first full year of the Centre.

Organization
Foods of Norway is an SFI – a Centre for Research-based Innovation. The Department of Animal and Aquacultural Sciences at NMBU (Norwegian University of Life Sciences) hosts the centre, in close collaboration with NMBU's Department of Chemistry, Biotechnology and Food Science, Department of Basic Sciences and Aquatic Medicine, and Department of Food Safety and Infection Biology.

The industry partners are Agrifirm Innovation Centre, Animalia, AquaGen, Borregaard, Felleskjøpet Fôrutvikling, Geno, Norilia, Norske Felleskjøp, Norsvin, Nortura, TINE, Viken Skog, Seaweed Energy Solutions and Yara.

Foods of Norway's board comprises representatives from the industry partners and the host institution. The Centre Director leads the running of the centre, assisted by the centre management group which consists of the Centre Director, the work package leaders, centre coordinator and administrator. A Scientific Advisory Committee of international experts has been appointed to provide scientific and strategic advice.

Six integrated work packages
Foods of Norway has a special focus on developing sustainable feed ingredients from renewable bioresources that are not suitable for direct human consumption and that have the potential to be produced in large quantities at a competitive cost. The centre aims to develop new, innovative processing techniques by exploiting state-of-the-art biorefining technologies that allow conversion of natural bioresources into high-quality feed ingredients for fish and farm animals.

The centre's research plan includes six integrated work packages, each of which comprises several sub-tasks. An NMBU researcher leads each work package in which the industry partners are well integrated. Research is multidisciplinary with close synergies across work packages.

International cooperation
Foods of Norway has two international consortium partners - University of Copenhagen and Agrifirm Innovation Centre - in addition to several associated partners. In 2016, research collaboration between Foods of Norway and Chile (the Institute for Cell Dynamics and Biotechnology (ICDB) at the University of Chile) was established with a common goal of maximizing the use of macroalgae biomass.

Visibility
Foods of Norway emphasizes the importance of communication and dissemination. During 2016, Foods of Norway researchers have given 50 presentations at seminars and meetings for a wide variety of stakeholders, primarily in agriculture, aquaculture and forestry. The centre has been highly visible in national and international media, increasing awareness among trade and industry, politicians and the public at large of the challenges and potential solutions addressed by Foods of Norway's research.

Vision and objectives

The vision of Foods of Norway is:
To increase value creation in the Norwegian aquaculture, meat and dairy industries by developing novel feed ingredients from natural bioresources and by improving feed utilization.

The main objective in Foods of Norway is:
To make Norwegian fish and animal farming industries more competitive and innovative by developing novel feed ingredients from bioresources and ensuring efficient feed resource utilization.

The secondary objectives are:
Exploit modern biorefining technologies to develop high-value feed ingredients from lignocellulosic biomass.

Use innovative bioprocessing to develop novel feed ingredients from local natural bioresources such as macroalgae and animal and plant co-products.

Improve efficiency of existing feed resources through innovative bioprocessing.

Allocate feed resources across species (fish, pigs, broiler chickens and dairy cattle) for optimal production economy and minimal environmental impact.

Provide knowledge to ensure that the use of novel feed ingredients supports production of high quality Norwegian food products.

Identify biomarkers for optimal utilization of novel feed resources for use in future fish and animal breeding programs.

Photo: Shutterstock

Research plan

Background

Today, the Norwegian fish farming and farm animal industries rely largely on imported plant ingredients, such as soybeans. In addition, the use of human food as feed ingredients has been questioned, both for ethical and economic reasons. Future fish and animal production will require competitive and sustainable novel feed ingredients produced from non-food resources. Existing feed resources need to be used more efficiently, for example by genetic improvement of animals and optimal feed resource allocation across species.

Norway has limited land area for cultivating food and feed resources, but possesses large natural bioresources such as trees, grass, macroalgae, and co-products from fish, animals and plants that can provide a basis for the production of novel feed ingredients.

Foods of Norway has a special focus on developing sustainable feed ingredients from renewable bioresources that are not suitable for direct human consumption and that have the potential to be produced in large quantities at a competitive cost. The centre thus aims to develop new, innovative processing techniques by exploiting state-of-the-art biorefining technologies that allow conversion of natural bioresources into high-quality feed ingredients for fish and farm animals.

The plan

The research plan of the centre includes six integrated work packages, each of which comprises several sub-tasks. An NMBU researcher leads each work package and the industry partners are well integrated in the work. Research is multidisciplinary with close synergies across work packages.

Wood consists of three main constituents: cellulose, hemicellulose and lignin. In the biorefinery process, lignin will be separated out and used for high-value products, while cellulose and hemicellulose will be converted into sugars and used in the fermentation of certain yeast strains for the production of single-cell proteins.

We also aim to develop feed ingredients and high-value functional products based on macroalgae by using novel cultivation and harvesting technologies and new downstream processing methods. A major task will be to upgrade the nutrient value of the seaweed by a biorefinery process so we make use of the entire biomass in the fermentation process for the production of yeast.

Furthermore, Foods of Norway will have a special focus on improving feed efficiency and robustness of fish and farm animals by combining important phenotypic traits, new biomarkers for feed utilization and advanced genomic analysis to support genetic adaptation to existing and novel feed resources. Improvements in feed efficiency allow for the production of more food from feed resource inputs, and reduce feed costs and impact on the environment.

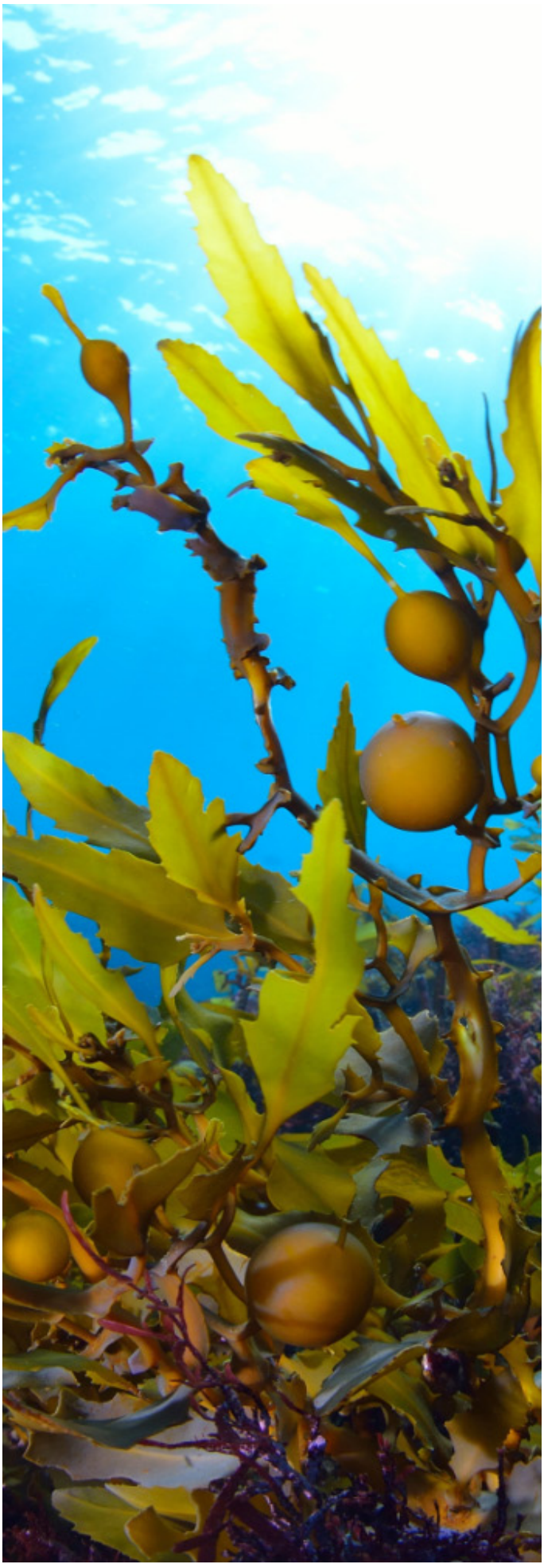


Photo: Shutterstock

Work package	Leader	Main objective
WP1: Development of novel feeds and processing technology	Vincent Eijsink	• Develop novel feed ingredients based on local low-value non-food biomass from forest, coastal areas, and agricultural land, either by directly converting the biomass to a feed ingredient or by converting the biomass into single cell protein. • Upgrade existing feed resources by improved processing technologies. • Improve the nutritional value of grass silage.
WP2: Impact of novel and improved feed ingredients on nutritional value and feed efficiency	Liv Torunn Mydland	• Investigate how diets based on novel and improved feed resources affect growth performance, energy and nutrient utilization in fish, chicken, pigs and dairy cows. • Study metabolic responses to increased levels of novel and improved feed resources e.g., changes in metabolic pathways, microbiota population, mitochondrial function, as well as regulatory metabolic and gastrointestinal hormones in fish, pigs, and broiler chicken. • Study metabolic responses, including rumen fermentation in dairy cattle. • Perform multi-mix optimization of the novel feed resources for optimal resource utilization across species. • Model the biological processes and to include important parameters in the existing NorFor model for dairy cows.
WP3: Impact on fish and animal health	Charles McLean Press	• Study dietary effects on the structure and functions of intestine, composition of microbiota, interactions between the host microbes, and general health in fish, pigs, broiler chicken and dairy cows. • Evaluate whether the beneficial effects of yeast also improve gut health in ruminants. • Evaluate effect of diets based on novel ingredients on disease resistance in fish and pigs; and • Integrate all available information into dynamic and mechanistic gut homeostasis models that will predict nutritional impact on fish and animal health.
WP4: Food quality assessment	Siv Skeie	Evaluate the impact of novel feed resources on the quality of: • Milk and fermented milk products (yoghurt and cheese) • Chicken and pig meat • Cattle meat • Fish products

Work package	Leader	Main objective
WP5: Genomics and genetics of feed efficiency, health and robustness	Gunnar Klemetsdal	• Establish methods (with WP2) for high throughput phenotyping for individual animal digestibility and /or feed intake. • Collect phenotypes and genotypes for individual digestibility and/or feed intake in salmon. • Develop statistical models and study genetic and genomic differences in digestibility in salmon. • Study genomic variations and identify candidate functional mutations (SNPs) that can be used for assess genomic prediction of digestibility. • Study effect of increased digestibility on other important traits. • Combine detailed biological information to identify new selection criteria for implementation in the breeding schemes.
WP6: Economical and environmental impact	Gro Steine	• Assess the value of novel and improved feed resources in relation to the performance of the animal. • Assess the environmental footprint of the novel and improved feed resources by Life-Cycle Analyses (LCA). • Assess the environmental impact of improved FE. • Assess the consumer socio-economic aspects of the food products. • Assess the potential for large-scale production of the ingredients developed and documented in WP 1-4.

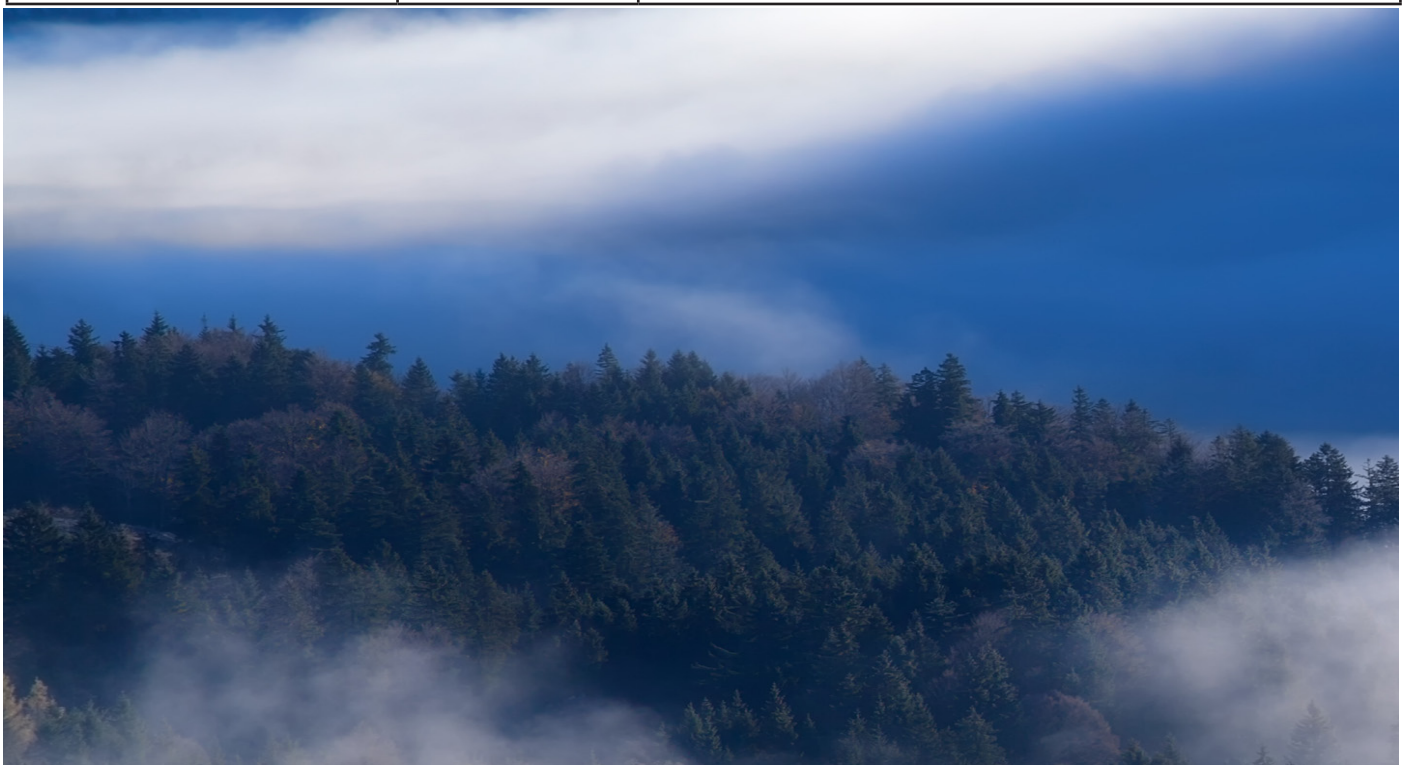


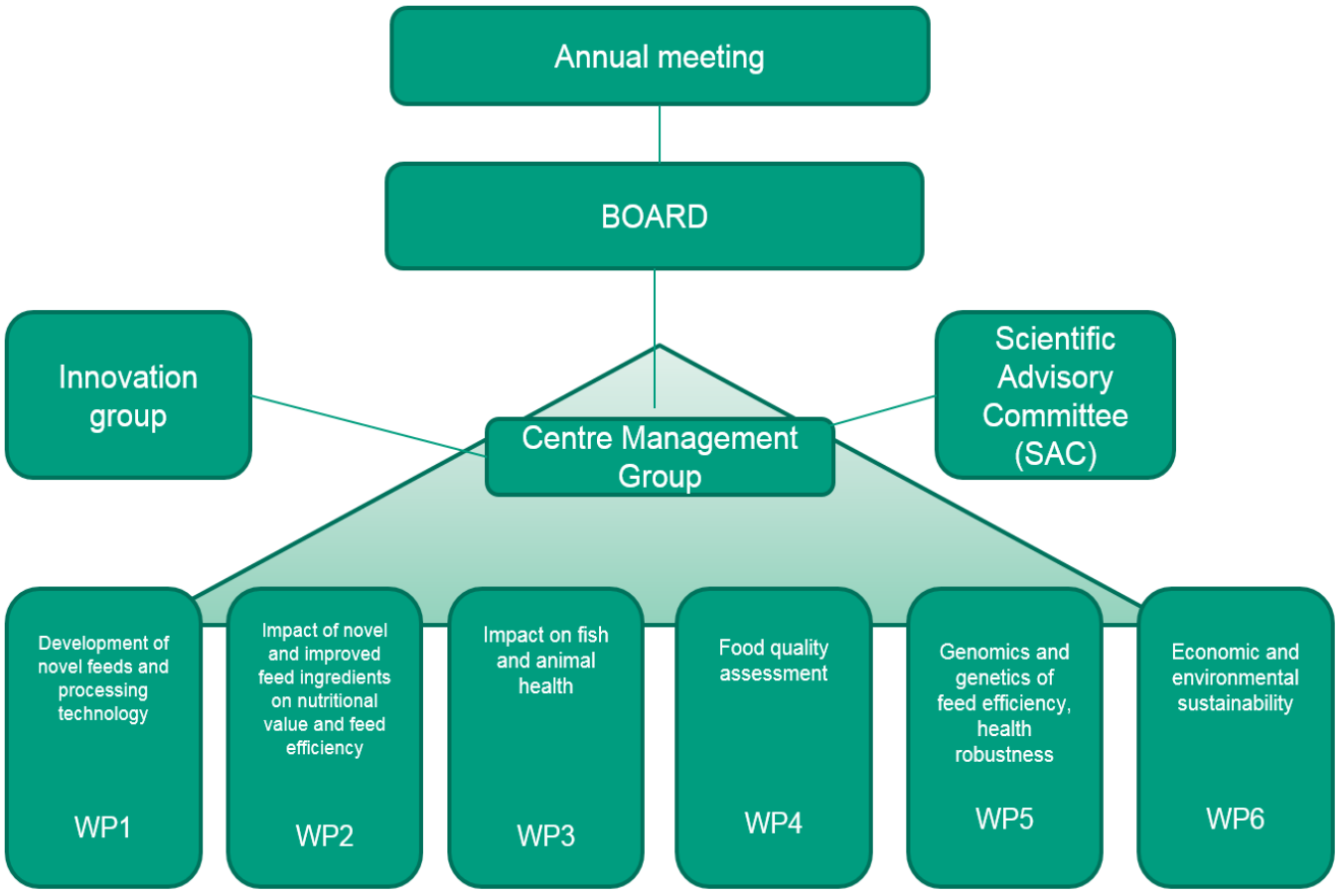
Photo: Shutterstock

Organization

The Annual Meeting convenes once a year to discuss the centre's activities, present result highlights from the past year and discuss forthcoming plans.

The Board is the ultimate decision making body of the Consortium. The board's main responsibility is to ensure that the intentions and plans underlying the contract for the establishment of the centre are fulfilled, and in particular that the activities presented in the project description are performed within the stipulated budget and time frameworks.

The Centre Director will be in charge of the operation of the centre, assisted by the centre management group which consists of the Centre Director, the work package leaders, centre coordinator and administrator. A Scientific Advisory Committee (SAC) was appointed by the board in 2016 and will ensure quality and excellence of the centre's work. SAC has three members; Wendy Rauw, researcher at INIA - Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria, in Spain; Birte Svensson, Professor at the Technical University of Denmark, and Anders Karlsson, Professor at the Swedish University of Agricultural Sciences. The Innovation Group will advise specifically on innovation related to centre activities, promote research activities to politicians and other decision makers, and provide advice on how results, ideas and concepts generated in the centre could potentially be commercialized.



The Board

From left: Torstein Steine (Deputy Chair), NMBU/ Department of Animal and Aquacultural Sciences; Ragnhild Solheim, NMBU/ Research and Innovation Department; Nina Santi, AquaGen; Knut Røflo (Chair), Felleskjøpet Fôrutvikling; Anne Storset, NMBU/Department of Food Safety and Infection Biology; Gudbrand Rødsrud, Borregaard and Morten Sollerud, Norilia.
Eirik Selmer-Olsen, TINE, was not present.
Photo: Håkon Sparre

Centre Management Group

From left: Charles McLean Press, WP3 leader; Margareth Øverland, Centre Director; Siv Skeie, WP4 leader; Gunnar Klemetsdal, WP5 leader; Gro Steine, Centre Coordinator and WP6 leader; Vincent Eijsink, WP1 leader; Barbara Eriksen, Administrator; Liv Torunn Mydland, WP2 leader.
Photo: Janne Karin Brodin

Partners with broad multidisciplinary expertise

The Foods of Norway consortium comprises four departments at NMBU, one international academic partner and four associated international academic partners, and 18 partners in industry and innovation, representing forestry, aquaculture and agriculture.

Academic partners:
NMBU:

- Department of Animal and Aquacultural Sciences (host)
- Department of Chemistry, Biotechnology and Food Science
- Department of Basic Sciences and Aquatic Medicine
- Department of Food Safety and Infection Biology

International:

- University of Copenhagen (partner)
- Aarhus University
- University of Minnesota
- University of Western Australia
- US Department of Agriculture – ARS

Industry and innovation partners :

- Agrifirm Innovation Centre
- Animalia
- AquaGen
- Borregaard
- Felleskjøpet Fôrutvikling
- Geno
- Innovation Norway
- NHO Mat og Drikke
- Norilia
- Norske Felleskjøp
- Norsvin
- Nortura
- Seaweed Energy Solutions
- The Federation of Norwegian Agricultural Co-operatives
- The Norwegian Farmers' Union
- TINE
- Viken Skog
- Yara

Centre activities in 2016

Cooperation between partners

Two joint meetings for all partners in Foods of Norway were held during 2016. The first meeting on 9-10 March provided an arena for partners and researchers to meet and discuss plans, activities and expectations, both within and across work packages. At this partner meeting, plans and research for 2016 were presented and discussed. The second meeting was a workshop on 17-18 October where the annual plans and milestones for 2017 were discussed.

Workshop 2016
Photo: Janne Karin Brodin

All partners participate in at least two work packages and the work packages are highly integrated, encouraging all the partners in the centre to collaborate closely. 2016 had a concerted emphasis on producing yeast and on feed efficiency experiments with Atlantic salmon. In this context, it should be especially mentioned that Borregaard organized the production of 1 ton of yeast using BALI sugars from spruce trees. This large-scale yeast production is extremely valuable and has allowed us to perform feeding experiments with pigs at NMBU's research farm and at the facilities of our international partner at the University of Copenhagen.

Seaweed Energy Solutions and Norilia have provided valuable seaweed and animal by-product biomass for the production of yeast by means of biorefinery processing at NMBU.

Photo: Shutterstock

A feed efficiency experiment with Atlantic salmon was conducted in 2016 in close collaboration with the researchers at NMBU and AquaGen.

All partners have participated in follow-up planning meetings organized by the work package leaders.

Seminar
The seminar "Fish feed for food security" was arranged on 27 October. More than 50 participants from both academia and industry attended the seminar.

Foods of Norway arranged a mini-seminar in December at the Department of Animal and Aquacultural Sciences primarily for employees at the department and representatives from the breeding companies Geno, Norsvin, AquaGen and Norsk sau og geit.

Scientific activities and results

Selection method for efficient animals in aquaculture production

One of the goals of Foods of Norway's research is to learn how to select fish that utilize feed more efficiently. In other words, more fish produced per unit of feed.

To meet the future global need for food, increased feed efficiency is essential. Aquaculture production has increased from 44.3 million tons in 2005 to 73.8 million tons in 2014. By 2030, the global demand for fish is estimated at 150-160 million tons per year.

Breeding strategies

Improved feed efficiency is the most imperative trait in animal breeding and genetics. Foods of Norway focuses specifically on developing breeding strategies to increase feed efficiency of farm animals. We are therefore investigating feed resource utilization in fish, dairy cattle and pigs. The approaches vary for each species.

Fast growing and high feed intake

Traditionally, feed efficiency has been improved indirectly through increased growth rate. This strategy has been fairly effective in the past, but now needs to be replaced by more precise and efficient methods.

Measure protein turnover

Protein metabolism is a major determinant in the conversion of feed into growth. In collaboration with AquaGen, Foods of Norway's PhD student Hanne Dvergedal studies protein metabolism. The aim is to develop direct methods to select for the most efficient animals in aquaculture.

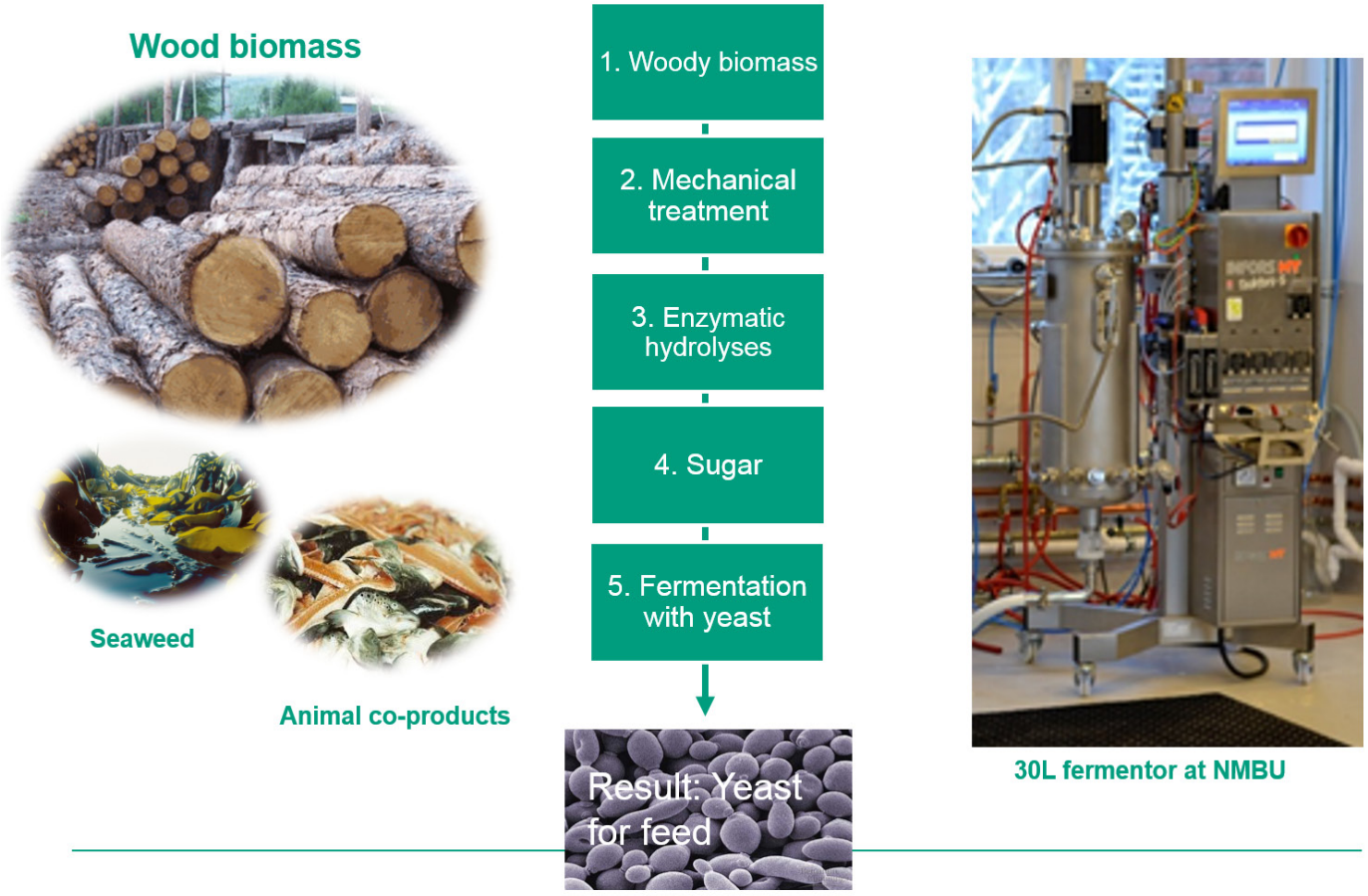
In a pilot trial conducted in 2016, the protein turnover in muscle, liver and mid-intestine of 510 Atlantic salmon was examined to find bioactive markers that can be used to trace protein efficiency of individual fish. Building on these findings, subsequent research will investigate the existence of genetic variation in the salmon's ability to produce high-quality fish products on as little feed as possible, while still safeguarding fish health.

PhD-student Hanne Dvergedal
Photo: Liv Røhnebæk Bjergene

Novel feeds and processing technology

Norway has limited land area for growing feed crops, but has access to large natural bioresources such as forests and seaweed. Thanks to advanced processing technology, this biomass can be transformed into valuable products, including novel feeds.

A main objective in Foods of Norway is to develop novel feed ingredients from local low-value non-food biomass, such as trees and by-products from chicken and pigs. This can be done by converting the biomass into single cell protein or yeast. Tree fibres are converted to sugar, which is the energy and carbon source for the yeast. Yeast derived from the processing of non-food biomass is a potential high-quality and safe source of protein in fish and animal farm diets.



30L fermentor at NMBU

In Foods of Norway, we aim to find the best combination of sugars, nutrients and yeast.

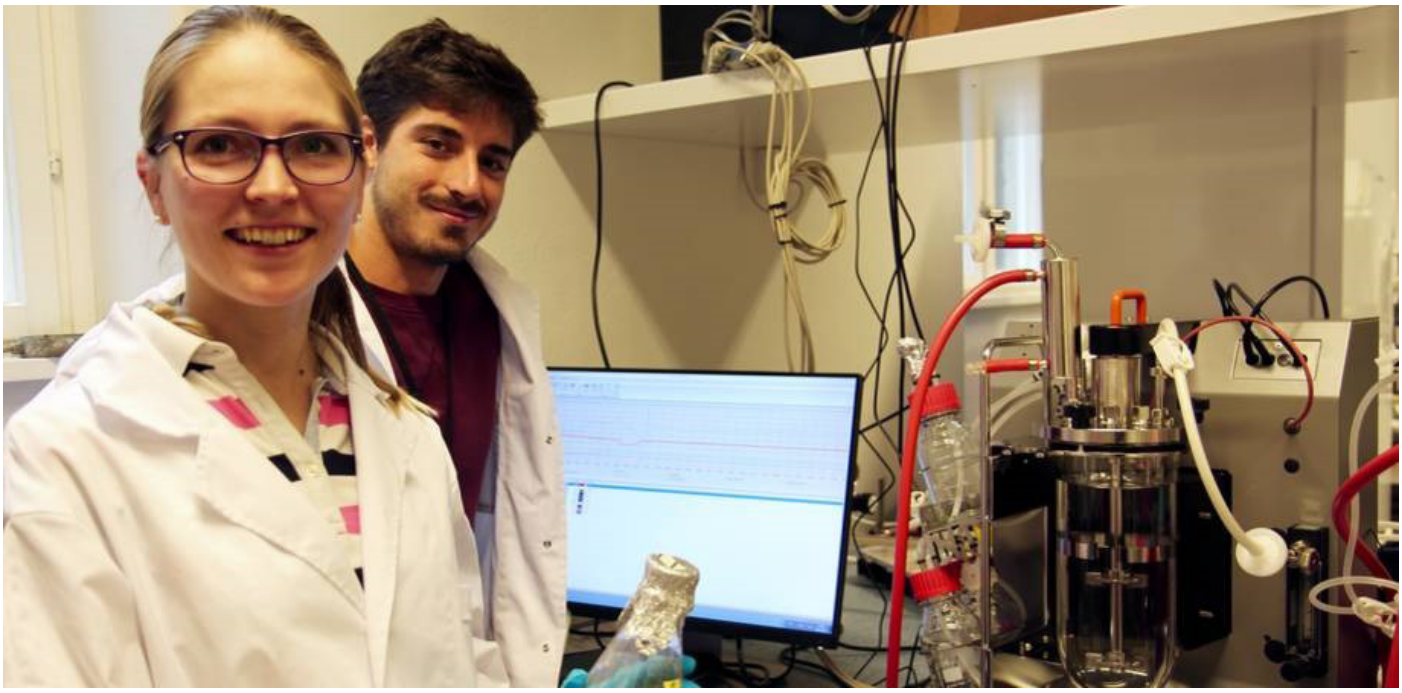
The “recipe” to produce yeast from trees is:

- Hydrolyze by-products from fish and animal by-products by adding a well-documented cocktail of enzymes to break down the biomass into nitrogen and other valuable nutrients.
- Add the hydrolysates from fish and animal by-products in a fermentor together with sugars from trees.
- Microbes, such as yeast, enjoy this combination of sugars and nutrients. As a result, they produce high-quality feed proteins.
- Spray-dry the yeast, which can replace other protein sources such as soybean meal in animal feeds.

Research highlights in 2016
Enzyme technology is essential to break down the biomass. NMBU is in the forefront of this fundamental enzyme technology.

During 2016, NMBU has developed a biorefining laboratory with 30-liter fermentors, providing us with increased expertise in bioprocessing and fermentation.

With NMBU's biorefinery up and running, researchers have been able to scale up from small-scale screening to producing yeast on a feed-trial scale. Standardized methods for chemical analysis of the biomass have been developed, including analyses of hydrolysates from fish and animal by-products to select the best input streams for yeast fermentation.



Kiira Vuoristo and David Lapeña Gómez
Photo: Liv Røhnebæk Bjergene

Foods of Norway partner Borregaard has developed new technology to produce green chemicals and sugars from trees, known as the BALI technology. In 2016, yeast grown on BALI sugars and seaweed hydrolysates has been produced on a feed-trial scale. In addition, yeast has been produced on a large scale under Borregaard's supervision, using BALI sugars.

Why yeast can be a valuable feed resource
Yeast grown on sugars from tree biomass has proven to be a sustainable protein source in fish diets due to:

- High protein content
- Favourable amino acid profile
- Its content of bioactive components
- Good flavour
- Ability to improve animal health

International cooperation

Foods of Norway has two international consortium partners - University of Copenhagen (DK) and Agrifirm Innovation Centre (NL) in addition to several associated partners: Århus University (DK), University of Minnesota (US), University of Western Australia (AUS), USDA-ARS (US) and the Swedish University of Agricultural Sciences (SE).

Collaboration with our international partners has been an integral part of planning research activities and experiments to develop feed resources and in the evaluation of these experiments with farm animals.

Beneficial research collaboration between Foods of Norway and Chile

During 2016, research collaboration between Foods of Norway and Chile was established. The mutual aim is to maximize the use of macroalgae biomass.

Just like Norway, Chile has a long, cold-water coastline full of macroalgae. This biomass can be used for the production of bioactive compounds, chemicals, feed and food ingredients and biofuel through novel technologies. The Institute for Cell Dynamics and Biotechnology (ICDB) at the University of Chile has substantial expertise in converting macroalgae to bioenergy and fine chemicals. Their insight complements that of the Foods of Norway team in areas such as knowledge of e.g. how to hydrolyze the biomass by using enzyme technology and the production of yeast through fermentation. By joining forces and exchanging insights in enzymology, fermentation and chemical characterization of seaweed, the use of biomass can be maximized.

Mutual research exchanges

In 2016, several research exchange visits between Foods of Norway and ICDB took place:

- Cristina Ravanal from ICDB visited NMBU and worked together with PhD student Sandeep Sharma and postdoctoral researcher Kiira Vuoristo.
- Foods of Norway Centre Director Margareth Øverland and researchers Felipe Eduardo Reveco-Urzua and Kiira Vuoristo visited Chile in November with the aim of further cementing this collaboration.

Alginates to break down seaweed

One aspect that the Norwegian and Chilean researchers are looking at is the use of enzymes called alginate lyases to break down seaweed into sugars. The sugars can be fermented to yield different products, including feeds.

Cristina Ravanal (ICDB) and Sandeep Sharma (NMBU)
Photo: Liv Røhnebæk Bjergene

Recruitment

The number of personnel has steadily increased during the year, with the addition of a centre coordinator, a research assistant, three PhD students, a researcher and one postdoc. During the centre period, the goal is to recruit at least 20 Master students, 12 PhD students and 6 postdocs. The gender distribution in the centre is about fifty percent each females and males.

New employees

Hanne Dvergedal is studying for her doctoral degree on topics linked to Foods of Norway with emphasis on feed efficiency in salmon, integrating genetics and nutrition. Two experiments will be conducted at NMBU's new fish laboratory in collaboration with Foods of Norway's partner AquaGen.

Gro Steine is Foods of Norway's centre coordinator working closely with the consortium partners. Gro is also responsible for Work Package 6 on economic and environmental sustainability.

Gro Steine earned her doctorate in Animal Science and Agricultural Economics.

For her PhD degree **Mette Hofossæter** will investigate the pathophysiological effects of novel feed from non-food biomasses on the intestinal health of Norwegian production animals. The effect will be evaluated based on morphological and molecular changes of the intestinal mucosa. Experimental material will be collected from in vivo trials in Atlantic salmon and pigs.

Ragnhild Ånestad was appointed as research assistant and works closely with Foods of Norway researchers running experiments with fish and farm animals. Ragnhild is in charge of developing methods for measuring digestive enzyme activity.

Ana Cruz started in September as a PhD student under the Research Council of Norway's industrial PhD scheme and is an employee at Felleskjøpet Fôrutvikling. The working title of her thesis is "Novel protein sources produced from advanced bioprocessing for monogastric animals".

Felipe Reveco-Urzua is a researcher at NMBU's Department of Animal and Aquaculture Sciences. Felipe obtained his doctorate from the Faculty of Veterinary Medicine at the University of Chile. In Foods of Norway he is responsible for task 4.2 (Chicken and pig meat) in Work Package 4 - Food quality assessment.

Kiira Vuoristo is a postdoc at NMBU's Department of Chemistry, Biotechnology and Food Science. She is working with evaluation of sugar streams, screening of yeast candidates and optimization of the fermentation and downstream processing of yeast in Work Package 1.

Communication and dissemination activities

Communication strategy
The media showed a great interest in Foods of Norway even before the centre officially opened. The interest in the centre has continued.
Foods of Norway emphasizes the following main principles for communication:

- Accessible
- Clear
- Independent

Our target groups for internal and external communication are:

Internal:

- Industry and research partners

External:

- Decision makers
- Public opinion

In order to reach the various target groups, a combination of written, verbal and electronic information has proved successful.

Below are some media statistics for Foods of Norway.

Facebook	Number of followers	338
	Records since opening	34
Newsletters	Number since opening	3
Chronicles	Number since opening	9
Popular science articles	Norwegian media	34
	Foreign media	11

Foods of Norway's newsletter
Foods of Norway has established a website, www.foodsofnorway.net where information about the centre is published. In addition, we use Facebook for continuous updates. As part of our communication strategy, we issue an electronic newsletter twice a year to all partners and others in our network. The newsletters are also published on our website:
www.foodsofnorway.net/news/newsletter

The newsletter features research news highlights, ongoing activities and new members of staff.

Keynote lectures
In the course of 2016, Foods of Norway researchers have given 50 talks at seminars and meetings.

Selected talks:

Photo: Liv Røhnebæk Bjergene

Global forum for innovations in agriculture 2016

Centre Director Margareth Øverland was an invited keynote speaker at the Global forum for innovations in agriculture on 16-17 February 2016 in Abu Dhabi. Professor Øverland gave a talk to public decision-makers, private sector champions and public society leaders on how trees can be converted to salmon feed. The title of her talk was "Trees for salmon feeds".

Aftenposten's climate conference 2016

The oceans were the focus of Aftenposten's climate conference 26 October 2016. Some 1200 people listened to Foods of Norway researcher Jon Øvrum Hansen talk about how biomass such as spruce and macroalgae is being converted to novel, sustainable animal feed ingredients. The Norwegian title of the presentation was «En historie om å finne nye kilder til mat – både til mennesker og dyr».

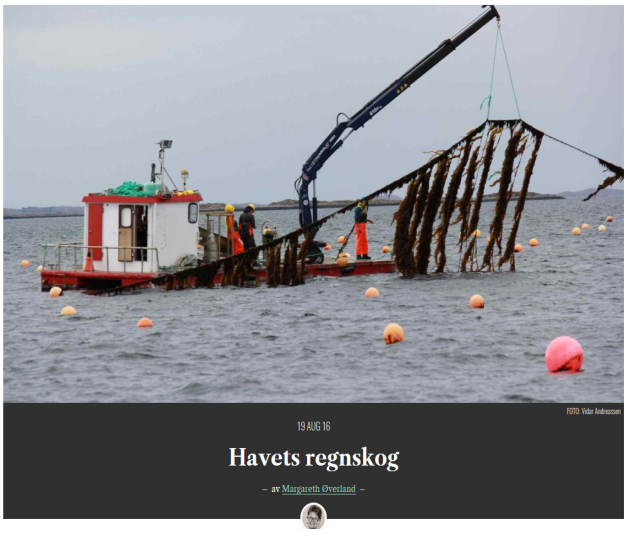
Photo: Håkon Sparre

Foods of Norway in the media
Foods of Norway has a proactive media plan. We work strategically towards the media in order to reach our target groups for communication.

International news coverage
Foods of Norway has an extensive network of partners from industry, research institutes and academia, both in Norway and abroad. Since the research is highly relevant in a global perspective, we have worked proactively towards international scientific and news media.

National news coverage
National media has shown great interest in Foods of Norway's research. In order to reach our target groups, Centre Director Margareth Øverland has strategically promoted the centre in various news media. Here are some examples:

09.06.2016 NRK Nordland



19.08.2016 Agenda Magasin

09.06.2016 NRK Nordland

23.02.2016 forskning.no

Attachment

Personnel

Key researchers

Name	Main research area
Margareth Øverland	Feed ingredient evaluation, nutrition and health, management
Vincent Eijsink	Fundamental and applied enzymology; bioprocessing; management
Liv Torunn Mydland	Process; feed ingredient evaluation, analytics
Charles Press	Veterinary pathophysiology, veterinary immunology
Henning Sørum	Bacteriology, pre- probiotics, microbiota, antibiotic resistance, fish diseases
Siv Skeie	Product quality
Gunnar Klemetsdal	Genetics; nutrition; feed efficiency
Gro Steine	Economics and sustainability
Anne-Helene Tauson	Monogastric nutrition, physiology and metabolism

Visiting researchers

Name	Period	Affiliation	Topic	Gender M/F
Cristina Ravanal	15.08.16-09.09.16	ICDB, University of Chile	Biorefining of macroalgae	F
Maria Elena Lienqueo Contreras	25.09.16-01.10.16	ICDB, University of Chile	Biorefining of macroalgae	F
Karl D Shearer	25.10.16-10.11.16	NOAA, Seattle	Sustainability assessment	M

Post docs with financial support from the centre budget

Name	Period	Topic	Gender M/F
Kiira Vuoristo	2016-2018	Biorefining, fermentation technology, enzymology	F

Post docs working on projects in the centre with financial support from other sources

Name	Period	Funding	Topic	Gender M/F
Caroline P Åkesson	2015-2017	NFR	Veterinary pathology	F

Researchers with financial support from the centre budget

Name	**Topic**	Gender M/F
Svein Horn (Professor)	Bioprocessing, applied enzymology, management	M
Bjørg Egelandsdal (Professor)	Product quality of meat	F
Christian Sahlmann	Macroalgae ecology and food safety; fish nutrition	M
Magnus Arntzen	Analytics; characterization of biomass and process fractions	M
Bjørge Westereng	Biorefining facilities, bioprocesses, analytics	M
Leidy Lagos	Pig nutrition, health	F
Felipe Reveco-Urzua	Animal health, product quality	M

Researchers working on projects in the centre with financial support from other sources

Name	**Funding**	**Topic**	**Gender M/F**
Jon Øvrum Hansen	NFR	Bioprocessing	M
Randi Sørby (associate Professor)	NMBU	Veterinary pathology	F

PhD students with financial support from the centre budget

Name	**Period**	**Topic**	**Gender M/F**
David Lapeña Gomez	2015-2018	Bioprocessing, enzymatic processes, analysis and testing of hydrolysates	M
Hanne Dvergedal	2016-2019	Feed efficiency in fish	F
Mette Hofossæter	2016-2019	Animal health	F

PhD students working on projects in the centre with financial support from other sources

Name	**Period**	**Funding**	**Topic**	Gender M/F
Sandeep Sharma	2014-2017	NMBU	Biorefinery processing	M
Peyman Mosberian Tanha	2013-2016	NMBU	Fish nutrition and health	M
Ana Cruz	2016-2019	Felleskjøpet Fôrutvikling/NFR	Animal nutrition	F

Master degrees

Name	**Period**	**Topic**	Gender M/F
Rouzbeh Keihani	2015-2016	Bioprocessing, fish nutrition and health	M
Marte Helene Tøfte	2016-2017	Feed efficiency in fish	F

Statement of Accounts

Foods of Norway costs 2016 (1000 NOK)

Host NMBU	Industry partners (Norway)	International partners	Equipment	Total costs
10 559	5 819	372	0	16 750

Foods of Norway funding 2016 (1000 NOK)

Host NMBU	Industry partners (Norway)	International partners	Research Council	Total funding
5 621	7 469	482	3 178	16 750

Publications

Estensoro, Itziar; Ballester-Lozano, Gabriel; Benedito-Palos, Laura; Grammes, Fabian; Martos-Sitcha, Juan Antonio; Mydland, Liv Torunn; Calduch-Giner, Josep Alvar; Fuentes, Juan; Karalazos, Vasileios; Ortiz, Alvaro; Øverland, Margareth; Sitjà-Bobadilla, Ariadna; Pérez-Sánchez, Jaume. **Dietary butyrate helps to restore the intestinal status of a marine teleost (Sparus aurata) fed extreme diets low in fish meal and fish oil.** *PLoS ONE* 2016 ;Volum 11.(11)

Mosberian-Tanha, Peyman; Øverland, Margareth; Landsverk, Thor; Reveco, Felipe E.; Schrama, Johan W.; Roem, Andries J.; Wittrup-Agger, Jane; Mydland, Liv Torunn. **Bacterial translocation and in vivo assessment of intestinal barrier permeability in rainbow trout (Oncorhynchus mykiss) with and without soyabean meal-induced inflammation**. *Journal of Nutritional Science* 2016 ;Volum 5.

Westereng, Bjørge; Arntzen, Magnus Øverlie; Aachmann, Finn Lillelund; Varnai, Aniko; Eijsink, Vincent; Wittrup-Agger, Jane.
Simultaneous analysis of C1 and C4 oxidized oligosaccharides, the products of lytic polysaccharide monooxygenases acting on cellulose. *Journal of Chromatography A* 2016 ;Volum 1445. s.46-54

Øverland, Margareth.
Skog og makroalger - det grønne gullet. *Praktisk økonomi og finans* 2016 ;Volum 32.(3) s.292-296

Øverland, Margareth; Skrede, Anders. **Yeast derived from lignocellulosic biomass as a sustainable feed resource for use in aquaculture.** *Journal of the Science of Food and Agriculture* 2016

Master thesis

Keihani, Rouzbeh.
The effect of Laminaria hyperborea and its bioactive components on the intestinal health of Atlantic salmon. Ås: NMBU, IHA 2016 55 s.
NMBU

Photo: Gisle Bjørneby

Photo: Håkon Sparre

Host institution

Norwegian University of Life Sciences
Department of Animal and Aquacultural Sciences

Contact persons:
Margareth Øverland, Centre Director
Gro Steine, Centre Coordinator

www.foodsofnorway.net

sfi = Centre for Research-based Innovation

The Research Council of Norway

Photo: Knut Martin Løken