The Research Council of Norway

# Work programme 2012–2021

Programme

## Sustainable Innovation in Food and Bio-based Industries – BIONAER

The Research Council of Norway

# Work programme 2012-2021

## Research Programme on Sustainable Innovation in Food and Bio-based Industries – BIONAER

The Research Council of Norway
Stensberggata 26
P.O. Box 2700 St. Hanshaugen
NO-0131 OSLO
Telephone: +47 22 03 70 00
Telefax: +47 22 03 70 01
post@forskningsradet.no
www.rcn.no/english

This publication may be ordered at
www.forskningsradet.no/publikasjoner

or green number telefax: +47 800 83 001

Cover design: Melkeveien designkontor
Cover photo/illustration: Shutterstock
Printing: 07 Gruppen
English translation by Victoria S. Coleman and Carol B. Eckmann

Oslo, January 2013

ISBN 978-82-12-03260-6 (printed version)
ISBN 978-82-12-03261-3 (pdf)

**Research Programme on Sustainable Innovation in Food and Bio-based Industries – BIONAER**

The BIONAER programme will promote research that increases the level, profitability and sustainability of production in the value chains for agriculture, forestry and nature-based industries, and for seafood from the time raw materials are taken out of the sea until they reach the consumer.

## Contents

# 1 Summary

The primary objective of the Research Council of Norway's Research Programme on Sustainable Innovation in Food and Bio-based Industries (BIONAER) is *to promote research that increases the level, profitability and sustainability*[1] *of production in the bio-based industries.* The scope of the programme covers research to promote innovation and management of the value chains for agriculture, forestry and nature-based industries, and for seafood and marine resources from the time raw materials are taken out of the sea until they reach the consumer.

The visionary framework of the BIONAER programme is the concept of the bioeconomy, also known as the bio-based society. The bioeconomy encompasses all sustainable production and processing of biological resources for food, health and fibre products, industrial products and energy. Other programmes and funding instruments at the Research Council also have sizeable budgets for funding research activities addressing the bioeconomy in their respective areas. Close cooperation and coordination between the BIONAER programme and other Research Council programmes and funding instruments will yield innovative research that facilitates the application of emerging technologies and lifts bio-based value creation in Norway to a considerably higher level of economic return. The BIONAER programme will work actively to coordinate its activities with other public research and innovation instruments, including the research funds of the fisheries, aquaculture, forestry and agriculture industries, and Innovation Norway, which complements Research Council funding instruments in many areas.

Four cross-cutting perspectives will apply to all activities under the BIONAER programme: achieving complete biological ***closed-loop systems***; incorporating the environmental, social and economic aspects of ***sustainability*** across the board; maintaining consistent focus on market orientation and ***value creation*** in the Norwegian bio-based industries; promoting ***interdisciplinarity*** to ensure the societal relevance of knowledge-building under the programme. And for food production in particular: ensuring ***food security*** and ***safe and healthy food***.

The scope of the BIONAER programme encompasses numerous, more or less independent value chains. In order to ensure flexibility and adequate integration of a closed-loop system perspective in the approach to activities involving these value chains, four thematic priority areas have been established under the programme: 1) Basis for production and framework conditions, 2) Primary production, 3) Processing, marketing and the consumer, and 4) Service-based value creation.

Activities under the BIONAER programme must be able to adapt to shifts in the interaction between research, technology and society. The programme will employ dialogue-based, flexible work forms with a conscious focus on communication as a means of ensuring that it meets the needs of the research community and society at large. Annual priorities for the programme will be identified in a dialogue with the research community and industry, and in relation to current research policy and other political guidelines.

[1] The concept of sustainability incorporates economic, social and ecological factors, in keeping with the Brundtland Report, *Our Common Future.* The UN World Commission on Environment and Development (1987).

Innovation projects for the industrial sector will be used as a tool for motivating companies in all segments of the value chains to intensify their level of research activity. Long-term industry-oriented as well as more strategic basic research will be channelled through large-scale interdisciplinary projects when this is deemed suitable for considerations relating to capacity and the overall organisation of the Norwegian research system. In certain cases, funding may be awarded to projects of a more traditional size.

Active international research cooperation and effective distribution of tasks at the national and international levels are crucial to a creating a thriving bioeconomy that can effectively address the Grand Challenges. This will be given great weight under the BIONAER programme.

# 2 Background

The world is facing major global challenges related to population growth, climate change and dependence on non-renewable resources. Dealing with these will require resilient systems that can adequately safeguard the food supply, the environment and human health for current and future generations. There is also a need to pave the way for the transition to a low-carbon society. Research is essential to developing the knowledge and solutions that Norway needs to solve these challenges.

The Research Council of Norway's BIONAER programme continues the activities of two previous programmes at the Council: The Food Programme (MATPROGRAMMET) and the Research Programme on Nature-based Industry (NATUROGNAERING). The scope of the BIONAER programme covers research to promote innovation in and management of the value chains for agriculture, forestry and nature-based industries. The programme is also responsible for developing knowledge on optimal handling of seafood and marine resources from the time raw materials are taken out of the sea until they reach the consumer.

Norway must both tackle major global challenges at the national level and position itself to contribute at the international level. The BIONAER programme will actively promote knowledge-building in traditional value chains, while at the same time serving as a change agent in its role as strategic driver for the development of new work forms and topics of focus.

For the past several decades, utilisation of non-renewable fossil resources has been the cornerstone of the Western economy. The understanding that these resources are finite has led to greater focus on the potential for value creation and economic growth on the basis of renewable biological resources. Increasingly, in Norway and internationally, this potential is being referred to as the *knowledge-based bioeconomy*. The bioeconomy, also known as the bio-based society, encompasses all sustainable production and processing of biological resources for food, health and fibre products, industrial products and energy.

There are a wide range of possibilities for expanding the use of resources in existing production activities relating to biological resources, including agriculture, forestry, reindeer husbandry, aquaculture, fisheries and related industries. However, Norway also has tremendous unexploited potential for increasing value creation on the basis of entirely new products created in the interface between traditional primary production, processing and emerging technological solutions. Enabling technologies such as biotechnology, information and communications technology (ICT), and nanotechnology are opening up completely new areas for use of biological resources as raw materials for industrial products.

The scope of the BIONAER programme does not extend to the entire bioeconomy. Other programmes and funding instruments at the Research Council also have sizeable budgets for funding research activities addressing the bioeconomy (please refer to Section 6.)

## Strategic perspectives

The BIONAER programme was launched against the following strategic backdrop:

### *1 The major global societal challenges (Grand Challenges)*

As a result of population growth, the need for food and energy will rise dramatically in the coming years, bringing with it distribution challenges. The impacts of climate change extend

across national boundaries, and the climate is changing more rapidly than previously projected. This will magnify the impact of the other global challenges. Report No. 30 (2008-2009) to the Storting *Climate for Research* identifies poverty, the demand for energy, climate change, loss of biological diversity, migration and increasing pressure on the world's food resources as the most pressing challenges of our time, and warns that the basis for future society is at risk unless we manage to solve these problems.

## *2 The Grand Challenges in a Norwegian context*

The cumulative effect of the Grand Challenges on Norwegian bioproduction will in all likelihood be significant, but the ramifications for Norway will vary in different areas. In the face of significant changes to the climate, there will be a need for plants and animals that tolerate the new conditions, and emissions of greenhouse gases will have to be reduced. However, it is also anticipated that climate change will open up new opportunities for biological production in Norway.

The population is expected to rise in Norway, too, in the years ahead, and the country thus also has a responsibility to produce more food. It is a stated political objective to increase Norwegian land-based food production to keep pace with the needs of a growing Norwegian population. Norway produces seafood on a very large scale, currently providing approximately 33 million meals a day in 130 countries. With effective, sustainable planning, Norwegian seafood production can be increased exponentially in coming years, thereby helping to secure the global food supply.[2] Norway also has vast forestry resources and the capacity for value creation linked to primary production and, not least, processing of wood-based products.

Although Norway may not directly feel the full weight of all of the global challenges itself, the country has a moral responsibility for helping to improve sustainability, expand the use of renewable resources and utilise existing resources optimally, including minimising loss.

## *3 National and international policy and industrial initiatives*

A range of national policy areas and documents provide the direction and guiding principles for the activities and scope of the BIONAER programme (see the list of documents below). Internationally, the EU, the OECD and a number of individual countries have drawn up strategies in recent years for research, innovation, employment and value creation rooted in bio-based production.[3] The concept of the bioeconomy is also on the Nordic agenda (the Nordic Council of Ministers for Fisheries and Aquaculture, Agriculture, Food and Forestry), and is given high priority in Horizon 2020 – the upcoming EU Eighth Framework Programme for Research and Innovation. Several Joint Programming Initiatives (JPIs) also address Grand Challenges relating to the bioeconomy.[4]

[2] The Royal Norwegian Society of Sciences and Letters and the Norwegian Academy of Technological Sciences: *Value created from productive oceans in 2050* (2012).

[3] EU (2010): "The European Bioeconomy in 2030: Delivering Sustainable Growth by Addressing the Grand Societal Challenges"; OECD (2009): "The Bioeconomy to 2030: Designing a Policy Agenda"; Germany: "Innovation Bio-economy" (Bio-economy Council Report 2010); Denmark (2009): "Agreement on Green Growth"; Finland (2009): "Using Natural Resources Intelligently"; Ireland (2009): "Developing the Green Economy in Ireland".

[4] Agriculture, Food Security and Climate Change (FACCE-JPI); Healthy and Productive Seas and Oceans (JPI Oceans); A Healthy Diet for a Healthy Life (JPI HDHL).

## *4 Strategic documents and initiatives at the Research Council*

Given its focus on the emergence of the bioeconomy, the BIONAER programme will play a central, future-oriented role in achieving the Research Council's strategic priorities. The bio-based society is one of the Council's main priority areas, when it comes to both budget increases and further development of Norwegian research policy.

A foresight analysis was conducted under the Food Programme in 2008-2009 in cooperation with representatives of trade and industry, the research community and special interest organisations. Among other things, the foresight study pointed out that the importance of cooperation and task-sharing between Norwegian and international research communities is growing. The BIONAER programme will work actively to advance the objectives of the Research Council of Norway's Strategy on International Cooperation and Innovation Strategy. The *international strategy* provides clear signals on how to achieve coordinated initiatives by integrating international activities into corresponding national activities. The *innovation strategy* reflects international research trends that emphasise the important role science and research will play in solving societal challenges. The strategy attaches importance to the participation of Norwegian companies in research activities and to ensuring that the findings generated are of benefit to trade and industry and the public sector alike.

### Scientific perspectives

The subject area covered under the BIONAER programme is broad and multifaceted. A bioeconomic approach to sustainable industrial and social development must be based on integrated, interdisciplinary knowledge-building. This field of knowledge, however, is so huge that Norway cannot fund cutting-edge development across the board. Priorities must be set to concentrate activities in areas in which Norway has the capacity to excel. At the same time, it is vital to continue to expand the knowledge base to remain adequately prepared for developments in areas that are also of importance to Norwegian society.

The relevance of know-how relating to the bioeconomy extends beyond national borders. International cooperation is fruitful for all countries involved, and is absolutely vital for small nations such as Norway. Participation in international research cooperation within all areas of the bioeconomy is crucial for Norwegian innovation.

The inherent need for coherence and interdisciplinarity in knowledge-building for the bioeconomy places new demands on research groups; these must work together more than ever to produce genuinely interdisciplinary and socially relevant knowledge. Numerous Norwegian research groups are working in this field, and all of the universities in Norway are involved in activities targeting various fields relating to the bioeconomy. A wide range of independent research institutes are carrying out relevant agriculture-based and marine research. The institute sector has undergone restructuring in this area in recent years, with the aim of promoting cooperation, constructive task distribution and highly focused research activities. The restructuring of the research institutes under the Ministry of Agriculture and Food is still ongoing.[5]

Norway is home to internationally leading research groups and knowledge-based companies in several areas. The BIONAER programme will engage in dialogue with relevant research environments and public authorities to help to prioritise research topics and secure funding for research on these topics.

[5] Cf. among others, *En robust instituttsektor* ("A robust institute sector") – the Research Council's evaluation of the research institutes under the Ministry of Agriculture and Food (2010) (Norwegian only).

Within this landscape of new and existing opportunities, the BIONAER programme will provide support for research and development activities that promote sustainable resource management, innovation and value creation in bio-based industries. Close cooperation between traditional primary production and new and existing processing industries combined with new connections between raw materials and emerging technologies will open up considerable opportunities for new products, services and value creation.

## Key documents providing guiding principles for the BIONAER programme

**Report No. 30 (2008-2009) to the Storting *Climate for Research*** identifies the global challenges relating to food security and recommends continued focus on industry-oriented research within the strategic areas of food, the marine sector and biotechnology. The white paper underlines the need for more sustainable food production in the face of changing climatic conditions and tougher competition, and emphasises the tremendous potential of Norwegian seafood production.

**Meld. St. 9 (2011-2012) Report to the Storting (white paper) *Velkommen til bords* ("Welcome to the Table")** (Norwegian only) sets out four overall priority areas for Norwegian agricultural and food policy: *food security, agricultural activities throughout the country, increased value creation* and *sustainable agriculture production.* The bioeconomy is used as the platform for the discussion on knowledge-building in the white paper, which stresses that research and innovation are needed within all of the priority areas. Particular focus is given to increased food production, the agronomic disciplines, the food industry, the forestry sector and economic growth in rural industries. The Ministry of Agriculture and Food will give special priority to funding research on:

- Sustainable production to ensure a safe and adequate food supply to meet national challenges in the food sphere;
- The climate, including emissions reduction, adaptation to climate change, and renewable energy; cf. also **Report No. 39 (2008-2009) to the Storting *Climate Challenges – Agriculture Part of the Solution***;
- Innovation and competitiveness in the agriculture and food sector;
- Knowledge development for management purposes.

The white paper on agricultural and food policy points out that cooperation between the authorities, industry players and knowledge environments is one of the sector's strengths and must be continued. The white paper attaches particular importance to the need for more targeted, effective dissemination activities to reach relevant stakeholders, further development of knowledge environments, international research cooperation, infrastructure, and securing access to qualified researchers.

The **HAV21 strategy** presented in November 2012 recommends that the Government funds knowledge-building activities to document the sustainability and quality of Norwegian seafood throughout the entire value chain as well as the correlation between seafood consumption and human health. The strategy also recommends an initiative for market and distribution research, brand-building and consumer behaviour in relation to seafood.

The Government has decided that a new white paper is to be drawn up providing an integrated, broad-based review of fisheries and aquaculture policy. The Government envisions a future in which Norway is *the world's leading seafood nation*. The white paper is to help to realise this vision and develop future-oriented fisheries and aquaculture policy. The research

strategy of the Ministry of Fisheries and Coastal Affairs (Norwegian only) is also relevant in this context.

**Meld. St. 21 (2011-2012) Report to the Storting (white paper)** ***Norwegian Climate Policy*** states that the Government will seek to increase the productive forest area and the forest carbon stock by implementing active, sustainable forestry policy.

**The National Strategy for Biotechnology for the future of value creation, health and the environment (2011-2020)** builds on the Government's vision of a Norway that will employ cross-sectoral research, expertise and cooperation to exploit the potential of biotechnology in a responsible manner in order to strengthen value creation, improve health and safeguard the environment. Three of the four thematic focus areas of the strategy lie within the scope of the BIONAER programme: 1) Aquaculture, seafood and management of the marine environment, 2) Agriculture-based food and biomass production,[6] and 3) Environment-friendly industrial processes and products.

**The Norwegian Government's national R&D strategy for nanotechnology for 2012-2021** promotes the responsible development of nanotechnology that can contribute significantly to industrial and commercial development in Norway and will be of relevance and benefit to society. Food from land and sea is identified as one of three key societal challenges to which nanotechnology can be applied to find solutions.

**The Norwegian Action Plan on Nutrition:** ***Recipe for a Healthier Diet*** **(2007-2011, Ministry of Health and Care Services)** points out that nutrition is a key component of general public health policy and that information on nutrition and diet must be based on thorough, up-to-date knowledge. The action plan recommends strengthening research on the connections between diet and health and increasing research targeted towards developing better and healthier food products.

**Meld. St. 28 (2011-2012) Report to the Storting (white paper)** ***Gode bygg for eit betre samfunn*** **("Good Buildings for a Better Society")** (Norwegian only) identifies wood from sustainable forestry as an environment-friendly material with an array of application areas and recommends that the construction industry obtains Environmental Product Declarations (EPD) that document the environmental impacts of building materials and other products.

**Report No. 7 (2008-2009) to the Storting** ***An Innovative and Sustainable Norway*** sets out recommendations for strengthening research activity in trade and industry, funding instruments to promote innovation, and innovation policy.

In addition to these government documents, the BIONAER programme will draw on strategic documents from industry organisations, among others, that discuss research challenges, such as:

- *Food for Life*, Norway's research strategy for the food industry (2010).
- Action plans for the Norwegian Seafood Research Fund (FHF) and the Foundation for Research Levy on Agricultural Products (FFL).
- National research agenda 2007-2030 for the Norwegian forest-based sector.

[6] Biomass is a term used to denote the total mass of living matter within a given area or (in water) within a given volume of habitat. The term encompasses plant and animal matter and bacteria.

# 3 Objectives of the programme

The scope of the BIONAER programme encompasses:

- agriculture, forestry and other nature-based value chains;
- seafood from the time the raw materials are taken out of the sea until they reach the consumer.

**Primary objective**

*The BIONAER programme will promote research that increases the level, profitability and sustainability of production in the bio-based industries.*

**Secondary objectives and strategic action points**

The BIONAER programme will:

1. Strengthen and develop:

    a. knowledge and expertise for new and existing bio-based industries and bioresource management;

    b. research-based innovation in food and other bio-based companies and bioresource management.

2. Motivate Norwegian knowledge environments to take part in international research cooperation.

3. Promote value chain-based and closed-loop system perspectives in the food industry and other bio-based industries.

4. Use innovative coordination and communication activities to enhance the benefits of knowledge and expertise gained by the industry and public administration.

Criteria for documenting goal achievement over time within the various segments of the programme will be developed on the basis of these objectives and strategic action points.

# 4 Thematic priority areas

The focus of the BIONAER programme is on enhancing value creation by further developing existing industries and facilitating the establishment of new industrial activities in Norway. The programme will employ a set of instruments designed to meet industry's knowledge needs in the field and provide a basis for various aspects of knowledge-building for use in resource management and policy development.

This entails a focus on research topics relating to the resource base, raw materials production, processing, marketing and consumption associated with the agriculture sector, marine sector and other nature-based value chains. In the sphere of primary production, the BIONAER programme is responsible for agricultural research, while fisheries and aquaculture research come under the purview of other Research Council programmes. The BIONAER programme will also target research activities on nature-based services in the tourism industry and care sector, as well as production and utilisation of biological resources (biomass) that have been used very little or not at all. In this context, relevant biomass may comprise residual raw materials from various stages of the production cycle and raw materials created by microbial processes.

Boosting innovation and value creation requires further adaptation of public incentives, the regulatory framework and other framework conditions. Creating conditions conducive for commercialisation of research-based knowledge is essential. Moreover, the public administration has its own specific knowledge needs in relation to the exercise of authority in the areas of food security and traceability, plant and animal health, and animal welfare, which also lie within scope of the BIONAER programme.

The following cross-cutting perspectives will apply to activities within all the thematic priority areas of the BIONAER programme:

- **Closed-loop systems:** Achieving complete biological closed-loop systems must be an overall aim. All production of biomass and residual raw materials, irrespective of application area, must be optimally utilised at every stage – with the aim of 100 per cent resource utilisation. Efforts must be made to reduce loss and waste and to increase shelf life and quality throughout the entire production cycle. It is essential to promote relevant synergies between the marine and agriculture sectors, expedient cross-utilisation between biological resource streams and production cycles, non-traditional use of biological raw materials and development of new, efficient processes and products. The framework must be laid to facilitate the application of new technologies that promote sustainable, profitable innovation. The risk associated with these types of development activities must be assessed on an ongoing basis.

- **Sustainability:** The environmental, social and economic aspects of sustainability must be taken into consideration across the board. All use of biological resources leaves its trace in nature and the BIONAER programme will work to promote sustainable production and solutions. Knowledge-building must be targeted towards the development of profitable, resilient solutions that function reliably in a preparedness context as well. Greenhouse gas emissions must be kept to a minimum in all stages of production, and industry must adapt to a changing climate.

- **Value creation:** Knowledge-based value creation and good profitability in Norwegian bio-based industries requires focus on market orientation, innovation and efficiency. This

includes a public sector framework for value creation as well as other products the sector needs. Activities under the BIONAER programme must consciously place all production in a wider market context. Contact with consumers and an understanding of consumer desires and needs will be vital here.

- **Interdisciplinarity:** Developing integrated knowledge and shedding light on key challenges facing trade and industry and society at large will require an overarching interdisciplinary approach. There will be an increasing need for cooperation between various science disciplines. Long-term knowledge-building must be relevant in the context of society, and thus the need to incorporate social science components into larger-scale natural science-oriented projects will grow.

The following perspectives specifically apply to food production:

- **Food security:** Norway must help to secure the global food supply. Taking greater advantage of the opportunities relating to seafood is of key importance. Knowledge is required to ensure that land-based food production increases at a pace with the needs of a growing Norwegian population.

- **Safe and healthy food:** Safe food that promotes good health must be the aim in all stages of the production cycle.

The closed-loop systems perspective described above must underlie the approach to be employed in all industries and activities within the scientific scope of the BIONAER programme. For practical reasons it is nevertheless necessary to divide the programme's area of responsibility into four thematic priority areas:

1. Basis for production and framework conditions
2. Primary production
3. Processing, marketing and the consumer
4. Service-based value creation

The boundaries between these four thematic priority areas will be flexible.

The BIONAER programme spans a wide range and can be broken down into numerous, more or less independent value chains. More specific priorities will be determined with the help of knowledge analyses and strategic planning within priority fields and when preparing annual funding announcements, which will involve active dialogue with various user groups among others (please refer to Section 5).

### 4.1 Basis for production and framework conditions

The BIONAER programme will continue to promote knowledge-building by funding R&D activities of relevance to sustainable land-use and resource management. It is a stated political objective to utilise the full range of agricultural land area and resources to produce products, services and public goods. In addition to food production, other objectives include the production of environmental goods, safeguarding biological diversity, minimising the environmental impact of industrial activities, and protecting and further developing forestry resources in Norway.

Full advantage must be taken of the tremendous international market potential of seafood. An understanding of market opportunities will also be beneficial when developing market-

oriented strategies for harvesting and cultivation of marine raw materials, including catch handling and live holding. Policy objectives in the marine sector focus on promoting sustainable industrial development and effective management of the marine environment (primarily addressed under other programmes at the Research Council).

There are several potentially conflicting objectives in the public framework for the bio-based industries. Activities under the BIONAER programme will seek to provide greater insight into the most central of these. The programme will also provide support for research that extends beyond current political targets in the field, including the need for new framework conditions and instruments to promote growth.

In addition to R&D focusing on the agriculture sector and the marine sector independently, the programme is responsible for funding R&D activities addressing the connections between the two sectors. There are numerous challenges relating to commercial use of land area, marine areas and raw materials with respect to other interest groups and industries. Research on the development of framework conditions, regulations and industrial policy for organising the bio-based industries will thus comprise a key area of research under the BIONAER programme.

There is a need for research that examines how social and socio-economic factors create a framework for and can motivate innovation and sustainable resource-based and land/sea-based industrial development. Greater insight is also needed into the basis for development and value creation provided by production structures, cultures and knowledge systems. International competition sets the fundamental premises for activities in Norwegian bio-based industries. In order to obtain the knowledge needed, the BIONAER programme will promote the development of high-quality research groups working within the social sciences as well as collaboratively with research groups in, for example, biology and technology disciplines.

**Trade and industrial policy**
The BIONAER programme is responsible for generating research-based knowledge of relevance to industrial policy for the following bio-based industries: fisheries, aquaculture, agriculture, forestry, reindeer husbandry and nature-based tourism. There is a need to learn more about how these industrial areas influence and are influenced by international trends. Ensuring stable framework conditions for the food industry is a political objective and will require an extensive knowledge base.

There is a corresponding need for research-based knowledge on the impacts of trade policy. In terms of the agriculture-based value chain, trade policy is focused on strong import protection and exploiting the existing room to take action. For the marine sector, trade policy objectives are designed to increase the global market opportunities for Norwegian products, for example by expanding market access. The World Trade Organization (WTO) and trade agreements with the EU affect the level of national support to industry, tariff rates and non-tariff barriers to trade, and by extension trade opportunities.

Climate challenges must be addressed at the national level, but within a framework of international conventions and obligations. Knowledge is needed on how changes in industrial policy affect trade, climate-related challenges and utilisation of natural resources and cultural environments. Policy changes at both the national and international level increase the need for economic returns on the resource base by raising efficiency, focusing on closed-loop systems, and/or using resources in alternative ways that create added value.

There is a need for research-based knowledge about the natural resource-based industries and how they can be developed within the established national political framework. Policy instruments in the areas of the environment, fisheries, aquaculture, forestry, reindeer husbandry and agriculture each set out policy targets that have ramifications for *industrial development, use of land and sea area*, and *settlement*. Climate change is the most complex challenge facing society today. New technology, new and improved production methods, and the ability to communicate well with the market are essential to adapting and maintaining or increasing the production of food and fibre under different climatic conditions. Knowledge is needed about the inherent tension between deregulation, which seeks to improve *economic efficiency in industry*, and regulation, which seeks to ensure that industry fulfils requirements based on other *socio-political objectives*. The demand for, and significance of, environmental documentation is growing. With an increasing focus on closed-loop systems and utilisation of residual raw materials, new industrial activities will be dependent on changes in legislation and the development of regulations, incentives and other framework conditions.

**Resource and land-use management**
Increased industrial activity and biomass production exert growing pressure on land and sea area. There is a need to learn more about how to utilise forestry resources, uncultivated pasture, the coastal zone and cultural landscapes in a sustainable manner that balances commercial interests with conservation of resources and biodiversity. Knowledge about the impacts of government regulation and the effects of trade, industrial, coastal and land-use policies and appurtenant policy instruments is important as a basis for decision-making in the political arena. There is a need for more knowledge about these areas and about the production of public goods, as well as knowledge about how public goods may be used as a basis for the production of private goods via industrial activity.

Different societal interests have somewhat divergent needs and desires in relation to the use of natural resources. In many contexts these interests may be in direct conflict with one another. New industrial development in such areas may pose challenges to companies, public authorities and politicians alike. Research-based knowledge derived from interdisciplinary activities as well as cooperation on new solutions are needed to translate industrial potential into action. The objective is to generate knowledge for use in developing policies that support sustainable growth and innovation in the primary and related industries.

## 4.2 Primary production

The Government has set a goal of increasing land-based food production in Norway by 20 per cent by 2030. The goal of achieving sustainable agriculture throughout Norway with focus on food security and enhanced value creation delineates the main course of action for R&D activities. Increased production will require maintaining and further developing fundamental know-how to achieve more productive, resource efficient and environmentally sound production of food and other bio-based products.

The trend of yield stagnation in cereal grains must be reversed, and an effort must be made to achieve new, more efficient production cycles. Livestock production offers opportunities for agricultural activities throughout the country, including opportunities linked to the utilisation of land area that cannot be directly used for the cultivation of food plants. Ambitious targets have been set for the forestry sector, focusing on increased production and harvesting and attaching greater importance to the vital role of the forests in climate and environmental development. Research is essential to achieving these targets. Climate change will give rise to

new challenges and new opportunities, and the industrial and research communities must join forces to address these.

Research activities must be carried out along several lines: the basis for production must be strengthened, primary production must be made more resilient to climate change, and negative impacts on the environment and biodiversity must be reduced. The latter also encompasses the agriculture sector's most important contribution to reducing greenhouse gas emissions. Good plant and animal health is crucial to ensuring food safety and food security and also provides a basis for efficient, sustainable production.

Although marine primary production lies outside the scope of the BIONAER programme, the realities of and opportunities afforded in this production segment also make up part of the programme's foundation. The marine value chain must be viewed within a larger context, and focus must be placed on synergies between primary production and processing via cooperation with other programmes at the Research Council, among other things.

**Soil and plants**

Boosting production of plants for animal feed and human consumption will play a key role in increasing overall land-based food production in keeping with political objectives. Consumers expect safe, healthy, good-tasting and visually attractive food products, which entails a wide range of demands that must be met at all stages of production. The food processing industry, which is subject to ongoing change, will in many cases impose a different set of requirements for raw materials than that needed for raw materials for direct human consumption. Research is needed on quality characteristics of raw materials in a broad sense, as well as on loss reduction and enhanced utilisation.

Knowledge-building within the field of basic plant physiology is essential to optimising cultivation and cultivation systems and promoting efficient resource utilisation in primary production. Research is needed to develop suitable, robust varieties of plants in order to maintain current levels of food production and encourage further growth. The special temperature and light conditions in Norway mean that plants need to have very special properties. Climate change is also driving the need to rapidly develop adapted plant material to ensure sustainable production for the producer and the environment alike. Yield losses before and after harvesting due to weeds, disease and pests are considerable today, and combating these in an environment and consumer-friendly manner will require more knowledge. Climate change will further complicate this picture and enhance the need to find out more about suitable measures.

Agronomic know-how adapted to current and future climatic conditions, production systems and structures is fundamental to achieving efficient, sustainable production. Food production will always entail emissions of greenhouse gases and exert pressure on the environment; ongoing knowledge and technology development will be necessary to minimise these impacts. The development and transfer of technology adapted to biological production and Norwegian production conditions will play a key role here. Knowledge about the soil and the interaction between soil and plants is vital to maintaining fertile cultivable fields in the future as well. Increased use of plants for fibre applications, new feed products (e.g. for fish), bioenergy and other industrial products will require a deep understanding of cultivation for these purposes.

**Livestock**

Escalating market competition and more pressing demands for cost-effective production have been key drivers of the structural changes taking place in the agriculture sector in recent

years. The result has been increasingly fewer and larger production units, and more professionalised knowledge and technology-based operations. The livestock industry's transition to new, efficient production systems may have an effect on animal performance, health and well-being. This lends new urgency to the need for research addressing various aspects of current and future production systems.

Reindeer husbandry is a separate area of livestock production. This industry faces special challenges within the primary production sphere relating to animal health and welfare and production forms.

Research on livestock spans a wide range, from basic knowledge to applied topics in livestock science and veterinary medicine. Ethical animal husbandry and optimal animal welfare are also key topics.

The number of food-producing animals is expected to rise as a result of improved global standards of living. There is a need for more specific knowledge on the part played by livestock production in an environmental and climate-related context. This includes research questions relating to risk assessment and utilisation of residual raw materials from livestock production, as well as the role of livestock production in greenhouse gas emissions and other climate-related problems.

Climate change brings about new risks, including the introduction of new infectious agents and a decrease in feed quality. At the same time, global population growth is putting increasing pressure on existing food resources, which will lead to greater competition for feed ingredients. A better understanding of how to improve utilisation of new and traditional feed ingredients in a synergy between biology and technology is essential to promoting efficient, environment-friendly livestock production. The risk of transmission of disease and biotoxins from animals to humans is also a key topic in a closed-loop system perspective. Research is needed to ensure knowledge-based preparedness as well.

Norwegian livestock breeding has a long tradition of documenting a variety of traits associated with production and health. This provides a basis for export of genetic material, which will in turn bolster Norway's livestock industry. There is growing demand for research-based knowledge on genetic contexts, for example to strengthen international competitiveness.

**Forests**

The past decade has seen a growing awareness of the importance of forests in society. This is due in good part to the role played by forests in a climate context in terms of carbon uptake and storage and as a provider of renewable energy and raw materials. There must be continued investment in long-term measures to increase forestry production and deliveries of renewable energy and to maintain or enhance carbon sequestration in forests and long-lasting wood products. The challenge lies in striking a balance between intensifying climate measures in forests, ensuring economic return in primary forestry and fulfilling Norway's obligations to safeguard environmental values and biological diversity.

Society's growing demand for sustainable production and optimal utilisation of raw materials will lead to greater focus on production of specific products and qualities. Forestry is shifting towards more product-adapted deliveries through sorting based on the requirements of the end product. Adaptation of wood types, genetic processing and exploiting the opportunities from technology development in the production chain will be relevant research topics in the longer

term. Customisation of raw materials for various types of products will give rise to major research-related challenges and will require efficient, effective and environmentally sound production techniques.

Wood is an environment-friendly product with great potential in the bioeconomy. It is renewable, stores carbon and does not require very energy-intensive processing. Norway has considerable unutilised forestry resources and sizeable capacity for development and production of wood products of high value. More extensive R&D is needed on all of the main forest wood assortments: saw timber, pulpwood and wood biomass for energy. There is still a need for research on less-processed niche products in the agriculture sector (e.g. Christmas trees and ornamental foliage) as well.

## 4.3 Processing, marketing and the consumer

The BIONAER programme will promote research-based innovation in existing industrial and processing activities for food from land and sea, feed production and use of wood in the construction industry, and more.[7] The programme will also foster new, value-creating opportunities for utilising biological resources. The further development and use of new technologies in new application areas for bioresources will be critical for realising the Norwegian bioeconomy.

An underlying principle for activities under the BIONAER programme is that residual raw materials will be considered on a par with primary raw materials in general, that loss is to be avoided and cross-utilisation between resource streams must be encouraged, as this may lead to wider-ranging, more sustainable and efficient ways of utilising Norwegian bioresources.

**Food**

Food security is a major global challenge, and food production must be increased dramatically worldwide. In Norway, the target is to increase agriculture production by 20 per cent by 2030. Norway has an excellent natural and societal basis for producing food from the sea, and this is where the greatest potential lies for enhancing value creation in Norway in both the short and the long term.

The food industry is based on raw materials from the agriculture and marine sectors. It is Norway's second-largest industrial branch, with activities dispersed throughout the country and a wide array of small and medium-sized players. Norway has a high-cost food industry compared to its competitors. Competence-building at all levels, technology development, innovation and restructuring are therefore of fundamental importance to ensuring competitiveness in domestic and international markets. The BIONAER programme will promote the development of knowledge to create a sustainable, innovative and competitive food industry with low production costs and high product quality.

Closer research-based collaboration between the agriculture-based and marine-based food industries is expected to provide benefits in technology, product development and marketing, among other areas. Increased automation in the food processing industry is vital to achieving profitable production within the national cost framework for seafood and agriculture-based food. Processing of meat from reindeer husbandry poses special challenges. The collection and use of residual raw materials for energy purposes and as ingredients in feed,

[7] The responsibility for research on certain other bio-based processes and products has been placed with other programmes at the Research Council (please refer to Section 6).

pharmaceuticals and health food products also require extensive new knowledge and application of new technologies.

The agriculture-based food industry operates primarily within the Norwegian domestic market. In close cooperation with other research initiatives on primary production, the BIONAER programme will build knowledge to develop high-quality, safe, healthy and competitive agriculture-based food products that can boost value creation and self-sufficiency in Norway.

By promoting the differentiation of raw materials and processing of high-quality, safe and healthy seafood in Norway, the BIONAER programme will promote a knowledge framework for enhancing overall value creation in the marine sector. Focus on quality and food safety along the entire value chain, catch handling on board fishing vessels and possibilities for live holding will be incorporated into this. Activities will be based on an integrated, sustainable perspective and close cooperation with other research programmes responsible for the marine sector (please refer to Section 6).

Food is central to people's lives, and availability, quality and the dining experience are all very important. Knowledge about consumer trends in relevant markets at home and abroad is a prerequisite for fostering a competitive food industry in Norway and for exploiting the country's potential for global seafood exports. Research under the BIONAER programme is intended to help to provide consumers with suitable, high-quality food products that are tailored to modern lifestyles and meet consumer demands relating to the environment, health and ethical production. Achieving cost-effective and transparent value chains will require know-how in the areas of traceability, documentation, labelling systems, export markets' environmental and product requirements, producer responsibility, and more.

Awareness of Norwegian food traditions and food culture is growing. A wide range of smaller players market local products and organic foods, adding variety and breadth to the selection available to Norwegian consumers and the tourist segment. These activities contribute to regional value creation, and the BIONAER programme will cooperate with the regional research funds on knowledge-building, when relevant.

*Food, health and well-being*
The Government seeks to promote production and an ample selection of healthy and health-promoting food products and meals, and the Norwegian food industry is working systematically to do its part. The industry is dealing with challenges related to reducing salt and sugar content and limiting saturated fat in foods. A proper diet will improve consumers' day-to-day lives as well as prevent the emergence of serious diseases whose treatment will require significant public resources. Research challenges are related to identifying the components in food that have health effects and determining how these function alone or in interaction with other components in various meal solutions. Effects will vary for different population groups such as children, the elderly and persons with particular genetic dispositions. Activities under the BIONAER programme will generate more knowledge about the positive effects of seafood alone and in combination with other foods in meal solutions and will include consumer-oriented research to boost consumption of food of marine origin.

*Safe food*
All food sold in Norway is to be safe. A more open global market entails new research challenges in the realm of food safety. A lack of knowledge may result in health risks, higher costs, a tarnished reputation, increased loss and lower value creation. More knowledge is

needed to ensure that international food safety regulations are rooted in scientific risk assessments. Optimal handling in the primary stage is critical to food safety, but risk factors may emerge and change during processing, storage and handling in the retail stage as food makes its way to the consumer. Non-traditional application areas, focus on closed-loop systems and cross-utilisation will also give rise to new food safety-related challenges. More knowledge is needed about the effects that nutrients and foreign agents harmful to health have on each other.

*From production to the consumer*
To be competitive, the food industry must ensure the availability of food through efficient, quality-preserving and sustainable distribution, logistics and transport and a well-organised retail trade. There are numerous issues that require further study in this area.

**Processing of feed ingredients**
Norwegian and international aquaculture activities are steadily expanding. The demand for suitable, effective feed ingredients is climbing, while the availability of marine resources for use in feed is dropping. Meeting this demand and the need for feed in the livestock industry is an area of untapped potential.

Norway produces a large amount of plants and residual raw materials from seafood production, etc. that are used as ingredients in animal and fish feed. Research has made it possible to gradually increase the proportion of vegetable ingredients in fish feed, but there is still much to learn about this cross-utilisation. Research is needed on processing, on the relationship between feed and the quality of the end product, and on health perspectives, consumer understanding, and more.

With the help of knowledge-building across a wide spectrum and radical innovations involving the use of biotechnology, for example, it is expected that tree fibre can become an important feed resource for fish, with major potential in the global market.

**Wood-based construction products**
A great deal of knowledge is still needed in vital segments of the value chains for wood-based construction products from forest to market. The use of wood poses challenges to the construction industry in particular, due to a lack of digital tools and documentation of the performance of wood-based construction solutions in a lifecycle perspective. This includes prerequisites for durability and useful life, as well as recycling and re-use of materials and lifecycle analyses.

The general awareness of the multiple uses of wood is on the rise. Within the wood-based value chains there are now many opportunities to promote the use of wood in the markets for new construction, restoration and furniture/interior decor. Knowledge is needed to promote innovation, new combinations of materials, industrialisation, profitability and market orientation in wood-based value chains. In this context one challenge lies in incorporating planners, developers, contractors and others as key players in the development of more value chains based on closed-loop systems.

**Innovative bio-based products**
Advances are being made in the development of new bio-based products by refining or processing all types of biomass. Today these types of products compete on the market with chemically-produced and petroleum-based products. Enabling technologies such as ICT,

nanotechnology and biotechnology open up new vistas for the development of new products based on fibre, wood, cellulose and residual marine raw materials.

The BIONAER programme will focus on innovative products based on biological raw materials, residual raw materials and biological processes. Products must be primarily designed for use in the value chains for wood, food and feed. Product opportunities extend across industrial sectors and application areas. R&D targeted towards specific products, implementation of know-how and practical application of ICT, nanotechnology and biotechnology with the aim of expanding utilisation of biomass lies within the scope of the BIONAER programme. The programme has special responsibility for research to identify new ways of utilising residual raw materials from biological primary production. The collection and use of residual raw materials as ingredients in feed, pharmaceuticals and health food products require extensive knowledge-building and application of new technologies. Basic research in these areas is funded under other programmes at the Research Council (please refer to Section 6).

Marine and terrestrial bioprospecting may lead to new activities in a variety of sectors.

## 4.4 Service-based value creation

The agriculture and fisheries industries manage resources (buildings, landscape, uncultivated land, genetic resources, culture and people) of major significance to a number of public goods. This provides a good point of departure for the development of new, more diverse industrial activities and will help to bolster competitiveness.

**Outdoor activities and the tourism industry**

The Norwegian coastal and cultural landscape and deep-rooted cultural traditions are enormous assets for tourism, settlement and local value creation. Uncultivated land and coastal resources form the basis for environment-friendly production, products and recreational activities that are unique on the national as well as the international market. There are strong links between agriculture, fisheries, the environment, reindeer husbandry, other industries and the tourism industry. Preservation of the cultural landscape, public goods, identity and quality of life are key concepts in this context, providing an excellent basis for culture-based industrial development and value creation.

This area encompasses fishing and hunting tourism, rural tourism, culinary traditions and tourism, nature guiding, outdoor recreational activity, and sports animals and pets. Norwegian culinary traditions need to be disseminated, developed and made available in the context of the tourism industry in relation to national and international demand. The nature and culture-based tourism industry needs know-how to increase professionalisation and innovation capacity. With regard to outdoor recreational activity, there are growing challenges related to the public right of access to and accessibility of outdoor recreational areas. Other relevant research topics are related to resource management and resource-based industrial development in the coastal zone, on uncultivated land and in the cultural landscape.

In a field as multifaceted as this, effective coordination of instruments is needed, both instruments of a regional nature and more direct industrial policy-related measures. Research topics must be placed within this context.

**Health and care**

Health, welfare and care services represent a growing segment of the agriculture industry, and provide good opportunities to maintain a variety of production forms.

Green care services and multifunctional farms and forestry utilise agricultural resources in new ways to promote welfare policy objectives for various target groups within the educational and health sectors. This extensive field of research encompasses farms as arenas for learning, rehabilitation and activity, including therapeutic measures, and forests and other natural landscapes as arenas for rehabilitation, recovery and positive experiences.

Research is needed on therapeutic gardening, animal-assisted interventions, green work and training, services for people with special needs and farms as an educational resource. Interest in animal-human interaction is growing, such as the ways in which domesticated animals can promote good physical and mental health in people. These topics must be developed within a multidisciplinary framework, with the aim of strengthening cooperation between the health science research community and relevant user groups in the educational and health and care sectors.

# 5 Work forms and instruments

## 5.1 Work forms – flexibility, cooperation and dialogue

Research activities funded under the BIONAER programme must contribute to solving specific industry challenges, as well as cope with various areas of interface with society at large. In order to address the most pressing societal challenges the programme will incorporate cross-cutting perspectives such as *closed-loop systems, sustainability* and *value creation* into all its activities. Flexible work forms will be essential to handling new directions that emerge for research needs over time. Annual priorities for the programme will be identified in a dialogue with the research community and industry, and in relation to current research policy and other political guidelines.

Research and technology have a more direct impact on social development today than previously. Activities under the programme must be able to adapt to shifts in the interaction between research, technology and society. This will be achieved in part through extensive use of dialogue and communication activities.

It is clear that interdisciplinarity and cooperation will be crucial to developing the knowledge needed to realise the bioeconomy. The foundation must be laid for new constellations and forms of interaction within the research community and between the research community and industries/companies, the public authorities and consumers. This will call for new approaches to leadership and management of research and innovation processes as well as the capacity and willingness to be flexible when it comes to news ways of working, new meeting places and new networks. A deliberate, targeted effort will be made to develop work forms for funding and organising research activities that address existing needs and challenges.

The programme will initiate state-of-the art reviews and establish sub-strategies for the thematic priority areas in the work programme. Priority research areas and topics for annual funding announcements for long-term competence-building (Researcher Projects and Knowledge-building Projects for Industry) will be defined. In this context, the political framework set out by the ministries in connection with their allocations to the BIONAER programme will be viewed in relation to the programme's active project portfolio. In light of this, dialogue meetings will be organised to obtain input from relevant players. Annual *forums for dialogue* between industry players, industry organisations, the research community and the relevant authorities will be established. In addition, more *ad-hoc workshops and seminars* addressing specific challenges and research questions will be held. Dialogue meetings on topics of relevance to other research funders will be organised in direct cooperation with these funders. This applies in particular to the industry research funds and other relevant programmes at the Research Council.

## 5.2 Instruments employed by the programme

**Long-term competence-building and project size**

The research questions to be studied in projects funded under the BIONAER programme will require specialised research in traditional disciplines. There will be a need to link together competencies in new ways to find adequate solutions to complex societal challenges. This will call for knowledge-building across subject areas and disciplines. The integration of social science perspectives into projects will help to ensure that the projects actually generate the knowledge needed to tackle the most pressing challenges and that the research results are implemented in policy design and applied by industry players.

Large-scale projects that incorporate cooperation and genuine multi- and interdisciplinary research can be useful for solving wide-ranging challenges. Thus, long-term research under the BIONAER programme will primarily be channelled through large-scale interdisciplinary projects when this is deemed suitable for considerations relating to capacity and the overall organisation of the Norwegian research system. Large-scale interdisciplinary projects are able to encompass both industry-oriented research and strategic basic research. Such projects can also better address and integrate the divergent knowledge needs of industry and the public administration. The projects will have to be organised in a manner that promotes effective information flow within the project itself as well as active dialogue with users, with the aim of ensuring that research results are put to active use. Encouraging cooperation between small and large players is an important instrument for boosting value creation.

In cases where the research questions are narrower/more targeted, or where for various reasons it is not expedient to conduct large-scale projects, the programme will fund projects of smaller scope, that is projects of a more traditional size (NOK 1–4 million in annual funding). The need to establish various types of networks between large-scale interdisciplinary projects and smaller-scale, more targeted projects addressing the same topics will be assessed during the programme period.

Narrower research questions may also be studied in international collaborative projects. Support for such research may also be sought from other funding sources, such as the Research Council's funding scheme for independent basic research projects (FRIPRO) and the regional research funds.

**User-driven research**
The funding instrument Innovation Projects for the Industrial Sector will be used to encourage companies in all segments of the value chains to step up their research efforts. To be eligible for funding, innovation projects will have to address topics within the overall thematic area of the BIONAER programme; normally there will be no other thematic limitations.

**Other funding instruments**
Other funding instruments include support for events, funding to enable Norwegian players to position themselves in the competition for international funding, mobility grants, network-building measures and certain types of courses. All of these instruments involve limited financial awards. The need to employ them will be assessed on an ongoing basis.

# 6 Coordination with other related instruments at the Research Council

The Research Council is focusing on research related to the bioeconomy across a broad spectrum. The BIONAER programme will be a key component in this, but other thematic programmes and programmes on generic technologies will have important roles to play as well. Close, systematic cooperation and flexible coordination between these programmes will be a high priority and success criterion. Joint dialogue with users and joint strategic planning and funding announcements are relevant measures in this context.

Within the area of *seafood*, strategic, ongoing cooperation with the research programmes Aquaculture – An Industry in Growth (HAVBRUK) and the Oceans and Coastal Areas (HAVKYST) will be crucial, particularly for realising the vision of Norway as the world's leading seafood nation. In the area of *food and health*, the Research Programme on Public

Health (FOLKEHELSE) and the Research Programme on Environmental Exposures and Health Outcomes (MILPAAHEL) will be important partners in cooperation. The Large-scale Programme for Energy Research (ENERGIX) will be a key partner in bioenergy research.

The Programme for User-driven Research-based Innovation (BIA) provides funding to research projects in areas that are not covered by the Research Council's industry-oriented thematic programmes. The BIONAER programme will cooperate with the BIA programme on an ongoing basis to draw up a clear delineation in the area of primary production and processing of biological resources.

The programmes Norwegian Environmental Research Towards 2015 (MILJO2015) and Climate Change and Impacts in Norway (NORKLIMA) are responsible for multi- and interdisciplinary research on climate and the environment at a more general level. These programmes share an important area of interface with the BIONAER programme on environmental and climate-related research questions dealing with bio-based closed-loop systems. The programmes will engage in ongoing dialogue and issue joint funding announcements on overlapping research questions, among other things.

Close, systematic cooperation will be established between the BIONAER programme and the programmes on generic technologies with regard to the application of new technology. Biotechnology research conducted under the Research Programme on Biotechnology for Innovation (BIOTEK2021) will be of particular relevance to the bio-based industries. Potential areas of cooperation with the Programme on Nanotechnology and Advanced Materials (NANO2021) and the Research Programme on Core Competence and Value Creation in ICT (VERDIKT) will be assessed as well.

The National Financing Initiative for Research Infrastructure (INFRASTRUKTUR), the programme Commercialising R&D Results (FORNY2020), and the SkatteFUNN Tax Incentive Scheme can provide important support to increase the level of activity in the research institutions, promote commercialisation of research results, and step up R&D efforts in companies.

There are grey zones to be found in many thematic areas shared between the various programmes, and the Research Council will determine the distribution of responsibility in specific areas on an ongoing basis. In many cases, strengthening cooperation between relevant programmes will be a good way of increasing research activity in these grey zones. This particularly applies to new, innovative fields of knowledge.

# 7 Coordination with industry research funds and Innovation Norway

It is essential that the BIONAER programme and other public research and innovation instruments targeting the bioeconomy complement rather than compete with each other. Cooperation has been established with Innovation Norway via the Wood-based Innovation Programme, the Marine Value Creation Programme and the Bioenergy Programme. An effort will be made under the BIONAER programme to expand cooperation with Innovation Norway within the entire scope of the programme. Importance will also be attached to productive dialogue and relevant cooperation with the regional research funds.

There are two major industry funds in the area of food: the Foundation for Research Levy on Agricultural Products/the Agricultural Agreement Research Fund and the Norwegian Seafood

Research Fund (FHF). Together these funds have some NOK 300 million at their disposal annually, including the basic funding received by the Norwegian Institute of Food, Fisheries and Aquaculture Research (Nofima). The funds finance research activities aimed at achieving common industry goals.

In the area of forestry, three funds – the Forest Research and Development Fund, the Forestry Development Fund and the forestry industry's value creation fund (Skogbrukets verdiskapingsfond) – have a total of roughly NOK 13 million at their disposal annually. The funds are of major significance to their respective industries. An effort will be made under the BIONAER programme to enhance cooperation and coordination with all of these funds to ensure optimal task-sharing and integrated activities to the benefit of the industries.

The BIONAER programme collaborates with the Foundation for Research Levy on Agricultural Products/the Agricultural Agreement Research Fund on an ongoing basis. Dialogue meetings with representatives of industry and the research community to obtain input with regard to prioritising of research topics have been useful, and will be continued.

Both the BIONAER programme and the HAVBRUK programme cooperate actively with the FHF. The FHF has established advisory expert groups in the fund's priority areas, which will provide relevant forums for the BIONAER programme with an eye to constructive dialogue with players in the marine sector.

# 8 International cooperation

Active international cooperation and effective distribution of tasks at the national and international levels are crucial to a creating a thriving bioeconomy that can effectively address the Grand Challenges. This will be given great weight under the BIONAER programme, in keeping with the Research Council of Norway's Strategy on International Cooperation. The programme will actively promote international cooperation, particularly when it will improve the quality of knowledge-building or stimulate more or better innovation in trade and industry.

Norway is a participant in several European Joint Programming Initiatives (JPIs) of relevance to the BIONAER programme:

- Agriculture, Food Security and Climate Change (FACCE-JPI)
- Healthy and Productive Seas and Oceans (JPI Oceans)
- A Healthy Diet for a Healthy Life (JPI HDHL)

The BIONAER programme administration will actively follow up these initiatives on its own or in cooperation with other segments of the Research Council administration.

Other key instruments for promoting international cooperation will be participation in joint calls for proposals across national boundaries; for example, joint calls under the ERA-NET scheme, joint Nordic calls (which are often issued under the auspices of the Nordic organisations NordForsk and the Nordic Innovation Centre), and bilateral calls under the auspices of the programme itself or as part of funding announcements issued centrally by the Research Council.

The programme will take active part in joint calls issued under new and existing ERA-NETs. Since start-up, the BIONAER programme has participated in four ERA-NETs:

- WoodWisdom-Net on wood, forestry and wood-based materials
- Sustainable Food Production and Consumption (SUSFOOD) (post-farmgate)

- CORE Organic II on organic food and farming
- Animal Health and Welfare (ANIHWA)

The programme will also participate in the new ERA-NET on the value chain for fish which is currently being established.

The BIONAER programme will participate in *Nordic cooperation* under the Nordic Joint Committee for Agricultural Research and the Nordic Innovation Centre and will take part in the effort to develop a joint Nordic strategy for the bioeconomy. The programme will seek to develop Nordic cooperation in areas of particular interest to the Nordic countries or in research areas where there is no longer critical mass in Norway.

*The EU Seventh Framework Programme for Research and Technological Development* and *Horizon 2020* are both of major importance to the BIONAER programme. Detailed information will be provided to users on developments under relevant themes. An effort will be made to optimise task-sharing in terms of funding opportunities under the framework programmes as well as to build up Norwegian research groups of sufficient calibre to participate in the framework programmes.

The programme will employ instruments to support institution-to-institution collaboration in cases where creating ties between Norwegian research groups and institutions in selected countries will strengthen knowledge-building in Norway. The need to implement specific measures to promote participation in international cooperative efforts will be assessed on an ongoing basis. Funding to enable Norwegian players to position themselves in the competition for international funding will be relevant in this context.

The BIONAER programme will maintain focus on international cooperation in its budget and its project portfolio. The focus and scope of this collaboration will be reviewed prior to the issue of each funding announcement and will be clearly expressed in the funding announcements themselves.

# 9 Communication and dissemination activities

It is generally recognised in Norway and in Europe that the application of research outcomes in industrial and social development does not necessarily match the investment in knowledge-building. Effectively communicating about research and disseminating and implementing research findings constitute a major challenge. Communication and dissemination will therefore comprise core activities under the BIONAER programme, in keeping with the objectives and principles set out in the Research Council of Norway's communication strategy.

**Objective of communication activities:**
To enhance the understanding of the significant role research will play in developing the bio-based industries, to strengthen ties between the research community and industry, and to ensure that research results and new knowledge are put to use.

Relevant target groups:

- industry;
- the research community;
- the public administration and the authorities;
- special interest organisations and society at large;

- other activities under the Research Council and other public agencies in the research and innovation system;
- international partners in cooperation.

Targeted, integrated information activities are vital to communicating new knowledge to users quickly and efficiently. The programme will consider collaborating with consulting firms, professional forums and industry organisations to further refine the communication of research results and increase the use of research-based knowledge in industrial activities. The Research Council's role as a meeting place to promote effective communication and dissemination will be enhanced and strengthened. Network-building and development of dynamic forms of collaboration in connection with the establishment of larger-scale, more interdisciplinary projects will help to better integrate communication into research activities and increase knowledge transfer as well. The BIONAER programme will require new research projects to have a specific communication and dissemination plan from the outset.

An effort will be made under the BIONAER programme to reach out to all of the target groups and communicate to them what the bioeconomy entails, why it is important for Norway, and what potential it holds for enhancing profitability, sustainability and resource utilisation, for the industries themselves and society at large.

Communication activities will be planned and implemented according to a more detailed communication plan that will be updated on an annual basis.

# 10 Budget

The bioeconomy provides huge room for opportunity to increase value creation and develop sustainable solutions in all areas of activity based on bioresources. Major gains can be achieved by systematically implementing emerging technologies and facilitating the establishment of new industrial activities on the basis of today's bio-based industries. Broad-based knowledge-building is crucial to exploiting this potential, and this is precisely what the BIONAER programme seeks to promote.

The BIONAER programme's budget for 2013 is comprised of the following allocations (rounded up to nearest NOK million):

- Ministry of Agriculture and Food – NOK 158 million
- Ministry of Fisheries and Coastal Affairs – NOK 33 million
- Ministry of Trade and Industry – NOK 10 million
- Fund for Research and Innovation – NOK 10 million

A zero-growth budget will enable the BIONAER programme to cover the most important research needs for the segments of the Norwegian bio-based industries encompassed by the programme. Although the aim is to achieve the best possible advances in a bioeconomic perspective, activities will have to be rooted for the most part in current realities. Annual priorities will be determined in consultation with key representatives of trade and industry, the research community and the allocating ministries.

Achieving the aspirations articulated in this work programme of fully exploiting the dramatic potential for value creation and new industrial activities inherent in the bioeconomy will in all likelihood require substantially larger investments in knowledge-building than are possible today. Building up larger-scale initiatives will also take time. Research institutions will have

to be given financial assistance to “change lanes” for extensive research activities on the bioeconomy. There are several focus areas that stand out.

The bio-based industries offer wide-ranging opportunities for helping to prevent the most serious health challenges among the population. In the area of food and health, there is tremendous potential for utilising marine as well as agriculture-based resources. Heavy involvement on the part of the Ministry of Health and Care Services will be essential to exploiting this potential. Consideration should also be given to the role the regional health authorities can play in this context.

Bioresources from the sea, forest and land can help to create new value in a wide array of industries. The application of new technologies, marine and land-based algae, vegetable material and timber residue, etc. can provide the large volume of raw materials that will be needed in the years to come for fish feed, various energy purposes, food products, pharmaceuticals, and more. The large-scale use of wood, which is an environment-friendly construction material, is also of relevance here. Broad-based involvement on the part of the Ministry of Trade and Industry and other relevant ministries will be crucial to obtaining necessary increases in funding.

The BIONAER programme plans to allocate a major portion of its budget to user-driven research. Compared to the rest of Norwegian trade and industry, Norwegian bio-based companies have a poorly-developed tradition of conducting their own research. The potential for value creation and the motivation within the companies dictate that it is essential to promote this type of research through the use of Innovation Projects for the Industrial Sector, which provide a form of risk reduction through public funding. An increase in user-driven research must be closely tied to more long-term competence-building within the research communities. The BIONAER programme will actively seek to link these two objectives.

The BIONAER programme board and programme administration will strive to increase the visibility of the more radical opportunities opened up by the Norwegian bioeconomy, including estimating the costs of pertinent knowledge-building for use during annual budget processes.

# 11 Organisation

The programme board of the BIONAER programme was appointed by the Division for Innovation on 1 January 2012. On 1 July 2012 the programme was placed under the Division for Energy, Resources and the Environment. The programme board reports to the research board of the latter division via the executive director.

The programme board is charged with administering the instruments at its disposal to achieve the programme’s objectives. The programme administration of the BIONAER programme is responsible for carrying out the day-to-day tasks of the programme and consists of a programme coordinator assisted by personnel with scientific and administrative expertise.

This publication may be ordered at:
www.forskningsradet.no/publikasjoner

**The Research Council of Norway**
Stensberggata 26
P.O. Box 2700 St. Hanshaugen
NO-0131 Oslo

Telephone: +47 22 03 70 00
Telefax: +47 22 03 70 01
post@forskningsradet.no
www.rcn.no/english

January 2013

Design: Melkeveien Designkontor AS
Photo: Anders Lien
(Leonardo-bridge), Norges sjømatråd
and Shutterstock