



NIBIO

NORWEGIAN INSTITUTE OF
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Green Knowledge

39 Examples from NIBIO's Activities in 2020



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Cover: Trials with grey mold on spruce seedlings in NIBIO lab

Photo: Erling Fløistad

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Foreword

The year 2020 will go down in history as unusual and different — the year of the coronavirus. Naturally, it has also affected the work of NIBIO. But despite that, we have a great deal to show for in terms of specialist production and dissemination, across a wide range of areas that are important to many people in the Norwegian society.

The year 2020 was also special for another reason — this was the year NIBIO celebrated its fifth birthday. Mergers take time and can be difficult, but also create space for development and essential change and NIBIO has come a long way in these five years.

We carry out extensive specialist activity all over the country, and increasingly beyond Norway's borders too. Our broad foundation, covering specialist production problems and value creation, resource and environmental issues with economics and social science included, means that we can fully back up our slogan "NIBIO — Making Sustainability Meaningful." It is the core of our social responsibility. In other words, our aim is for our expertise to contribute to a positive society, where sustainable solutions depend on the abilities and specialist insight that allow us to balance a range of considerations.

With enormous diversity and more than 1,000 projects in our portfolio, it is virtually impossible to present a full picture of NIBIO's specialised activities. In this brochure, we therefore present just a small selection of articles which are a sample of our specialised activities in 2020. We hope these samples are enough to tempt you to want to find out more about NIBIO and all the exciting projects and specialised development that our 700 employees contribute towards.

Enjoy!

Nils Vagstad
Director General

This is NIBIO



Division of Food Production and Society

This division is a leader in core research areas, such as agronomy, plant production, cultural landscapes, agricultural technology and social research. Its researchers contribute to innovation and value creation throughout the agriculture and food production value chains, producing applied knowledge for public governance, businesses and the general public.



Division of Forestry and Forest Resources

This division is Norway's largest supplier of research-based knowledge in forestry and forest resources. It includes sustainable use of resources, optimum forest production, forest inventory, efficient value chains, innovative use of timber products, climate impact of forest and other land use, and the development of rural industries.



Division of Biotechnology and Plant Health

This division manages Norway's most comprehensive knowledge based on plant health and plant protection. It carries out research on diagnostics, biology, and mapping, as well as on combating organisms that lead to plant disease, pests, and weeds. Other key focus areas include biotechnology, algae, pesticides, and organic chemistry.



Division of Environment and Natural Resources

An innovative R&D institute focusing on soil, water, bioresources, and environmental technology. Climate and environmental measures are core elements of the division's work, alongside its efforts to develop sustainable and holistic solutions and services. This division is also involved in numerous international projects.



Division of Survey and Statistics

The core competence of this division lies within economic statistics and analysis, resource mapping, and geomatics. The division is responsible for capturing, managing, comprehensively analyzing and presenting data. It includes the Norwegian Genetic Resource Centre and the Budget Committee for Agriculture. Its target audiences are public authorities, industry, and political leaders.

Key Figures:

Number of employees: approx. 700. (December 31, 2020)

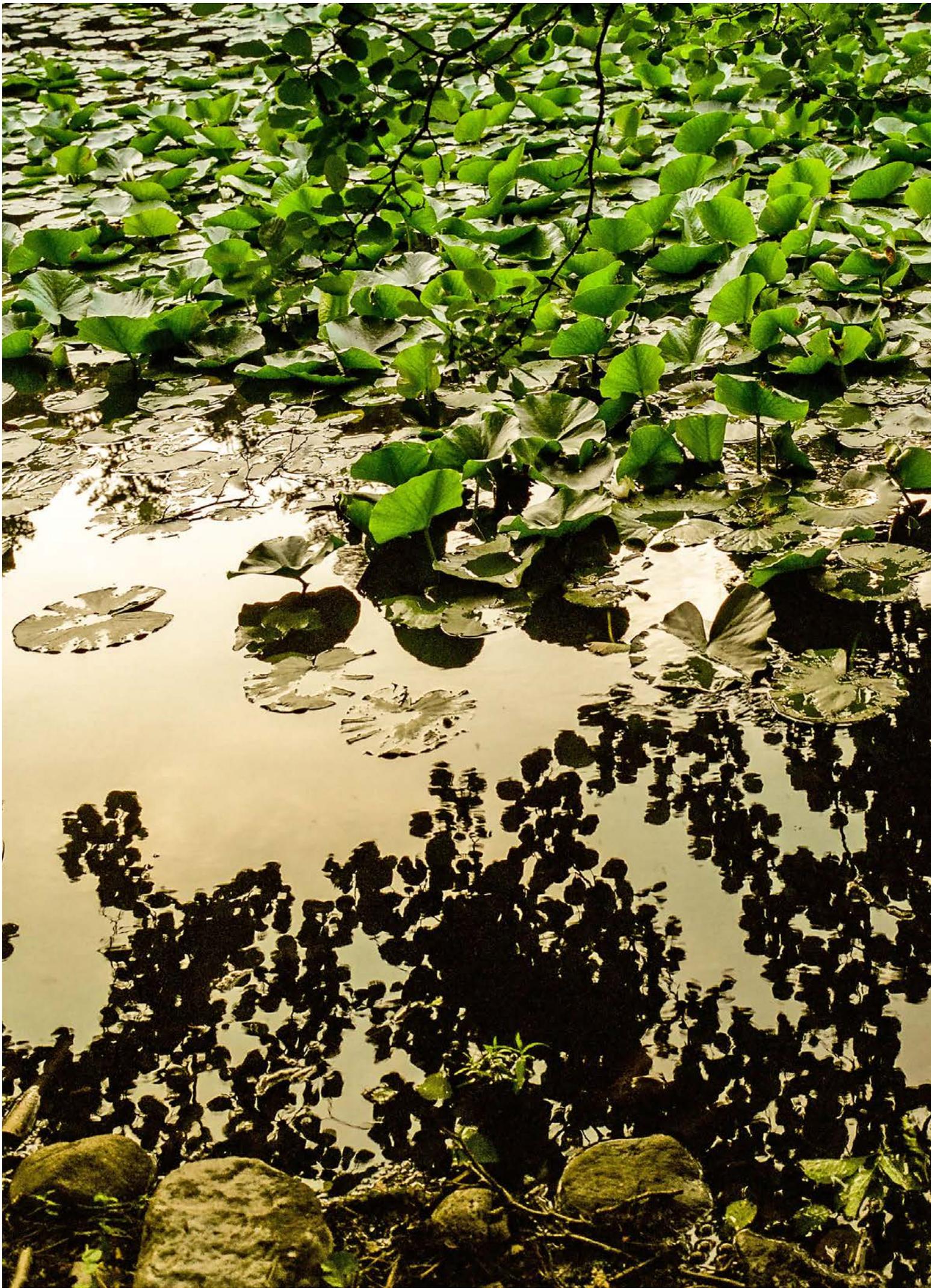
Estimated turnover for 2020 was 747 million NOK.

Number of international projects: approx. 100, of which approx. half are EU or EEA

Present in all regions of Norway

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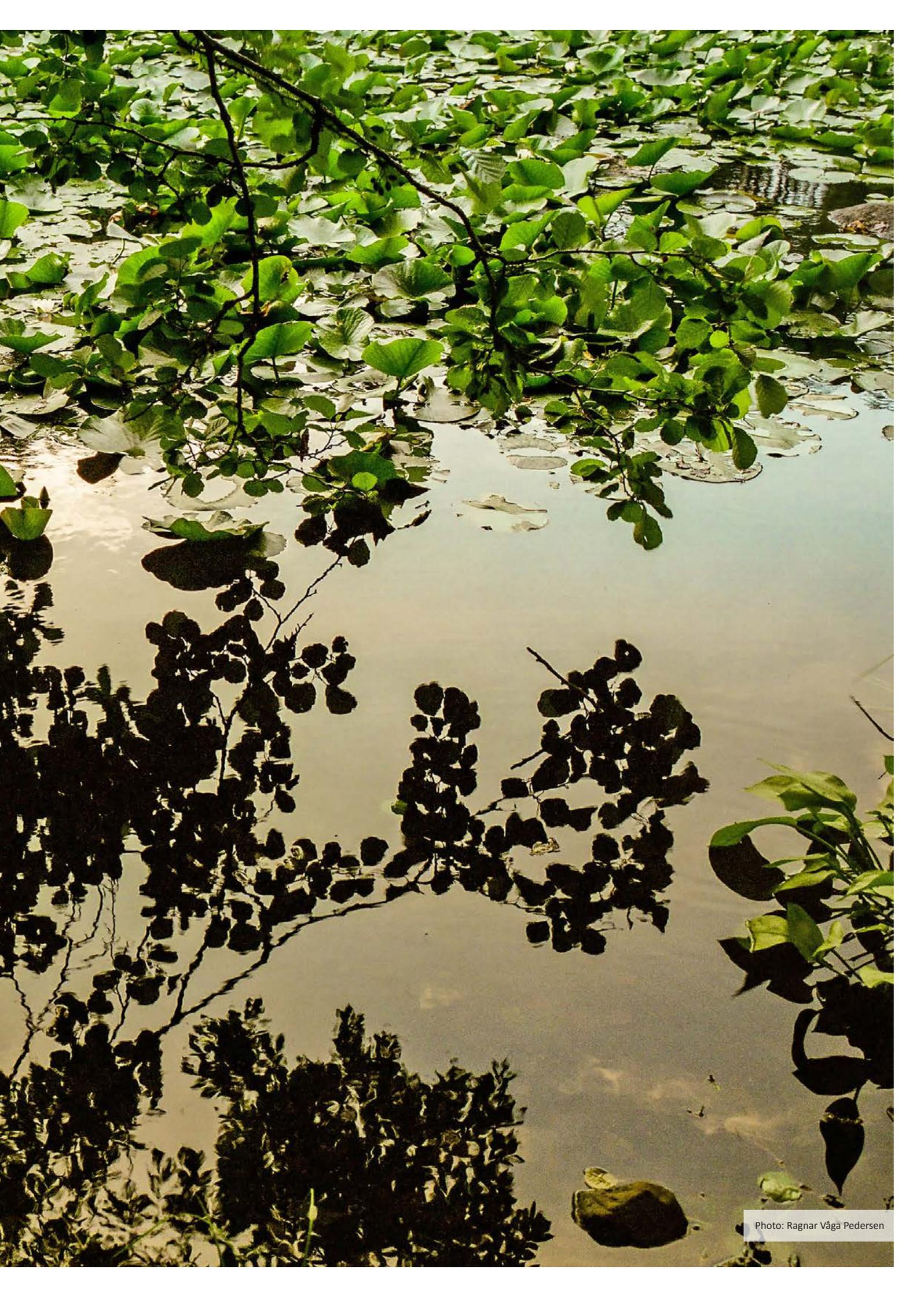


Photo: Ragnar Våga Pedersen



Photo: Erling Fløistad



Agriculture needs alternatives to glyphosate

Couch grass and other creeping perennial weeds are a major problem for grass and grain producers. Spraying with glyphosate is often the chosen solution, but the EU is now considering to phase out this herbicide.

Glyphosate is the most commonly used pesticide in Norway and the rest of the world. However, there are strong signals from Europe that this substance will be phased out in the next few years. In 2017, glyphosate was approved for another five years, until the end of 2022. If glyphosate is phased out, there are fears that this could have major negative consequences on agriculture and food production.

NIBIO has been looking into potential measures that could help replace or reduce the use of glyphosate.

“In Norway, glyphosate is used to tackle couch grass and other weeds. There are no good chemical alternatives for dealing with couch grass in cereals, since alternative products have a shorter-lasting effect,” says NIBIO researcher Kirsten Semb Tørresen.

Tørresen is one of several researchers at NIBIO who have spent years working to compile and obtain

relevant knowledge about non-chemical and chemical alternatives to glyphosate.

In the project “Testing and information of alternatives to glyphosate in cereals”, NIBIO with collaborating partners have investigated mechanical alternatives to glyphosate and how we can reduce its use by using the VIPS-Ugras decision support tool. The project is now coming to an end.

NIBIO is also Norwegian partner in the European AC/DC-weeds project, which aims to develop methods for the sustainable control of weeds such as couch grass, perennial sowthistle and creeping thistle in agriculture.

The project focuses on new tillage methods involving less use of ploughing and more use of crops that are better able to compete with the weeds. An extensive series of trials was set up in 2019 in Germany, Finland and Norway. The trials will run until 2021.



Goal: With reduced or no access to glyphosate in the future, we need sustainable alternatives. NIBIO is compiling and obtaining knowledge about non-chemical and chemical alternatives to glyphosate that can be used to maintain food production.

Collaboration: “Testing and information of alternatives to glyphosate in cereals”: NMBU and Norwegian Agricultural Extension Service (NLR)

Funding: Action plan for sustainable use of pesticides
Collaboration: AC/DC-weeds: Universität Rostock (project owner), NMBU, Luke Natural Research Institute Finland, University of Copenhagen and INRA

Funding: ERA-NET Cofund SusCrop Horizon 2020/ The Research Council of Norway

Contact: Research Scientist Kirsten Tørresen. Email: kirsten.torresen@nibio.no, mobile: +47 971 80 114. Division of Biotechnology and Plant Health



Photo: Åsmund Asdal



Better use of the phosphorus layer in soil

We used to believe that growing vegetables in the Norwegian climate required liberal application of phosphorus fertilizer. Researchers are now urging moderation, as well as crop rotation between vegetables with different root systems.

Phosphorus is one of the most important nutrients in terms of plant growth. But its liberal use over time has resulted in a large excess of phosphorus in the soil. This excess increases the risk of phosphorus leakage into rivers and lakes. Over time, this creates favourable conditions for algae growth, which in turn results in poor water quality for fish, animals and people. The excessive use of phosphorus fertilizer is also expensive for farmers and an unnecessary use of a limited resource.

Compared with other European countries, the Norwegian climate leads to lower soil temperatures and a shorter growing season. This reduces phosphorus uptake and creates poorer conditions for the utilization of phosphorus reserves in the soil. That is why we believed it was important to apply phosphorus generously in order to achieve good vegetable growth. New research has shown that most vegetable cultures can be fertilized with less phosphorus than that which has been the norm.

Over the last 10–15 years, Erling Stubhaug has contributed to around 90 field trials of phosphorus fertilization in the main vegetable cultures. His advice is clear: reduce phosphorus fertilizer use and focus more on the phosphorus stored in the soil.

“Practically speaking, we could achieve a reduction of 30–40% in Norwegian vegetable production,” he explains.

Different root systems give vegetables different abilities to utilize the soil’s phosphorus. With their deep roots and many root hairs, brassicas like cabbage, broccoli, cauliflower and sprouts are able to make good use of the phosphorus reserves. Cultures like onion and leek have shallower root systems with no root hairs, so they need more phosphorus fertilizer.



- Goal:** A balanced system of phosphorus fertilizer application, which utilizes the reserves in the soil more efficiently. This is best achieved through crop rotation between different types of vegetables with different abilities to utilize the phosphorus reserves in the soil.
- Collaboration:** Norwegian Agricultural Extension Service
- Funding:** Norwegian Agriculture Agency, Yara Norge AS, knowledge development funds from the Ministry of Agriculture and Food
- Contact:** OAP Erling Stubhaug. Email: erling.stubhaug@nibio.no, mobile: +47 902 05 677. Division of Food Production and Society



Photo: Siri Elise Dybdal



Norway's first CRISPR food plant

Researchers at NIBIO have succeeded in creating Norway's first gene-edited food plants. The researchers used the CRISPR method to gene-edit strawberries to make them more resistant.

Researcher Tage Thorstensen and his team at NIBIO are the first in Norway to successfully use CRISPR technology to knock out susceptibility genes in wild strawberries. These are genes that make the plants more vulnerable to disease, particularly fungal disease.

CRISPR works kind of like "gene scissors" that can remove, insert or swap pieces of DNA as desired, in any type of living organism. It is hoped that the tool could help to solve challenges associated with food security, climate change and sustainability.

Thorstensen has used CRISPR in his work with lettuce and strawberries. He explains that the development of a specialist CRISPR tool for strawberries took time.

"In plants, you need special plant vectors in order to get the CRISPR molecules into the plant cells. We had to adapt these for strawberries, and then we had to get these CRISPR tools into the strawberry cells.

This was the main bottleneck, since strawberries are a much more difficult plant to work with than other model plants used in research. But just before summer, we received confirmation that we had managed. That was a great moment, because it meant we could make a more accurate cut in the gene we wanted," says Thorstensen.

This is the first time they succeeded to edit the genome of the cells in the entire plant, and that the modification was inherited by the next generation.

"This is knowledge we can use on a larger scale, on more plant types, and that can benefit Norwegian farmers. Plants like these allow us to significantly reduce the use of sprayed chemicals," Thorstensen points out.

In this way, production can become more sustainable and profitable. And if the researchers succeed with strawberries, they may also succeed with potatoes, cereals and other plants.



Goal: To use CRISPR on wild strawberries to knock out susceptibility genes – genes that make the plants more vulnerable to disease.

Funding: Toppforsk – Research Council of Norway and knowledge and development funds from the Ministry of Agriculture and Food

Contact: Research Scientist Tage Thorstensen. Email: tage.thorstensen@nibio.no, mobile: +47 402 00 909. Division of Biotechnology and Plant Health



Photo: Jon Schärer



Increasing grain yield on existing land

There is a huge potential to increase Norwegian grain production. This is mainly because the arable land we currently use has a significantly higher potential yield than the volume currently harvested. Analyses show that this “yield gap” is greater in Norway than in other European countries.

Yield gap is the difference between the theoretically achievable yield potential and the actual yield obtained through practical cultivation on a farm level. For Norwegian grain, the general yields have stagnated, and the arable area has been reduced since the 1990s.

The aim of the yield gap project is to identify main yield constraints and areas with unexploited yield potential. Researchers, the grain industry and also society need more knowledge about the yield potential in different regions on the basis of natural conditions. The same applies to the effectiveness of different agronomic measures and the interaction between these.

This is the first time yield potential has been simulated for grain species in Norway, and the analyses show that the yield gap in Norway is greater than

the European average, including that of most other Nordic countries. Till Seehusen believes there are many reasons for this.

“The short growing season is very challenging here in Norway, particularly if there is a lot of precipitation when a field is being prepared or harvested. Norway also has a lot of small farms on which many grain producers are part-time farmers. This means it can be difficult for them to perform all necessary field operations at the right time and under optimal conditions. In addition, average field size is smaller than in most other countries. This leads to a higher proportion of headlands, which are more susceptible to soil compaction and reduced yield.”

However, comparatively high grain yields in recent years confirm that even small changes can have a large effect if the conditions are right.



- Goal:** By identifying the unused potential in Norwegian grain production, we will obtain more knowledge about the size of yields we can potentially obtain in different regions on the basis of natural conditions.
- Collaboration:** Norwegian University of Life Sciences (NMBU), Wageningen University (WUR)
- Funding:** The work was done in cooperation with AGROPRO and participation in the TempAg network. The Norwegian work was funded by the Research Council of Norway and Ministry of Agriculture and Food.
- Contact:** Research Scientist Till Seehusen. Email: till.seehusen@nibio.no, mobile: +47 932 69 878. Division of Food Production and Society



Photo: Gunnhild Sjøgaard

Climate Cure 2030 — forestry measures

Forest covers 37 % of our country with an annual net uptake of around 23 million tonnes of CO₂ equivalents. It is possible to increase net uptake in forests through improved forest management, and with time, increase the level of annual C sequestration on a national level.

NIBIO provides relevant knowledge for directorates and ministries for use in, for example, Climate Cure 2030 and the government's climate plan published in January 2021. Some of the mitigation measures that will achieve an increase in CO₂ uptake in Norwegian forests in the long-term include improved regeneration with higher planting density than is the current practice, and increased use of improved plant material.

Traditional forest-management measures will increase CO₂ uptake, but may also improve tree quality. Better quality is important because it implies a higher proportion of sawn wood and more timber, which can be used for long-lasting wood products. This increases the climate benefit of the trees due to longer carbon storage in products.

Most of the forestry measures will only have an effect in the long-term, partly because there will be limited land available each year—only a small part of a forest

is felled and regenerated each year—and, partly because it takes some time for new forest to start to grow really well. However, to achieve the potential benefit that will only be realized well into the future, it is important for these measures to be implemented as quickly as possible.

Climate change is projected to raise temperatures and increase precipitation in Norway, which could provide better growing conditions for many trees. However, climate change is also projected to increase the risk of damage to forests as a consequence of more frequent and extreme natural disturbances, such as windfall, insect damage, and forest fires, which will contribute to increased greenhouse gas emissions. Preventive forest management can limit emissions from such disturbances.



Goal: Potential for contribution to climate change mitigation from Norwegian forest through forest management.

Funding: Norwegian Agriculture Agency and Norwegian Environment Agency

Contact: Head of Department Gunnhild Sjøgaard. Email: gunnhild.sogaard@nibio.no, mobile: +47 917 27 960. Division of Forest and Forest Resources



Photo: Kathrine Torday Gulden

Evaluation of agricultural climate measures

As a basis for *Climate Cure 2030*, NIBIO evaluated four measures for reducing greenhouse gas emissions from the agricultural sector. These are cover crops, drainage, reduced food waste and changing from a diet based on meat to one based on vegetables and fish.

The report *Cover crops as a climate measure in Norway* evaluated which areas are suitable for cultivating cover crops, and the potential degree of implementation by 2030. It calculated the emission savings through carbon-binding in soil and reduced nitrous oxide emissions.

Gradually increasing the land area with cover crops to 20% of the potential land suitable for grain cultivation, could reduce CO₂ equivalents by 0.44 million tonnes of CO₂ in the period 2021–2030.

The report *Drainage and Greenhouse Gas Emissions* studied the effect of drainage on nitrous oxide emissions and profitability and evaluated the extent of area with drainage needs. Draining all the land assumed to be poorly drained would achieve an estimated reduction of 162,000 tonnes of CO₂ equivalents by 2030, and a further 1 million tonnes of CO₂ equivalents by 2080.

The report *Socioeconomic analysis of halving food waste in accordance with the Industry Agreement on Reduction of Food Waste* studied the measures that were used as a basis for the industry agreement.

The calculations show that halving food waste by 2030 would result in total emission reductions from Norwegian agriculture equivalent to 1.9 million tonnes of CO₂ equivalents.

The main finding from the report *Climate Cure 2030: transitioning from red meat to vegetables and fish* shows that, in many cases, changing one's diet results in a negative cost per measure, and a total emission reduction potential of around 2–8 million tonnes of CO₂ equivalents in the period 2021–2030. The report also looked into other, additional effects of the measure that could produce negative results.



Objective of Climate Cure 2030: To study measures and instruments that could achieve a minimum 50% reduction in greenhouse gas emissions not included in the Emissions Trading System in 2030 compared to 2005.

Collaboration: Norwegian Institute for Sustainability Research (NORSUS)

Funding: Norwegian Agriculture Agency and Norwegian Environment Agency

Contact: Research Scientist Lillian Øygarden. Email: lillian.oygarden@nibio.no, mobile: +47 916 84 113. Division of Environment and Natural Resources



Eastern Norwegian red cows at Varteig, Sarpsborg

Photo: Kjersti Kildahl

Self-sufficiency in Norway: the numbers

In 2019, the self-sufficiency ratio, or the amount of domestic food consumption calculated as caloric intake, was 43%. If we exclude fish, the ratio is 42%. Adjusted for imported feed concentrate, it falls to 34%. In the last 10 years, it has varied from 41% to 48%.

These figures originate from the basis prepared by NIBIO for agricultural policy negotiations.

The *self-sufficiency* is calculated in energy, but protein, kilos or money can also be used. Natural fluctuations in weather and yield affect self-sufficiency.

“Variations in food grain harvests explain a large part of the annual changes in the self-sufficiency,” says Lars-Johan Rustad. “For example, the dry year of 2018 had consequences for food and feed production that continued into 2019.”

“Grain in the form of flour” represents almost 30% of total energy consumption. Meat represented 13% in 2019, and is the second-largest food product. The self-sufficiency ratio for livestock products is generally high. It is noticeably lower for plant products.

Discussions often use the phrases “self-sufficiency based on Norwegian feed” or “excluding fish.”

Imported input factors other than feed concentrate are also important. The coronavirus situation of 2020 demonstrated this in terms of foreign labor.

The *coverage ratio (SSR)* shows how much Norwegian food we could have consumed if exported food from Norway was part of domestic consumption. It is often around 90%, and in 2019 it was 86%. Fish for export represents most of the difference between the self-sufficiency and coverage ratios.

The self-sufficiency and *coverage ratio (SSR)* tell us little about our *self-sufficiency* in a crisis. They are not measured on self-sufficiency preparedness or food security.

“In a prolonged crisis situation, many aspects of our current diet and production are likely to change. More plant production would probably focus more on food for humans and less on animal feed,” Rustad comments.



Goal: To prepare a basis for agricultural policy negotiations.
Funding: Ministry of Agriculture and Food
Contact: Head of Department Lars-Johan Rustad. Email: lars-johan.rustad@nibio.no, mobile: +47 911 27 954. Division of Survey and Statistics



Photo: Siri Elise Dybdal

Alarming discovery of imported *Phytophthora*

Species in the microorganism genus *Phytophthora* are crossing the border on imported plants and have killed trees both in landscape areas and natural environments. One study observed *Phytophthora* in 37.6% of imported woody ornamental plants.

For the last two years, NIBIO researchers have been working on an assignment for the Norwegian Food Safety Authority to survey for *Phytophthora* in imported plants. The study started in 2018, based on a strong suspicion that *Phytophthora* species were arriving in the form of stowaways in the soil around the roots of woody plants. This suspicion has now been confirmed.

“It is very alarming that 19 *Phytophthora* species were found in samples from imports in 2018 and 2019, six of which are species new to this country. As many as 38 out of 101 samples in 2019 were infected with one or two *Phytophthora* species”, explains NIBIO researcher Venche Talgø.

“Plant import is a high-risk activity, and the findings in the survey are likely just the tip of the iceberg”, says Talgø when commenting on the findings. She explains that these disease causing microorganisms have already killed a large number of trees alongside Norwegian rivers like the Glomma, Drammenselva, Nidelva and Akerselva.

The plant material in the study came from the Netherlands, Italy, Germany, Denmark, Belgium, Sweden and Poland, and had phytosanitary certificates from the export countries.

“The survey shows that phytosanitary certificates and lack of symptoms on arrival in Norway are no guarantee that the plants are healthy”, NIBIO researcher Martin Pettersen adds.

“As we have seen with Covid-19 and people, plants can also be affected without showing symptoms. Latent infection can make the plants sick several months after they arrive in the country. When we consider how many plants we import every year, it is very worrying that more than one-third of the imported plant material contains *Phytophthora*.”

According to Talgø: “We should now move from surveying to implementing effective measures to reduce this serious problem.”



Goal: Monitor alien species in the *Phytophthora* genus on imported plants.
Funding: Norwegian Food Safety Authority
Contact: Research Scientist Venche Talgø. Email: venche.talgo@nibio.no, mobile: +47 920 69 664. Division of Biotechnology and Plant Health



Photo: Michael Angeloff

Genetic variation in Norwegian forest trees

Genetic variation ensures that trees survive and thus are able to provide us with a range of benefits, among others timber, paper, carbon binding and biodiversity.

The species' ability to survive and adapt to different environments, or to changing living conditions, depends on genetic variation. Without this variation, all individuals would react in the same way, which would weaken their ability to survive.

Variation ensures forest trees' ability to adapt to changing climate conditions, which is vital for their evolution and improvement. Genetic variation is also important in terms of resistance to pests and disease.

Understanding forest trees' variation, growth rhythm, growth and other properties is important if we are to manage resources properly and achieve sustainable forest production and survival.

Studies covering 70 years

Knowledge about tree species' genetic variation through long-term research and genetic studies is vital in terms of ensuring the sustainable use and development of forest tree resources.

In the report *Genetic variation in Norwegian forest trees*, NIBIO researchers have compiled information from genetic studies of forest trees for 13 of our 35 tree species. Spruce, pine and birch are the tree species for which we have the most information. The NIBIO report provides an overview of the tree species for which we have genetic knowledge, and about which studies have been performed from the 1950s to the present day.

Unique variation in Norwegian tree species

Norwegian forests are dominated by a small number of species that are found over large parts of the country: spruce, pine and birch. Together, these three species represent more than 90% of the standing forest volume in Norway.

Norway is in an unusual situation, in that most of the tree species here are growing at their absolute northern limit. Marginal populations like these can have a genetic variation which is particularly important for us to know about, to protect the genetic resources.



Goal: Communicate the significance of genetic resources and genetic variation.
Funding: Ministry of Agriculture and Food

Contact: Senior Scientific Adviser, Norwegian Genetic Resource Center, Kjersti Bakkebo Fjellstad.
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Division of Survey and Statistics



Photo: Lone Ross Gobakken

Reducing construction and building waste

In 2017, the building and construction industry generated around 2 million tonnes of waste. High costs, lack of appropriate technology and limitations in the applicable regulations are preventing greater reuse and recycling of construction components and waste fractions.

NIBIO and Economics Norway were commissioned by the Directorate of Construction Quality to evaluate the socioeconomic benefit of measures such as waste minimization, reuse and material recycling in the construction industry. The objective is to achieve national targets for the reduction of the volume of generated waste.

In the period 2013–2017, the volume of waste from the construction industry increased from 1.8 to 2 million tonnes per year, while material recycling of this waste decreased by 400,000 tonnes per year. The goal for the construction industry is to move increasingly toward a circular economy with a more closed material cycle, with as little loss as possible and a lower proportion of new materials entering the cycle. Norwegian waste policy prioritizes cost efficiency, profitability and minimal socioeconomic cost. The benefit of measures must exceed the overall costs.

The best way of reducing the volume of construction waste is by waste minimization and increasing reuse and material recycling. At the moment, waste minimization is the fastest strategy for achieving the effect for the construction industry. The most significant initiatives are associated with prefabricated building elements.

Other measures include introducing new technology and increasing the recycling of waste fractions that currently have a low recycling rate, such as timber. Reusing materials and building components is currently not very profitable. It is time-consuming, technically difficult and involves stringent documentation requirements.



Goal: Reduce the volume of waste in the construction industry.
Collaboration: Samfunnsøkonomisk Analyse AS (Economics Norway)
Funding: Directorate of Construction Quality
Contact: Acting Head of Department Lone Ross Gobakken. Email: lone.ross.gobakken@nibio.no, mobile: +47 911 97 268. Division of Forest and Forest Resources



Photo: Maximilian Pircher



User-friendly ag tech for Norwegian farmers

Farmers face a “jungle” of digital services, and the risk of investing in the wrong technology and software could be more serious than ever. In the PRESIS project, researchers provide farmers with user-friendly technological services adapted for Norwegian conditions.

An important element of the project is to ensure that farmers have ownership of their own data. The researchers are therefore developing storage solutions for the data collected.

“The idea is to allow the farmer to book drone flights or to use their own drones. They then upload the data the drones have collected and store it in our system,” explains Kjersti Balke Hveem. The data can then be processed, for example to create a fertilizer map that is transferred to the fertilizer spreader. This is unique – there are no other systems like this available at the moment, at least none that are suitable for Norwegian conditions.

Data can also be gathered via sensors on tractors or from satellites. However, satellite images are significantly less accurate and require cloud free weather conditions. The advantage of drone-based measurements is that we can obtain much more

detailed information, clouds are not a problem and the system requires zero investment from the farmer.

In 2020, NIBIO performed more than 65 drone flight missions over fields in Viken, Trøndelag, Innlandet and Rogaland. The information collected on the assignments is compared with physical samples taken at the same time and used to ensure that the measurements match the reality in the various regions.

The aim is for the technological services to provide maps for fertilizer distribution in grain fields, for crop and quality estimates in grass fields, and to chart weed growth in grain fields in order to create herbicide distribution maps. These are information services that have the potential to reduce unnecessary impact on the climate and environment from agriculture, as well as to improve efficiency and reduce costs.



Goal: In the PRESIS research project, researchers aim to provide Norwegian farmers with access to user-friendly and well-tested technological services for precision agriculture.

Collaboration: Norwegian Agricultural Extension Service

Funding: Agricultural Agreement

Contact: Research Scientist Kjersti Balke Hveem. Email: kjersti.balke.hveem@nibio.no, mobile: +47 976 25 157. Division of Food Production and Society



Photo: Venche Talgø



More bacterial diseases discovered in trees

Bacterial diseases appear to be an increasing problem for trees in Norway, according to a new NIBIO report on forest health.

Plant pathogenic bacteria tend to spread through plant material. The large-scale import of ornamental plants, fruit trees and forest plants is therefore extremely concerning. Among others, the dreaded fire blight plant disease was detected in Norway for the first time in professional fruit cultivation in the summer of 2020.

Pseudomonas syringae is another bacterium that damages fruit trees, but it also attacks tree species in green spaces, forests and other natural environments. For example, the bacterium has been observed in willow, and researchers from NIBIO have isolated the bacterium in several areas with sick or dead willow trees, from Trøndelag to Ås.

“In Norway, we have recorded several incidences of bacterial disease in tree crops. Our focus has been on fruit trees, but forest trees have also been affected, particularly deciduous trees,” explains researcher Juliana Perminow.

Norway has had strong import protection and very good plant health. However, the industry called for foreign material in order to access varieties with properties that increase productivity. Plant health was not the main focus, and the authorities have accommodated the industry and removed import bans on items such as plants for planting of pome fruit and strawberry.

So far, NIBIO has not undertaken many projects that involve surveying bacterial diseases in trees, and many of the discoveries have been made purely by chance by interested researchers.

Perminow says that testing plants at the Plant Clinic could be an important way of picking up early signs of outbreaks but notes that outbreaks only tend to be reported when the damage is already extensive.

She now hopes that the authorities will start to see that large-scale imports of plants can have drastic consequences.



Goal: Provide information about findings from damage monitoring in Norwegian forests.
Funding: Ministry of Agriculture and Food
Contact: Research Scientist Juliana Perminow. Email: juliana.perminow@nibio.no, mobile: +47 920 59 165. Division of Biotechnology and Plant Health



Photo: Venche Talgø

Fire blight detected in fruit orchards

Fire blight is considered to be one of the world’s most harmful diseases in apple and pear trees. In the summer of 2020, the disease was detected in a commercial orchard in Norway.

In many countries, attacks of fire blight have major economic significance in terms of fruit production, and the disease is also known to destroy ornamental plants and trees in parks and green spaces.

Fire blight was first detected in Norway 33 years ago, but a variety of measures kept it away from fruit production areas. Sporadic outbreaks of the disease have occurred in apple trees in private gardens, but now the bacterium has been detected for the first time in commercial fruit production in Norway.

“Suspected fire blight was confirmed in all the samples, first through a lateral flow test and then a DNA analysis,” explains NIBIO researcher Juliana Perminow.

Fire blight can spread very quickly at temperatures above 20°C. Weather conditions, including high temperature, moisture and wind were favourable to the development and spread of fire blight in Ryfylke

district in 2020, when outbreaks were observed in July in Cotoneaster in several locations.

Latent infection of fire blight in plant material generally represents a major risk of the harmful bacterium introduced from abroad. Until November 2015, the import of fire blight host plants to Norway was prohibited, but the authorities have since allowed the import of plants for planting of pome fruit from countries known to have a prevalence of fire blight.

Fire blight is very difficult to control, since there are no chemical products that work against the bacterium. Intensive work has been ongoing since 1986 to identify and destroy infected plants. However, for the last few years there have been inadequate resources to remove all of these in cities like Bergen and Stavanger. Instead, the focus has been on the preventive removal of healthy host plants close to areas of fruit production and nurseries.



Goal: Monitoring and control of dangerous pests.
Funding: Norwegian Food Safety Authority

Contact: Research Scientist Juliana Perminow. Email: juliana.perminow@nibio.no, mobile: +47 920 59 165. Division of Biotechnology and Plant Health



First cut.

Photo: Kjersti Kildahl



New map for vegetables, grain and grass

Norway has a huge variety of natural conditions for plant cultivation. To ensure sustainable Norwegian food production, the land with the greatest potential for plant cultivation must be used for food production.

In 2020, NIBIO presented new maps showing the cultivation potential for vegetables, grain and grass in different parts of the country.

“The new maps are an important contribution toward achieving conscious land use, and will help make Norwegian food production more sustainable,” says project manager Siri Svendgård-Stokke.

The model behind the maps is based on soil properties, weather data and the seasonal requirements for crops. Because the model relies on soil data, the maps are only available for areas on which agricultural soil surveys have already been performed – in other words, approximately half of the country’s agricultural land.

The aim is that farmers achieve successful production within their production environment.

In the past, knowledge about soil was passed down from generation to generation. In modern agriculture, with much of the land being leased,

that is no longer the case. It is therefore becoming increasingly important to find alternative ways of imparting this knowledge.

It is also important for decision-makers to be aware of the land’s food production potential when making political decisions on the use of agricultural land for purposes other than agriculture.

The maps can be used as a basis for analyses of the land’s value and suitability for different crops when there is competition for the land, or to assess market potential, production environments and sales channels.

The maps are welcomed by Olaug Bollestad, Minister of Agriculture and Food:

“Consumers are demanding more and more fruit and vegetables. When farmers and the public administration set out to meet this demand, the new maps will be an excellent aid,” says the minister.



Goal: To provide the industry and public administration with decision-making support to improve the utilization of soil as a resource.

Collaboration: Norwegian Meteorological Institute, Norwegian Agricultural Extension Service, Norwegian University of Life Sciences

Funding: Ministry of Agriculture and Food

Contact: Head of Department Siri Svendgård-Stokke.
Email: siri.svendgard-stokke@nibio.no, mobile: +47 478 14 011.
Division of Survey and Statistics



Photo: Erling Fløistad



Forest maps provide new opportunities

The SR16 forest resource map provides detailed information about the forest in Norway. SR16 stands for “SkogRessurskart” (forest resource map), on which the pixel size (grid) is 16 x 16 meters. It is based on a combination of the National Forest Inventory’s ground-based field sample plots and remote sensing data. It includes information on tree species, biomass, stand age and other forest characteristics.

The digital forest maps have now been updated to cover more than 95% of Norway’s forest area. The maps provide a new and much more detailed and comprehensive picture of Norwegian forest resources than has previously been possible.

Many people in public administration at county and municipality level currently use the AR5 map system which has now been updated with new forest data.

Digital forest map services are needed to improve critical public infrastructure such as power supply and fire preparedness. The Norwegian Water Resources and Energy Directorate (NVE) wants to gain knowledge about how much and what kind of forest is growing along the power line corridors. NIBIO has also been working with the Directorate for Civil Protection (DSB) to ensure that they will be

able to use the information in the SR16 maps to prevent and fight forest fires, for example through new and improved maps that visualize fire risk in the forest.

The free to use map service also provides the Norwegian forestry industry with great opportunities. Data from aerial laser scanning gives highly accurate three-dimensional information about the forest’s structure that is then combined with color information from the Sentinel-2 satellite to create a comprehensive map of the forest. SR16 will be updated annually and will continue to be developed through the addition of more features.

The SR16 forest resource map has been established as part of Norge Digitalt and is available from Kilden and for download on Georange.



- Goal:** Digital forest maps providing a detailed and comprehensive overview of Norwegian forest resources.
- Collaboration:** Viken Skog, NORSKOG, Norwegian Geotechnical Institute (NGI), Norwegian Water Resources and Energy Directorate (NVE), Norwegian Agricultural Extension Service
- Contact:** Research Professor Johannes Breidenbach. Email: johannes.breidenbach@nibio.no, mobile: +47 974 77 985. Division of Forest and Forest Resources
Senior Engineer Bjørn Borchsenius. Email: bjorn.borchsenius@nibio.no, mobile: +47 410 71 073. Division of Survey and Statistics



Photo: Sigrídur Dalmannsdóttir



Testing timothy grass in northern Norway

Timothy grass is the most important forage grass in Northern Norway, but which variety is best suited to cope with the winter conditions? Researchers have tested different varieties of timothy grass for factors such as tolerance to ice cover.

“Using high yielding varieties in northern regions is always risky” Sigrídur Dalmannsdóttir explains. “The highest yielding varieties are usually adapted to a longer and warmer growing season, and thereby tend to be vulnerable to overwintering damage.”

After 1-4 months of ice cover treatment during mid-winter, the results showed that the longer the timothy grass is covered with ice, the slower its regrowth gradually becomes. However, there are major differences between the varieties.

“The varieties that are best adapted to northern conditions have a different growth pattern compared to the southern varieties,” Dalmannsdóttir points out. “The plants grow most vigorously during early- and midsummer when the days are long and nights are bright. But the growth curve of northern varieties drops off faster toward the fall than those of southern varieties. This means less yielding in the second cut.”

There are large climatic variations between the different regions of Northern Norway, also in addition to large variations between years. Finding the optimum variety that provides good and stable yields is therefore not easy.

“Engmo has an excellent survival capacity but has practically no regrowth after the first cut. This variety is best suited in areas with a short growing season and long periods of ice cover. The Grindstad variety is significantly less tolerant to prolonged ice cover, but provides greater yields than the more winter-hardy varieties. The Snorri variety has good overwintering capacity and greater yield potential during late summer compared to most of the winter hardy varieties,” Dalmannsdóttir says.



Goal: In the “Timothy Grass for Northern Regions” project, researchers tested different timothy varieties to establish which are best suited for conditions in Northern Norway.

Collaboration: Norwegian Agricultural Extension Service of Northern Norway, Finnmark Agricultural Service

Funding: Norwegian Agriculture Agency (Climate and Environment Program), Graminor AS, Felleskjøpet Agri SA agricultural cooperative, County Governor of Troms and Finnmark

Contact: Research Scientist Sigrídur Dalmannsdóttir. Email: sigridur.dalmannsdottir@nibio.no, mobile: +47 465 46 249. Division of Food Production and Society



Beef and sheep farmer Erlend Moberg

Photo: Kjersti Kildahl

Nutritious food for the four-legged

All over the world, food production and biodiversity are threatened by intensive use. In Norwegian forests, and on heaths and mountains however, the main threat is rather too little use and the abandonment of grazing land.

“It’s a shame,” says beef and sheep farmer Erlend Moberg. Every year, he drives his animals 150 km from their home farm south-west of Bergen to their summer grazing land at the foot of the Vikafjellet mountain between Voss and Sognefjord.

A lot of unused grazing land

“We consider 45 % of the total land area of Norway to be useful grazing land,” says grazing surveyor Yngve Rekdal. This provides forage that is ideal for animal growth. Of this, 10 % is in the best grazing category.

In addition to the value for food production, this low intensity grazing supports a higher biodiversity than land that is not grazed.

Rekdal has surveyed the resource base and the use of grazing land all over the country. The work is presented in the *Beef Cattle and Rough Grazing* report.

Varied nutrition base

Nature and grazing quality will vary according to bedrock, topography and climate. Rich bedrock provides large areas of the best class of grazing land in Nordland, Troms and the lowlands around the Oslo Fjord. Poor bedrock in Agder provides more meager grazing.

The fjord and valley regions in Western Norway, Trøndelag, Nordland and Troms are typified by trickling screes sloping down toward fertile valley bottoms and coastal strips (strand flats). This is the type of grazing to which Moberg takes his cows and calves. They spend around three months on the rough grazing land.

“In the industry, it pays to maximize our use of forage from rough grazing,” he says. “Financially, because the animals live on a ‘free’ resource that would otherwise not be harvested, and health-wise because they get exercise and thrive when allowed to roam freely”.

Goal:	To quantify the forage potential of rough grazing — with a particular focus on beef cattle. A task within the project: <i>Sustainable Cattle Production on Roughage (GrassFedCattle)</i> .
Funding:	Research Council of Norway, Grant no. 255324/E50
Collaboration:	Norwegian University of Life Sciences
Contact:	Senior Adviser Yngve Rekdal. Email: yngve.rekdal@nibio.no, mobile: +47 959 33 520. Division of Survey and Statistics



Photo: Erling Fløistad

Increased digitization with SmartForest

NIBIO, the Norwegian University of Life Sciences (NMBU) and the University of Oslo, three foreign partners and 16 companies from the Norwegian forestry sector have established the SmartForest knowledge center for innovation and digitization in the forestry industry.

Digitizing the forestry sector will be conducted throughout the value chain – from planting and management, felling and general land use, to timber transport and processing, and on to customers and the market. The keywords are: overview, traceability and quality assurance, and protecting our resources and the environment.

The SmartForest project has a budget of NOK 234 million.

“Digital transformation will be achieved through a series of innovations that form the basis for developing a strong ‘forest tech’ sector in Norway,” explains project manager and Head of Research Rasmus Astrup from NIBIO’s Division of Forestry and Forest Resources. “Increasing the use of technology and the data generated in the various operations could reduce costs and increase profitability throughout the value chain. Improved planting will also reduce the environmental impact and road and rail transport needs.”

SmartForest will also be important for the reputation of the forestry sector and will help with recruitment for research, management and businesses.

“We are proud of this, and we look forward to many years of exciting, innovative knowledge development that will benefit forestry in Norway, with the help of our specialist colleagues on Ås campus and in the forestry industry,” says Astrup.

Nordskog is one of the partners involved in the SmartForest project. CEO Arne Rørå explains that for the past decades, forestry has benefited from major rationalization measures, but that there is still potential for further value creation through operations management and data management.

“It is great that we can now establish a world-class center for innovation in our industry that focuses on increasing value in the industry,” says Rørå.



- Goal:** To improve efficiency in the Norwegian forestry sector through increased digitization.
- Collaboration:** Norwegian University of Life Sciences, University of Oslo, DNV-GL, ARD Innovasjon, Norwegian Agriculture Agency and 13 companies in the forestry industry
- Funding:** Research Council of Norway (Center for Research-Based Innovation)
- Contact:** Head of Research Rasmus Astrup. Email: rasmus.astrup@nibio.no, mobile: +47 941 51 660. Division of Forest and Forest Resources



Photo: Pierre-Adrien Rivier

How degradable is biodegradable plastic?

More and more farmers are replacing conventional plastic mulch with biodegradable mulch film that can be tilled directly into the soil after use. Researchers are now examining how degradable it is in Norwegian conditions.

Biodegradable plastic requires a certain temperature to break down in soil, along with the presence of certain types of bacteria, fungi and other organisms. The extent to which the plastic degrades also depends on soil type.

“If the conditions are not optimal for degradation, farmers may run the risk of the plastics they plow into the soil remaining there for long periods, and also accumulating,” explains researcher Claire Coutris, who leads the *DGRADE* research project.

In the summer of 2020, nylon bags containing different types of biodegradable mulch film were buried on farms all over the country. Together with laboratory trials, this field test could provide information on how quickly and under which conditions the plastic films degrade, both with and without the presence of various soil organisms.

As well as clarifying whether biodegradable agricultural mulch breaks down completely in the Norwegian climate, or whether it turns into macro- or microplastics that accumulate in the soil, the researchers will look at what fate awaits biodegradable and compostable plastic in waste streams. This in order to determine whether composting and biogas production could be a source of plastics in the environment.

A third aspect of the project is to describe the environmental costs/benefits of biodegradable plastics and provide a life-cycle perspective of these materials in agriculture and waste streams.

«The hope is that, through good collaboration and communication, we can give farmers, consumers and waste companies advice on how to handle and use degradable plastic correctly. We also hope that this knowledge will benefit the manufacturers of degradable plastics,” Coutris says.



Goal: Examine the degradation of biodegradable plastics in soil and waste streams.
Collaboration: Norwegian Agricultural Extension Service, AgriRåd, Green Dot Norway, Simas AS and the Norwegian Institute for Sustainability Research (NORSUS)
Funding: Research Council of Norway and Norwegian Retailers’ Environment Fund
Contact: Research Scientist Claire Coutris. Email: claire.coutris@nibio.no, mobile: +47 954 28 281. Division of Environment and Natural Resources



Photo: Finn Måge



Fewer biological pesticides in Norway

Norwegian growers need microbial plant protection products to increase their adoption of integrated pest management. Norway has approved only a fraction of these pesticides compared to Sweden and Denmark.

The number of approved microbial plant protection products has increased dramatically over the last decade. However, there is a great deal of variation between countries. For example, Sweden and Denmark have approved five times as many microbial plant protection products than Norway.

“As of January 2019, 20 microbial plant protection products had been approved in Denmark and Sweden, compared to 4 in Norway,” explains Valborg Kvakkestad.

The researcher has looked into possible explanations behind the differences. The size of the market is slightly smaller in Norway. That could explain some of the differences, but not all. The main explanation is probably that the regulations have been implemented differently.

“Denmark and Sweden have had the same EU regulations since the 1990s, while Norway has had its own pesticide regulations. On June 1, 2015,

Norway adopted the same regulations as Sweden and Denmark. What the old and new regulations have in common is that pesticides must not have a harmful effect on health, or any unacceptable environmental effects,” Kvakkestad explains.

The main reason behind the current differences is probably how the regulations are implemented. Researchers compared the approval process for three microbial plant protection products in the Scandinavian countries, and it appeared that Norway spent more time on evaluating and making decisions on product applications.

One of the eight principles of integrated pest management is that sustainable biological, physical and other non-chemical methods must be preferred to chemical methods if they provide satisfactory pest control. Access to microbial plant protection products is therefore vital if farmers should use integrated pest management.

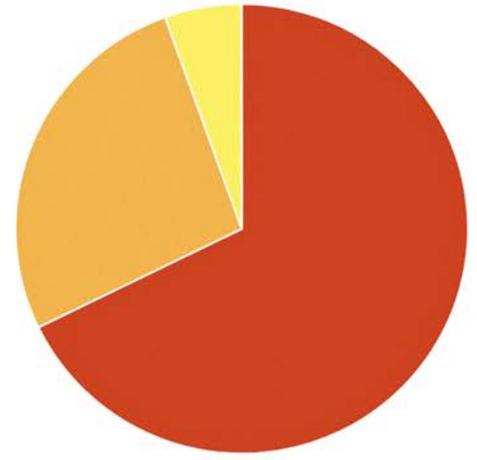


Goal: In the SMARTCROP project, researchers looked into the reasons behind the differences between Norway, Sweden and Denmark in terms of the approval of microbiological pesticides.

Collaboration: Rationale, contact Roma Gwynn

Funding: Research Council of Norway

Contact: Research Scientist Valborg Kvakkestad. Email: valborg.kvakkestad@nibio.no, mobile: +47 481 32 706. Division of Food Production and Society



A graphic view of land areas in Norway, shown in relation to each other

Illustration photo: NIBIO

Tool for planning work: New land barometer

Statistics and graphics showing that land resources in municipalities and counties have been brought together in the web-based land barometer, launched in 2019. It provides an overview of the agriculture and forestry production base in Norway.

“The barometer also shows how agricultural land is used,” explains project manager Ingrid M. Tenge. Information about how much land is in use for various crops and animal husbandry is taken from grant applications submitted to the Norwegian Agriculture Agency.

Information from the barometer is used in planning work, statements and political processes, and thereby provides a useful aid for public administration. Journalists and the general public are also among the target groups.

One of the barometer’s important sources is the detailed AR5 land resource map, a national map of the production base. Mountainous areas that have not been surveyed at AR5 level are supplemented with information from the “cruder” AR50 map.

The barometer also documents the quality of agricultural land in municipalities in which soil surveys have been performed. As well as fully

cultivated land, the barometer also includes land that *could* be cultivated; that is, land that could potentially be used to grow food, and that meets the climate and soil quality requirements for plant cultivation. The barometer shows how much land is cultivable and what type of land it currently is – for example, forest, marsh or cultivated pasture.

The figures behind the land barometer were taken from various thematic maps created by NIBIO, which are available on the Kilden map portal. Users can click onto a map via the barometer.

The new land barometer is dynamic and is updated automatically when there are changes to the databases from which the barometer obtains its information.

Project manager Tenge is relieved that the previous time-consuming manual method used to compile the land barometer is no longer necessary.



Goal: To compare statistics from various specialist areas and sources in order to compile an overview of the agricultural and forestry resource base in Norway.

Funding: Ministry of Agriculture and Food

Contact: Senior Adviser Ingrid M. Tenge. Email: ingrid.tenge@nibio.no, mobile: +47 901 04 465. Division of Survey and Statistics



Photo: Ragnar Våga Pedersen

DNA testing of Pink Salmon

In 2017, pink salmon were reported in more than half of the salmon rivers in Norway, mainly in Northern Norway, Central Norway and Western Norway, including Rogaland. Two years later, there were even more of them.

There are currently some gaps in our knowledge about the Norwegian pink salmon, as the Norwegian Scientific Committee for Food and Environment pointed out in its risk assessment regarding pink salmon, published in January 2020.

“We basically know relatively little about the pink salmon’s biology and the reasons behind the massive increase in its numbers,” said Snorre Hagen, Head of Research at NIBIO Svanhovd.

Nor do we know much about the behavior of pink salmon fry. Does it head straight out into the fjord, or does it stay in the mouth of the river for a while? If it stays, how much and what does the fry eat while it is there, and is there any competition for food in the rivers in which it lives? And not least—when the fry finally heads out to sea—what is it that actually determines its survival rate?

In March 2020, NIBIO and the Russian research institute KarRC RAS signed a letter of intent for

research work, which will include extensive DNA testing and analyses of the pink salmon.

“One thing we will investigate are pink salmon stocks on both sides of the border, to find out whether the stocks in the different rivers are genetically different to one another. This could provide us with information about the pink salmon’s movement patterns — and whether these depend on how long the species has been in an area,” Hagen explains.

He is asking recreational anglers who catch pink salmon to take a tissue sample and send it to NIBIO’s Svanhovd research station.

The aim is to build up a genetic database of different pink salmon stocks, to garner knowledge about how they develop over time.

“The more knowledge we have about this alien and invasive species, the better equipped we will be to deal with it,” Hagen concludes.



Goal: Build up a genetic database of pink salmon stocks to learn more about the species.

Collaboration: Karelian Research Center of the Russian Academy of Sciences (KarRC RAS)

Contact: Head of Department/Head of Research Snorre Hagen. Email: snorre.hagen@nibio.no, mobile: +47 932 40 197.
Division of Environment and Natural Resources



Photo: Stephen Dawson, Wikipedia/CC BY-SA

How does direct drilling affect soil?

The idea behind direct drilling as a soil improving practice is to leave the soil in fields as undisturbed as possible. However, there has been little research into the effects that direct drilling can have on water-related soil functions in areas with high precipitation.

As part of the work on her PhD at the University of Gloucestershire, NIBIO researcher Kamilla Skaalsveen compared the effects of direct drilling and conventional farming on two neighboring farms in Worcestershire in the UK. For some variables, she discovered there were bigger differences between soil types than there were between the different farming systems.

“In the silty clay soil on the farm that practiced conventional farming, the volume of organic material was roughly the same as that on the neighboring farm that practiced direct sowing. However, in the relatively poorly structured sandy soil, direct drilling appeared to be more effective at increasing the organic content.”

Soils in which direct drilling is practiced tend to develop a compacted and hard soil crust because the soil is left relatively undisturbed. This crust can reduce the water infiltration rate into the soil, but

Skaalsveen discovered that this also depended on soil type. Moreover, the results showed that the concentration of loose and bioaccessible phosphate increased downstream of fields that were direct drilled.

“This is due to the accumulation of plant material on the surface of the soil in this farming system,” Skaalsveen says. She adds that cover crops are an important element of direct drilling, as they can improve the soil structure, and help to reduce nutrient loss through nitrate leaching. However, phosphate is taken up by plants more slowly, which means that this is still a challenge.

“Whether direct drilling should be recommended as a means of improving water quality therefore depends largely on soil type and whether soil erosion or phosphate leaching represents the greatest threat,” Skaalsveen concludes.



Goal: Investigate the effects of direct drilling on water-related soil functions in areas with high precipitation.
Collaboration: University of Gloucestershire, UK
Funding: University of Gloucestershire and Environment Agency, UK
Contact: Research Scientist Kamilla Skaalsveen. Email: kamilla.skaalsveen@nibio.no, mobile: +47 988 22 515. Division of Environment and Natural Resources



Lapwing

Photo: Christian Pedersen

Less lapwings in the agricultural landscape

When the first lapwings arrive at Norwegian nesting sites, they are arriving in ever fewer numbers. Several bird species in the agricultural landscape have been declining in numbers since the turn of the millennium.

Lapwings were originally associated with nutritious coastal meadows. However, since the early 1900s, the species has spread inland and northward through the country and can now be seen mainly in or close to fully cultivated land, meadows and pastureland.

NIBIO researcher Christian Pedersen has been responsible for a new report containing data from 2000–2017 that shows changes in the population and distribution of seven bird species that breed in the Norwegian agricultural landscape.

“During this period, regular nesting of lapwings was recorded at only 8% of our monitoring sites,” says Pedersen.

Norwegian lapwing populations have declined by 75% percent in the last 15–20 years. Pedersen estimates that there are currently between 7,500 and 10,000 nesting pairs. The species is *endangered*, according to the Norwegian Red List (2015).

Causes of the decline include everything from destruction of nests by agricultural machinery and the use of pesticides that reduce food availability, to lapwing hunting in Southern European overwintering regions and along migratory routes.

“We cannot solve all of the lapwing’s problems, but we can help to ensure that we provide good conditions in the nesting areas in this country,” says the NIBIO researcher, noting that this includes:

- Marking nests in agricultural fields to avoid driving over nests. Harvesting crops from the interior of the fields towards the edges to allow the chicks to escape the machinery.
- Postponing the harvest in some locations until after the chicks have left the nests.
- Establishing “lapwing strips”. Farmers are paid to plow a zone close to cultivated pasture, to give the birds an area where they will be left in peace.



Goal: Document populations and developments in the Norwegian agricultural landscape.
Funding: Ministry of Agriculture and Food
Contact: Research Scientist Christian Pedersen. Email: christian.pedersen@nibio.no, mobile: +47 974 34 123. Division of Survey and Statistics



Photo: NRRI, Cuttack.

Digital tools in response to Covid-19

The COVID-19 situation in 2020 has posed challenges to many of NIBIO's international projects. It has however also fuelled several innovative ways to work remotely through digital applications, online tools and other methods.

In the Resilience project in India (www.resilienceindia.org), local farmers received training in how to harvest rice and other products from test fields and report digitally via an app or by SMS. This meant that the project did not lose important data because the researchers could not travel to the project areas.

“Digital platforms and other social media like WhatsApp have also been used to convey important information about weather, market, technology and coronavirus measures to Indian farmers,” says Udaya Sekhar Nagothu, senior researcher and Director of NIBIO's Centre for International Development.

In Kenya, the local project office in Nairobi has had daily contact with the Biofuel4Kenya project participants, who live on the shores of Lake Victoria. A WhatsApp group has become a key tool in running the project. Local staff post videos and photos to document the project's progress.

“Thanks to digital tools and virtual meetings, we have managed to maintain some level of activity on the projects. However, we are not always able to obtain all the information we need without traveling to the project areas. In some areas, there is also limited or no access to the Internet,” says Nagothu.

He believes the Covid-19 experience will prompt more digitalisation in international projects in the future.

“We have now seen how important digitalisation is in maintaining project activity during a global pandemic. In the future, digital tools could make processes more efficient and make us better prepared to face a range of situations that could restrict travel activities.”



Goal: Digital tools helped to maintain activity in international projects during the COVID-19 pandemic.

Contact: Research Professor/Director of NIBIO-Centre for International Development Udaya Sekhar Nagothu.
Email: nagothu.udayasekhar@nibio.no, mobile: +47 990 15 621.
Division of Environment and Natural Resources



Dairy goats in Hattfjelldal, Nordland

Photo: Kjersti Kildahl

Agriculture in Northern Norway

The number of agricultural holdings in Finnmark, Troms and Nordland is decreasing more than in the rest of the country. Profitability remained slightly higher than the national average.

This emerged from the NIBIO report *Agricultural value added in Northern Norway*. A common thread across Nordland, Troms and Finnmark is grazing and dairy farming.

“Dairy farming represents most of the value added in terms of gross product. However, sheep farming is more important for jobs. That means that percentage-wise, sheep farming contributes more in terms of total jobs than in terms of overall value added”, says project manager Heidi Knutsen.

Grass-based agriculture

Whether measured by value added or jobs, dairy farming and sheep farming are the most important production systems in this region. In Nordland, Troms and Finnmark, dairy production represents 58%, 57% and 78%, respectively, of total value added. That includes both cows and goats.

In 2018, the average income for a farmer in Northern Norway worked out at NOK 315,100 per full-time

equivalent. The national average was NOK 287,500. Knutsen explains that the difference is related to the fact that the dry summer of 2018 did not have such a dramatic effect in the north as it did further south in the country.

From 2009 to 2018, the number of agricultural holdings in Norway declined by 18%. In Nordland, Troms and Finnmark, the figures were 24%, 27% and 21%, respectively, in the same period. The amount of land per holding increased. Finnmark has the biggest farms in terms of acreage, with 320 decares per farm. The national average is 249 decares.

Documenting is vital

“If we are to claim that agriculture is important, we must be able to document why. The report is valuable in terms of planning and administration,” says Liv-Edel Berg, senior adviser for agriculture for the County Governor of Troms and Finnmark.



Goal: To study and document value added and jobs in agriculture and agriculture-based industries in Northern Norway.
Collaboration: Eastern Norway Research Institute at the Inland Norway University of Applied Sciences
Funding: Agricultural Council of Northern Norway
Contact: Senior Adviser Heidi Knutsen. Email: heidi.knutsen@nibio.no, mobile: +47 907 64 531. Division of Survey and Statistics



Photo: Kjersti Holt Hanssen

Biochar for carbon capture in forests

A new research project will examine the effects of applying biochar to forests. The new method could result in increased tree growth and carbon capture in Norwegian forests.

Biochar is produced by pyrolysis — combustion at high temperatures without an oxygen supply. Different types of biomass, such as wood chips or straw, are combusted, resulting in a product similar to barbecue charcoal. Biochar is resistant to decomposition. It can be used for soil amendment and to improve carbon capture in soils, but also as a fertilizer, especially if it is enriched with nitrogen.

While Norwegian agricultural land make up approximately 1.1 million hectares, or around 3% of the land area, the forests in Norway cover over 12 million hectares, or 37% of the country's land area. Forests also play a very important role in Norway's greenhouse gas accounting, and this is where biochar comes in.

Different methods for long-term carbon capture and storage in soil and forest, also known as Bio-CCS (Carbon Capture and Storage), are essential in our

fight to stabilize, or ideally reduce, CO₂ emissions. To achieve the target in the Paris Agreement of limiting the global warming to max 1.5–2°C within the next 80 years, it is essential to utilize trees' photosynthesis and the tremendous capacity of forest soil to capture and store CO₂.

Studies have shown that biochar can increase growth in agricultural crops by 10 - 25%. In pot experiments with tree seedlings, the average growth increase was over 40%. During the four-year FORBIOCHAR research project, the effect of standard forestry fertilizer will be compared with that of biochar, and biochar enriched with fertilizer.

“In theory, the nitrogen-enriched biochar could have a triple effect, with increased growth, increased carbon storage and less runoff,” explains NIBIO researcher Kjersti Holt Hanssen.



Goal: For several years, NIBIO's researchers have been developing methods for using biochar in agriculture. Through the new FORBIOCHAR research project, they will now also be testing out biochar in forestry.

Collaboration: Norwegian Forest Owners Association, Norskog, Norwegian Agriculture Agency, Norwegian Environment Agency, fertilizer producer Yara and Norwegian company Standard Bio

Funding: Research Council of Norway

Contact: Research Scientist Kjersti Holt Hanssen. Email: kjersti.hanssen@nibio.no, mobile: +47 996 44 123. Division of Forest and Forest Resources



Photo: Johanna Skrutvold



Aquatic environment and road construction

NIBIO is the specialist responsible for coordinating preliminary studies of the aquatic environment along the Tvedestrand–Bamble section of the E18. The aim is to establish the chemical and ecological status of watercourses, including natural values, alien species and important fish stocks.

NIBIO and FAUN are performing most of the pre-investigations, which include water sampling, automatic water monitoring, studies of the biology and biological quality parameters in rivers and lakes, environmental DNA, as well as studies and descriptions of substrate and habitats.

The studies along the new 55 km stretch of the E18 between Tvedestrand and Bamble involve around 70 stations in rivers, streams and lakes.

Project manager Roger Roseth explains that the ecological condition of many of the aquatic environments alongside the new E18 was unknown at the start.

“This is why it was important to perform pre-investigations of the freshwater environment, in order to establish their status so that we will be able to tell how the construction work may affect the ecology” he says.

Bottom-dwelling animals, benthic algae and fish tell us what kind of ecological condition a stream is in. Since quite a lot of the lakes and streams in the area are under-researched, they must be studied in order to see whether they contain aquatic life like fish or freshwater mussels.

One method that has been used is the collection of environmental DNA, with the assistance of the Norwegian Institute for Nature Research (NINA). Filtering water through a fine-meshed filter collects the DNA of organisms that live there. Genetic analyses can then be used to determine or assess which species the DNA comes from.

NIBIO has been involved in several similar monitoring projects in the past, including studies connected to the development of the E18 between Rugvedt and Dørdal in Bamble municipality.



Goal: Preliminary studies of the aquatic environment along the planned Tvedestrand–Bamble stretch of the E18 road.
Collaboration: Aas-Jakobsen, FAUN, Naturplan, NINA, NTNU, ViaNova, PELAGIA, LFI, Eurofins
Funding: Nye Veier
Contact: Senior Research Scientist Roger Roseth. Email: roger.roseth@nibio.no, mobile: +47 926 16 344. Division of Environment and Natural Resources



Photo: Therese Jægtvig



Greenhouse gas emissions from grazing sheep

Ruminants are responsible for around 5% of the annual greenhouse gas emissions in Norway. How can we be sure of that when no one knows the production of greenhouse gas emissions from Norwegian sheep and cattle during grazing?

For the first time in Norway, researchers have tried to measure enteric methane (CH_4) emissions from sheep grazing a cultivated pasture.

The sheep each have an oval gas container secured on their back with a harness. From this container, a plastic tube leads to the nose. The gas container uses a vacuum system to collect the greenhouse gases (CH_4 and CO_2) that are emitted when the sheep breathes out.

“We use the SF_6 -tracer gas technique,” explains Vibeke Lind. The sheep has a small bolus in the rumen, the size of an AA battery. The bolus contains the gas SF_6 (Sulphur hexa-fluoride) which is released at a known release-rate. The SF_6 is used as tracer gas to measure the emissions of other greenhouse gases.

“If we see that we are capturing 70% of SF_6 , then we assume that we are also capturing 70% of the CH_4 and CO_2 emissions.”

Grass height, dry matter production and nutritional content of the grass was measured on the day the animals were released into the pasture, and when they were removed again. The researchers thereby knew how much the sheep had eaten.

Although 90–95% of greenhouse gases are emitted through belching, a certain volume is also emitted in the other direction. As part of the project, the researchers therefore collected faecal samples from the last three days of each grazing period.

The data from the gas containers and faecal samples will provide a good picture of the total greenhouse gases emissions from the sheep.

“We know that the animals emit less methane when they are grazing on plants with high digestibility, because they utilize more of the energy. We believe this is similar to greenhouse gas emissions being reduced indoor when the animals are fed concentrate and high-quality roughage,” Lind concludes.



Goal: The goal is to study the climate footprint of animals in different grazing systems.
Collaboration: Swedish University of Agricultural Sciences (SLU) Umeå, Mære Agricultural College
Funding: Trøndelag County Authority, County Governor of Trøndelag and Steinkjer Municipality
Contact: Research Scientist Vibeke Lind. Email: vibeke.lind@nibio.no, mobile: +47 934 99 436. Division of Food Production and Society



Photo: Liv Birkeland



Catch crops and mulch benefit environment

Catch crops and mulch introduced in vegetable cropping systems could help to keep nutrients in the soil, improve soil structure, inhibit weeds and reduce greenhouse gas emissions.

The advantages of using catch crops and mulch are their ability to prevent erosion and compete against weeds. Catch crops may prevent nutrient loss, fixing nutrients in the upper soil layer, available for the following crop. While catch crops grown together with the cultivated crop in the season may compete for nutrients, mulch consisting of fresh plant material provides nutrients to the crop. Both measures allow farmers to achieve stable, fertile and sustainable soil conditions through increased carbon storage, improved soil structure and improved capacity for water infiltration in the soil.

“In trials at NIBIO Apelsvoll, we are studying how we can establish catch crops together with or following different vegetable crops,” explains Mette Thomsen. “We are also looking at the choice of catch crops, testing individual species and whether sowing time affects the crops.”

Sowing time depends on location and climate. In the trials at Apelsvoll, located in Mid/South Norway, as a rule of thumb, sowing no later than mid-August is the best time for establishing catch crops. But the species cover the soil and compete against weeds differently so there are variations in how densely and quickly the catch crops grow. The ability to retain nutrients are also different. An example is phacelia and chicory, competing very well against weeds, while rye tends to retain more nitrogen.

In terms of mulch, using cut green material from an old meadow is beneficial give. Preliminary results show that the mulch have a very good weed inhibiting effect and can provide sufficient nutrients producing yields in row crops (here leek) comparable to commercial fertilizer. Mulch also keeps the soil frost-free and thereby extends the harvesting period through the winter.



Goal: Sustainable vegetable production.
Collaboration: Norwegian Agricultural Extension Service
Funding: Grofondet and knowledge development funds

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Photo: Morten Günther

Surveying cross-border elk in Pasvikdalen

Not everyone needs a visa to cross the heavily guarded northerly border between Norway and Russia. Every winter, dozens of elk cross the Pasvikelva river from east to west, and their numbers seem to be increasing.

In the early 1900s, there was not a single elk in the Pasvikdalen valley. However, a lot has changed since then. At the end of the 1970s, we became aware that in the late fall and winter, significant numbers of elk were migrating across the border from Russia to Norway. The animals migrate south in Pasvikdalen, where the border fences with Finland and Russia form a wedge.

In the spring, the animals migrate north again, before spreading out over a large area. Some of the herds migrate over to the Russian side, where they find good summer grazing between the border and the fence, which in many places sits far back in Russian territory.

There is now a large local elk population, increasing the chances of human contact — elk are often hit by cars in Pasvikdalen, and people frequently encounter

the animals when hiking in the countryside. Elks have also become a nuisance to local farmers, grazing on their crops for parts of the year. Sør-Varanger municipality therefore commissioned weekly recordings of cross-border elks in Pasvikdalen every winter between 1981 and 2010. Numbers were also counted in the winter of 2019/20.

We also want to acquire more knowledge about which areas the elk uses at different times of the year. Together with Finnish and Russian researchers, the NIBIO scientists are now planning a new research project to survey the elks' migration pattern in Sør-Varanger. Some of the questions to be answered include: What is the condition of the grazing resources, how big is the total elk population in the municipality, and how is the elk population affected by climatic factors such as snow depth?



Goal: To survey elk migration patterns in Sør-Varanger

Collaboration: Sør-Varanger municipality

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Division of Environment and Natural Resources



Photo: Erling Fløistad

New climate-smart soil management network

A European research network wants to find sustainable solutions for the management of agricultural soil. Its aim is to help solve some of the social challenges involved in future food production in a changing climate.

Good soil is essential for the food we eat, for animal feed, timber and other biomass. The biodiversity found in soil is also important for many ecosystem services, and soil represents the biggest carbon store that we have on land.

However, soil is a limited resource, and erosion, nutrient loss, pollution and urban expansion represent significant threats. Intensive agriculture as a result of constantly increasing demand for food and biomass also results in a deterioration of soil quality in many countries.

In March 2020, the *European Joint Program EJP SOIL* was set up, comprising a network of 26 institutes in 24 European countries, with Norway represented by NIBIO.

EJP SOIL is busy identifying knowledge gaps and differences between existing regional and national activities. When the methods of climate-smart and sustainable agricultural soil management in the

participant countries are known, it will be easier to ascertain what the problems are.

“We will create a road map showing how to manage soil in the best possible way. This could be used strategically by European decision-makers,” says senior researcher Daniel Rasse, who heads the Norwegian part of EJP SOIL’s work.

“If we manage soil correctly, we can protect it and amplify the effect it has on ecosystem services. Climate-smart soil management can also help to reduce climate change thanks to soil’s carbon storage properties.”

EJP SOIL will develop coordinated and readily available information about soil, thereby helping to communicate knowledge about European agricultural soil. The hope is that it will strengthen interdisciplinary ties across the soil research community, as well as making it easier for these scientists to communicate with the industry and become more involved in soil management work.



Goal: Identify sustainable solutions for how to manage agricultural soil in a changing climate.
Funding: The Research Council of Norway
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Photo: Morten Günther

Do reindeer cause crop damage in winter?

In some areas, semi-domestic reindeer grazing on cultivated land can lead to major conflicts between the reindeer husbandry and agriculture industries. The disputes tend to centre around who is responsible, and who should pay for any reduction in crop. Thus, the question is: Do reindeer that graze on cultivated land cause loss of crop, and if so, what is the extent of this loss?

Reindeer live outdoors all year round, making use of whatever natural grazing resources they find. In winter, reindeer look for green plants, lichen, cordgrass, heather and shoots. If food is scarce, they may dig down through the snow on cultivated land in search of the green parts of grass that lie on or beneath the surface of the soil.

The reindeer husbandry industry has grazing rights on open rangeland in Sami reindeer grazing areas, but not on cultivated land, although this can be difficult to enforce. Section 28 of the Reindeer Husbandry Act states: “The reindeer shall be kept under supervision to prevent them, as far as possible, from causing damage, roaming outside their lawful grazing area or mixing with other reindeer.”

Even if reindeer are chased off cultivated land or moved some distance away, the herd may quickly move back and graze on the infields. Fencing is effective but expensive. NIBIO’s researchers have calculated the extent of crop loss caused by reindeer after grazing on cultivated land in the winter and spring 2019 at Dønna. The results did not show any significant reduction in crop due to reindeer during this period.

However, the researchers are cautious about generalising these results. Several studies are needed, over several years and in different locations, to be able to draw firm conclusions about whether reindeer grazing on cultivated land cause loss of crop.



Goal: To investigate whether reindeer that graze on cultivated land during winter and spring cause any crop reduction, and if so, what is the extent of this.

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Photo: Erling Fløistad

“Worms in apples” throughout the country

A shortage of rowanberries has caused apple fruit moths to attack apple trees all over the country in 2020. Not since 1994 have there been such extensive attacks — with up to 100% of crops being damaged in many orchards.

The culprit is the apple fruit moth, which has been considered the most serious apple pest in Norway since the late 1890s. Apple fruit moths prefer rowanberries, but in years with a shortage of berries they can invade apple orchards and cause attacks on apples.

NIBIO has developed a national forecasting model for apple fruit moth attacks. Among other things, the system can predict damage in apples and give advice as to exactly when to apply measures. The model is based on ecological data which can vary locally, and information has therefore been collected from around 50 stations all over the country.

There is little knowledge on survival and development of apple fruit moth larvae in apples. That makes it difficult to provide forecasts for the following year after severe attacks in apples. NIBIO researchers would therefore like to investigate further.

Gunnhild Jaastad, a researcher at NIBIO, explains that in 2019 there were a lot of rowanberries in which the moths could lay their eggs. The adults hatched in the spring of 2020, but there was a shortage of rowanberries that year, and they moved into apple orchards to oviposit.

“Apples and rowanberries have a fairly similar smell. Together with Swedish researchers we have analysed the volatile components of apples and rowanberries and found that some of their components are the same,” says Jaastad.

They now want to study apple fruit moths and their survival in apples and have started a preliminary project together with the Norwegian Agricultural Extension Service.

If the moth survives and overwinters poorly in apples, there would not be a crisis before the next year with low fruit setting in rowan, normally in 2–3 years.



Goal: There is little knowledge about how well the apple fruit moth survives and develops in apples, which makes it difficult to make predictions of attack. NIBIO researchers would therefore like to take a closer look at this.

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Strandebarm, Hardanger

Photo: Kjersti Kildahl

Nine facts about Norwegian agriculture

We currently drink 89 litres of milk a year — half as much as 30 years ago. We eat 18 kilos of cheese and 67 kilos of meat. That is 5 kilos more cheese and almost 20 kilos more meat than in 1988. Organic agriculture decreases, while sale of organic food increases.

These figures were published in NIBIO's annual publication *Norwegian Agriculture, Status and Trends*.

Number of farms halved in 30 years: In 2018, there were 39,600 farms in Norway, compared to 99,400 in 1989. *Production volume remained the same.*

Bigger farms: In 1999, the average farm had 36,3 acres of agricultural land. In 2018 the average was 61,5 acres. *Land area per farm grows steadily larger.*

Rented land is important: Around 45% of agricultural land is rented. *Bigger operators need more land, thus rented land increases.*

Less milk production: The number of dairy cows went down from 391,100 in 1980, to 217,500 in 2018. *Reduced milk consumption and higher productivity per cow explain the change.*

Meat consumption doubled in 40 years: Total consumption of beef/veal, mutton/lamb, pork and

poultry nearly doubled from the early 1980s, to 370,000 tons in 2017. *Poultry and pork stand for most of the increase.*

Lamb/mutton = low profit: The number of winter-fed sheep increased by 9% from 2014 to 2017, after measures to stimulate more production. *Resulting in overproduction and reduced profit.*

Import dependency: Consumption of fruit and berries was 86 kilos per capita in 2018, of which 30 kilos were produced in Norway. *Norwegian growing conditions limit production and cause imports.*

Organic paradox: Organic agricultural land decreased by 17% from 2012 to 2018. Meanwhile, sales of organic produce increased by 8% from 2017 to 2018. *4.2% of Norwegian agricultural land was organic in 2018.*

Forests — 1% owns 1/3: Around 39% of the land area in Norway is forest. One-third of the productive forest is owned by 1,200 of 127,000 owners in total. *Ca. 90% of volume sold is felled and delimbed using machinery.*



Goal: To provide an overview of Norwegian agriculture through statistics from various sources.
Funding: Ministry of Agriculture and Food
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Photo: Johanna Skrutvold

Possible road salt alternative

NIBIO has been monitoring the streams into and out of the *Østensjøvannet* lake to find out whether sodium formate as a de-icing agent causes fewer environmental issues than standard road salt.

Because of the negative effects of road salt (NaCl), Oslo's Agency for the Urban Environment has been testing out more degradable de-icing agents on its network of roads and cycleways. One of the alternatives is sodium formate, a de-icing agent that is also used at airports. The de-icing agent has been tested out on roads near the *Østensjøvannet* lake near Oslo.

Project manager Johanna Skrutvold says that sodium formate does not appear to have caused more immediate environmental issues than road salt. This is despite the fact that formates can generate an increased organic load in water, because oxygen is needed to break it down. This can lower oxygen levels in water, particularly at the bottom, which is not ideal for the organisms that live there. However, in *Østensjøvannet* they do not appear to have reduced after the transition from standard salt to sodium formate as a de-icing agent nearby.

Because of the high load from wastewater and other pollution, oxygen levels in the lake are far from optimum when the lake is frozen over. However, *Østensjøvannet* is well equipped to deal with salt loads because it is long and shallow.

“This means that there is relatively good circulation, unlike in deeper lakes where there can be a permanent saltwater layer and poor oxygen levels at the bottom,” says Skrutvold.

She emphasises that only a small part of the total area has been studied over just two winter seasons. The volume of de-icing agent used is also small in relation to what is used on roads that also drain to *Østensjøvannet*, such as the E6. This means we are still not sure of the impact that large volumes of formate may have, and what the long-term effects of sodium formate use may be.



Goal: To gain increased knowledge about whether formates can replace road salt on cycleways without compromising access, traffic safety and the environment.
Funding: Oslo Municipality and Agency for the Urban Environment
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Photo: Erling Fløistad



Good plant health reduces food waste

If we are to increase food production in order to feed the world, the plants we produce must arrive in our kitchens in good condition. But plants have many enemies, and their growers are constantly encountering new challenges due to climate change and global trade.

With a growing global population and an increased interest in plant-based diets, good plant health is a hot topic. The UN designated 2020 as the International Year of Plant Health in order to raise awareness of the importance of good plant health. Because protecting plants also means protecting lives. Good plant health contributes to less hunger, less poverty, a better environment and good economic development in poorer parts of the world.

“All plants have enemies that can attack directly or compete with plants for their space. If you do not protect the plants in the field, many crops will be outcompeted by weeds, eaten by insects or will succumb to fungi, nematodes, viruses and bacteria. If we cannot control plant enemies, we could lose 60–70% of production,” says Arne Hermansen, director of NIBIO’s Division of Biotechnology and Plant Health.

“Measures can prevent attacks or act chemically or biologically to combat pests directly. We can also employ mechanical measures against weeds using harrows or plows. These measures can bring losses down to 15%. Basically, control at field level is one of the most important measures we have against food waste,” he adds.

Without measures, weeds have the biggest effect on crop volume. On a global basis, it is calculated that there would be a 34% reduction in crop yield if we do not take action against weeds.

“We have to promote measures that prevent problems from being transported across national borders. Unfortunately, we have examples of pests that have spread, with major consequences on crops,” says Hermansen.



Goal: Raise awareness of the significance of good plant health.
Funding: Ministry of Agriculture and Food
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Photo: Morten Günther

Geese plow over the country

V-shaped formations of geese in flight are an impressive sight. But after the migrating geese have moved on, many farmers are left facing major grazing crop damage to their cultivated land.

Every spring, thousands of geese arrive to rear this year's brood of chicks, or rest on the ground before flying on to their final destination. Geese can be fascinating, but they also create challenges — not least for many farmers.

During their migration, geese stopover for a while in regular resting places and stay there for a few days or even several weeks. Some stay in the breeding areas for up to seven months. Jo Jorem Aarseth, researcher and head of NIBIO's department Natural Resources and Rural Development, has found that crop damage from grazing geese is an increasing problem in many parts of Norway.

A single goose can eat up to one kilo of grass each day. They forage a lot because the feed has a very short passage time through their digestive system, with most of the fibre coming straight out again. This also means that geese leave a lot of droppings behind, which in turn reduces the nutritional quality of the cultivated land.

When a flock of around 100 greylag geese land on a meadow at dawn, it may be several hours before the farmer notices them and chases them away. By then the geese may have caused significant damage. Hundreds of geese on a meadow also trample the grass, which may mean this grass could be left behind during the harvest. The geese can also carry and spread seeds from unwanted plants like cow parsley. All in all, the damage can reach levels where it is a substantial burden for the farm economy.

Many people are not aware of how good goose meat is. It is not without reason that the greylag goose has been dubbed "a cow on wings." Geese may themselves be vegetarians, but now NIBIO researchers are busy preparing a cookbook of goose meat recipes in a project headed by NINA and the Norwegian Farmers' Union.



Goal: To promote goose meat as a delicacy.
Collaboration: Norwegian Institute for Nature Research (NINA) and Norwegian Farmers' Union
Funding: Fram Center
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Division of Forest and Forest Resources



Photo: Ellen Svalheim



Wildflowers and regional seed mixtures

More and more public agencies and private garden owners are replacing their immaculately kept lawns by colourful wildflower meadows. But establishing such a meadow is not necessarily that easy. Now researchers are providing advice on regional adaptations.

Anyone wanting to establish a wildflower meadow for the first time may have many questions. Where can you sow and what should you sow? And when things start to sprout and grow, how to identify what you sowed, and what you didn't sow?

Many of the plants in wildflower meadows perform poorly in competition with grasses and other fast-growing species. Therefore, wildflower meadow seeds should ideally be sown on dry and barren sandy soil.

Plants that do best under dry conditions, like sunny and stony roadside verges, include harebells, clammy campion, bird's-foot trefoil, field scabious, orpine and oxeye daisy. If you have a mold-rich or well-fertilized area, recommended plants are red clover, bird vetch, bush vetch, red campion, caraway, bladder campion and yarrow. All you need then is the patience to wait for a colourful meadow to appear.

It can take many years before the full biodiversity potential develops in a wildflower meadow. Ideally, plant or sow in additional species to slowly increase the diversity in your meadow as seeds become available.

Wildflower meadows generally involve little work compared to lawns. Meadows tend to be mowed only once a year, after the plants have produced seed. Allow the grass to dry on the ground until the seeds have fallen. You should then remove the hay to prevent the unwanted addition of nutrients.

Imported seed mixtures can contain species that we do not want in the Norwegian flora. Researchers therefore advise against imported wildflower mixes, and they are constantly working to provide regional alternatives. Regional seed mixes containing Norwegian wildflowers are based on collections at NIBIO's research centres across the country.



Goal: The goal of seed production at NIBIO Landvik is to be able to offer regional seed mixtures from natural wildflower meadows for use in different parts of Norway.

Collaboration: University of Bergen, Norwegian Agricultural Extension Service Viken

Funding: Norwegian Agriculture Agency, Norwegian Environment Agency, Agder County Authority, County Governors of Rogaland, Vestland, Innlandet, Møre og Romsdal, Trøndelag, Nordland, Troms and Finnmark

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NIBIO

NORWEGIAN INSTITUTE OF
BIOECONOMY RESEARCH

Bioeconomy is based on the utilization and management of biological resources from land and sea. The institute aims to contribute to food security and safety, sustainable resource management, innovation, and value creation through research and knowledge production within food, forestry, and other biobased industries. The institute aims to deliver research, management support and knowledge for application in national emergency preparedness, businesses and society at large. NIBIO aims to be the national leader in the development of knowledge about the bioeconomy.

NIBIO is subject to the Ministry of Agriculture and Food as an administrative agency with special authority and its own board. The head office is in Ås, just outside Oslo. The Institute has several regional units and a branch office in Oslo.

The Norwegian Institute of Bioeconomy Research (NIBIO) was founded on July 1, 2015, as a merger of the Norwegian Institute for Agricultural and Environmental Research (Bioforsk), Norsk institutt for landbruksøkonomisk forskning (NILF), and the Norwegian Forest and Landscape Institute.

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