

Green Knowledge

36 examples from NIBIO's activities in 2025



Green Knowledge

36 examples from NIBIO's activities in 2025

Editor: Camilla Baumann

Title: Green Knowledge – 36 examples from NIBIO's activities in 2025

Written contributions: Hege Ulfeng, John Olav Oldertrøen, Kathrine Torday Gulden, Lars Sandved Dalen, Liv Jorunn Hind, Silje Kvist Simonsen and Siri Elise Dybdal from NIBIO. In addition, there are contributions from Georg Mathisen (Freelancer for NIBIO), Janne Karin Brodin (Norwegian University of Science and Technology), Janne Nordlund Othén (Swedish University of Agricultural Sciences), Wenche Aale Hægermark (NOFIMA) and Kartverket.

Photo editor: Erling Fløistad

Lead editor: Ragnar Våga Pedersen

Cover photograph: Silje Kvist Simonsen

NIBIO BOOK 12(1) 2026

ISBN: 978-82-17-03969-3

ISSN: 2464-1189

This is a translation of the original Norwegian publication "Grønn kunnskap – 36 smakebiter fra NIBIOs virksomhet i 2025", NIBIO BOK 12(1) 2026. ISBN 978-82-17-03916-7

Production: Aksell AS – aksell.no

www.nibio.no



Preface

In *Green Knowledge 2025*, NIBIO presents a small selection of our research and knowledge development within agriculture, forestry, environment, natural resources and the bioeconomy. The report shows how research, data and analysis contribute to sustainable solutions for society, public administration and business – in Norway and internationally.

Green Knowledge 2025 is firmly anchored in NIBIO's strategy and our three overarching goals: to be a clear agenda-setter in addressing major societal challenges, to develop knowledge that provides solutions of societal value, and to strengthen competitiveness in the bioeconomy. Through examples from across the institute, the report illustrates how research can be translated into practically applicable knowledge – from the farmer's field and individual trees in the forest, to municipal climate action and national decision-making frameworks.

This year's edition spans a wide range of topics: from plant health, soil health and food security to climate and land-use accounting, circular resource use, technological development and preparedness. Taken together, the cases illustrate how NIBIO's interdisciplinary expertise helps address climate change, biodiversity loss, pressure on land resources, and the need for increased self-sufficiency and stronger value creation.

Sustainable development depends on collaboration between research, public administration, business and society. The report offers a glimpse into NIBIO's extensive portfolio of projects and publications, demonstrating how knowledge is a prerequisite for the green transition. Guided by the vision *Vital knowledge for society and nature*, NIBIO works every day to strengthen the knowledge base for decisions made today – decisions that will have consequences for future generations.

We hope *Green Knowledge 2025* provides insight, inspiration and a deeper understanding of how research can contribute to a more sustainable and competitive future.

Enjoy the reading.

Ivar H. Kristensen
Director General

This is NIBIO



Division of Food Production and Society

The division is the country's leading and largest research environment in the primary sector of Norwegian land-based food production, encompassing both natural and social science disciplines. Here, knowledge is developed on input factors, farming practices, environmental impacts, and yields in crop and livestock production for the benefit of management, industry, and society. Additionally, research and development at the intersection of the green and blue sectors, which is an area of growth within the division, are also conducted.



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. 760

Estimated turnover for 2025 was 1.000 mill.

Number of international projects are approx. 100, of which approx. half are EU related (28 are Horizon Europe projects).

Present in all regions of Norway

Contents

Preface.....	3	From Greenhouse Gases to sustainable energy	25
This is NIBIO	4	Climate-resilient cultivation of winter cereals	26
		Cover crops are the key to healthier soils	27
Clearer land-use view with National base map	8	How do we ensure good soil health in Norway?.....	28
Old-growth forest mapped	9	Grazing reduces climate footprint	29
NIBIO leads national mapping research forum	10	Healthy seed potatoes combat Potato virus Y	30
Sámi reindeer herding – climate & land use.	11	Hunting for genetic variation in strawberry.....	31
Less potential arable land in Norway	12	More accurate date labelling cut food waste.....	32
Greenhouse gas accounting: LULUCF	13	Prevent pesticides from reaching groundwater	33
New national greenhouse gas calculator	14	Hunting cancer-inhibiting compounds at sea	34
Automation of forestry	15	Forever chemical detected in water sources.....	35
Patch spraying of weeds in cereals with AI.....	16	Effective measures against nitrogen runoff	36
New sensor tackles uneven fertilising	17	New guidance on leachate management.....	37
Boosting Norwegian food wheat requires action	18	Agriculture drives value and jobs in the north.....	38
New maps reveal Norway's veggie potential.....	19	How Malawi farmers get plant health advice	39
Potential to double fruit and veg	20	SRI boosts rice yields for Tanzania farmers	40
Many options with faba beans and peas	21	Cabbage root flies threaten Arctic agriculture	41
54 tonnes of waste wood show reuse potential.....	22	Good apple trees start underground	42
Underutilised wood makes buildings greener	23	Prevents inbreeding in rare cattle breeds	43
Measures that could make Norway more circular	24		







Photo: Iver Daaland Åse, Kartverket

Clearer land-use view with National base map

In February 2024, Norway received its first national base map for land-use analysis, developed by NIBIO, the Norwegian Mapping Authority (NMA), Statistics Norway (SSB) and the Norwegian Environment Agency (NEA). In 2025, the parties signed a cooperation agreement securing the management and further development of the map.

The base map provides a common, quality-assured data foundation for analyses and land-use accounting at all levels, making it easier to make knowledge-based decisions about land use.

This agreement marks an important step towards knowledge-based management of Norway's land and natural resources. By combining data, a better overview and insight is gained, allowing to make smarter decisions.

The base map integrates information on land cover, land use and ecosystems from several national sources into a single view. This provides authorities with a tool to establish local and regional land-use accounts and gives a clearer picture of the consequences of land conversion and changes. NIBIO has daily responsibility for implementing the cooperation agreement and serves as secretariat for the steering group, while SSB and NIBIO share production responsibility for the dataset.

As part of the collaboration, digital mapping solutions are also being developed to give users access to up-to-date information. NMA distributes the base map via geonorge.no, and NEA is responsible for ecosystem classification.

"The base map gives us, for the first time, a comprehensive overview of ecosystem distribution. The map will form a cornerstone of the natural capital accounts, which is the tool we need to monitor developments in nature," says Torfinn Sørensen from NEA.

The collaboration lays the foundation for further innovation in digital mapping and land management, providing decision-makers with an updated tool for managing the country's land down to the municipal level.



Purpose: Ensure a unified, up-to-date and quality-assured national base map for land-use analysis, providing better decision-making support for land use across Norway.

Collaboration: Norwegian Mapping Authority, Statistics Norway and the Norwegian Environment Agency

Contact: Research Scientist Linda Aune-Lundberg, Division of Survey and Statistics.
Email: linda.aune-lundberg@nibio.no | Phone: +47 995 78 533



Photo: Arne Steffenrem

Old-growth forest mapped

New nationwide maps provide better knowledge of old-growth forest.

In February 2024, the Norwegian Environment Agency was tasked with producing the first version of a publicly available map of existing old-growth forest, defined as forest that has not been clear-cut since around 1940. The work resulted in three maps, each representing a different approach to mapping old-growth forest.

The first map follows the definition of old-growth forest given in the mandate. It shows an overview of forest established before 1940 that has not been clear-cut since.

The second map shows forest areas established before 1940 where no interventions or management have been recorded since around 1965. The map indicates the likelihood that the forest meets these criteria.

The third map shows the degree of old-growth forest characteristics across seven classes, from the least old-growth-like to the most. The classification is based on old-growth indicators described using a set

of variables from *Nature in Norway 3.0*: proportion of dead wood, variation in dead wood, and forest development.

The new old-growth forest maps were developed using remote sensing data, i.e., satellite imagery and airborne LiDAR, combined with machine learning and computer modelling. The maps are raster-based with a pixel size of 16×16 metres, making them compatible with the SR16 Forest Resource Map.

According to the National Forest Inventory, approximately 2.5 per cent of Norway's forest is highly old-growth-like, while around 40 per cent has a low degree of old-growth characteristics. In addition, the inventory has increased plot density in protected areas to better monitor development there.

Data from the National Forest Inventory have great potential for mapping biodiversity, ecological condition or old-growth characteristics. This will also enable projections of future forest development.



Purpose: New nationwide maps provide better knowledge of old-growth forest.

Collaboration: Norwegian University of Life Sciences, Norwegian Institute for Nature Research, Natural History Museum, University of Oslo

Funding: Norwegian Environment Agency

Contact: Research Scientist Marius Hauglin, Division of Forest and Forest Resources.
Email: marius.hauglin@nibio.no | Phone: +47 994 59 839



Photo: Erling Fløistad

NIBIO leads national mapping research forum

NIBIO research scientist Jonathan Rizzi has been elected to lead the national R&D forum for geographic information. The aim is to strengthen research on geospatial data so that Norway is ensured high-quality maps that are accessible to everyone who needs them.

The national R&D forum has been established under the Norway Digital collaboration, a partnership between organisations responsible for producing georeferenced information or that are major users of such data. It will bring together research environments and public-sector actors to ensure that Norway has up-to-date and accessible map data.

“Without good maps, Norway stops,” says Dr Rizzi.

Maps and geographic information are essential for spatial planning, emergency preparedness and environmental management. NIBIO plays a central role in Norway Digital, both as a provider of georeferenced information and as a developer of systems and services. The collaboration ensures the free flow of data between public bodies and facilitates efficient use and sharing of map data.

Dr Rizzi highlights three main challenges: map data must be up to date and of high quality, easily accessible, and well protected against misuse.

Research into new technologies such as drones, satellites and artificial intelligence can make data collection and analysis more efficient. At the same time, data systems must be interoperable, and information must be available to the right person at the right time – without critical societal information falling into the wrong hands.

Norway has more than 30 years of experience in collaboration on map data, and NIBIO has been a driving force in this development, together with the Norwegian Mapping Authority and other actors.

“What we now need is greater participation from universities and research institutes. We need expertise across disciplines,” Rizzi concludes.



Purpose: Strengthen research on geographic information so that Norway has up-to-date, accessible and secure map data for the benefit of society.

Contact: Research Scientist Jonathan Rizzi, Division of Survey and Statistics.
Email: jonathan.rizzi@nibio.no | Telephone: +47 483 47 537.



Photo: Erlend Winje



Sámi reindeer herding – climate & land use

It is widely agreed that Sámi reindeer husbandry requires protection. Nevertheless, reindeer herders must often fight to protect the grazing resources of their animals, and thereby to safeguard their own cultural heritage, identity and future.

Reindeer herders follow the animals on their seasonal migrations throughout the year – from winter pastures to calving areas, to summer pastures and back again to winter grazing. They are in constant movement along traditional migration routes that are well known to both the reindeer and the herders, crossing municipal and county boundaries, and sometimes national borders.

However, modern reindeer husbandry faces pressures from private, municipal and national land-use measures, predators, outdoor recreation, tourism, as well as climate-related challenges that require new knowledge and adaptation.

“Many people in the reindeer husbandry sector want to meet to discuss key issues such as climate and land-use conflicts. The Nordic Reindeer Husbandry Conference has become an important meeting place

for discussing the challenges in the sector,” says Dr Gabriela Wagner.

“Much of our research is based on close collaboration with reindeer herders, and some projects are initiated directly by them,” says Dr Svein Morten Eilertsen.

One example is herders who operate across several municipalities, where it can be very demanding to stay updated on all ongoing planning processes. Many herders experience that their input is given only limited consideration.

NIBIO has examined how reindeer husbandry has been involved in various assessment processes related to planned land-use interventions in grazing areas. The result is a proposed methodology for assessing impacts on reindeer husbandry.



Purpose:	NIBIO has developed a proposed new methodology for assessing the impacts on reindeer husbandry in plans involving land-use interventions in reindeer grazing areas.
Collaboration:	Active reindeer herders, the land-use service of the Norwegian Sámi Reindeer Herders' Association, Sweco, Norconsult, the County Governors of Nordland and Trøndelag, and the Norwegian Public Roads Administration
Funding:	Ministry of Agriculture and Food
Contact:	Research Scientist Gabriela Wagner, Division of Forest and Forest Resources. Email: gabriela.wagner@nibio.no Telephone: +47 950 06 940. Research Scientist Svein Eilertsen, Division of Forest and Forest Resources. Email: svein.eilertsen@nibio.no Telephone: +47 934 99 412.



Photo: Kjetil Fadnes

Less potential arable land in Norway

A new review from NIBIO shows that Norway has less potential arable land than previously assumed. The update of the potential arable land map provides a more precise picture of which areas can be cultivated.

Only 3.7 percent of Norway's land area is agricultural land. Potential arable land is land that can potentially be cultivated in the future, but much of the mapped potential arable land is no longer suitable for cultivation due to changes in legislation and practice.

Good maps of cultivated and potential arable land are important so that management can enforce the Land Act. The law states that neither potential arable nor cultivated land can be used in a way that makes it unsuitable for food production in the future. In cases of significant societal benefit, exemptions may be granted.

"Much of the land that was mapped as potential arable is no longer suitable for cultivation. In the revised map, we have marked such areas, so this is clearly shown," explains Lead Engineer Kjetil Fadnes at NIBIO.

Peatlands are no longer available for new cultivation following the 2019 prohibition. Areas in national parks, nature reserves, and ravines are also marked with special provisions. The current reserve of potential arable land has been reduced to about eight million decares, down from twelve million previously. More than half of this reserve is in cold climate zones where food grains cannot be grown.

The map is now updated to vector data with smooth lines and better alignment with other map layers.

"The potential arable land map shows that it is not a good strategy to build over farmland and believe that new areas can be cultivated elsewhere. The reserve of land that can be cultivated is limited," Fadnes emphasises.

NIBIO's work provides management with a better tool for preserving farmland and planning future land use.



Purpose: Update the map of potential arable land in Norway to provide a better knowledge base for management, soil protection, and food security.

Contact: Lead Engineer Kjetil Fadnes, Division of Survey and Statistics.
Email: kjetil.fadnes@nibio.no | Phone: +47 906 01 894.



Photo: Erling Fløistad



Greenhouse gas accounting: LULUCF

The greenhouse gas accounting for LULUCF (Land use, Land use change and forestry) provides municipalities with insight into emissions and removals from forests and other land uses.

The most significant source of greenhouse gas emissions is the use of fossil energy sources such as oil, gas, and coal. However, how we manage forests and other natural areas also plays a major role in how the concentration of greenhouse gases in the atmosphere will develop in the years ahead.

To mitigate climate change, Norway has committed to reducing greenhouse gas emissions by at least 50 percent by 2030 compared with 1990 levels. This target applies to emission sectors such as waste, energy, industry, and agriculture. In addition, comes LULUCF, which includes emissions and uptake from terrestrial areas.

To track this, the country submits a national account of greenhouse gas uptake and emissions every year. The municipality-level greenhouse gas accounting for LULUCF has been developed by NIBIO in collaboration with the Norwegian Environment Agency and can help Norwegian municipalities prioritise measures to reduce greenhouse gas emissions linked to land use and land-use changes.

Land use changes are a big contributor to emissions, and this is especially the case when the land use changes from forest and peatland to other land use.

“Preventing development and new cultivation in forests and on peatlands are effective measures to reduce emissions,” says NIBIO Senior Adviser Katharina Hobrak.

“Municipalities decide how land areas are used. Therefore, it is important that we now also have land-use and greenhouse gas accounting for each individual municipality.”



Purpose: To help Norwegian municipalities prioritise measures to reduce greenhouse gas emissions linked to land use and land-use changes.

Collaboration: Norwegian Environment Agency

Funding: Norwegian Environment Agency

Contact: Senior Adviser Katharina Hobrak, Division of Forest and Forest Resources.
Email: katharina.hobrak@nibio.no | Phone: +47 452 00 883



Photo: Kjetil Fadnes

New national greenhouse gas calculator

The new greenhouse gas calculator helps municipalities gain knowledge of the climate impacts of their land-use plans.

Changes in land use, such as new roads, housing developments, and industrial areas, are a significant source of greenhouse gas emissions. The loss of natural areas is also the greatest threat to biodiversity in Norway.

In the Climate Report 2035 (Meld. St. 25 (2024–2025)) and the national planning guidelines for climate and energy, the importance of reducing the loss of carbon-rich areas is highlighted, and this is to be prioritised in land-use planning. The national planning guidelines state that the government shall provide updated knowledge, tools, and guidance on carbon-rich areas, and that municipalities shall use this knowledge in their planning.

NIBIO has now developed a calculator to make it easier to calculate greenhouse gas emissions associated with planned land-use changes. The Norwegian Environment Agency and NIBIO have established a collaboration to ensure that the calculator is freely

available, covers the entire country, and is continuously updated. The greenhouse gas calculator will be the state's recommended tool for obtaining knowledge about greenhouse gas emissions from planned land-use changes.

Around 70 municipalities have tested the calculator so far, with positive results. In 2026, all Norwegian municipalities, applicants, and consultants working on planning and assessments will have access to the greenhouse gas calculator on NIBIO's website, as part of the guidance provided in the national planning guidelines and the Norwegian Environment Agency's handbook for climate and environmental impact assessments (M-1941).

“This will become an important decision-making tool when municipalities need to consider climate in land-use planning,” says Senior Adviser Henrik Forsberg Mathisen at NIBIO.



- Purpose:** The new municipal greenhouse gas calculator is intended to help municipalities visualise the climate consequences of their land-use plans.
- Collaboration:** Norwegian Environment Agency
- Funding:** Norwegian Environment Agency
- Contact:** Senior Adviser Henrik Forsberg Mathisen, Division of Survey and Statistics.
Email: henrik.forsberg.mathiesen@nibio.no | Phone: +47 959 60 161



Photo: Steffan Lloyd

Automation of forestry

Self-driving brush cutters and drones that transport and plant in difficult-to-access terrain: NIBIO researchers are exploring the potential for increased robotisation and the use of drones in forestry.

Robotics is a newer research field at the intersection of mechanical, electrical, and software engineering. And although demand for robots in forestry is not high at present, it is an important area of research.

In the future, these new tools could make forestry and timber harvesting more environmentally friendly, for example by reducing ground damage during planting and harvesting.

One example is larger transport drones that can lift heavy loads in or out of difficult-to-access areas – such as delivering plants to a planting site or transporting timber from the felling site after harvesting.

“More selective harvesting on smaller areas will require smaller machines. Developing smaller harvesting machines and forwarders for small-scale forestry could be of great benefit,” says Stephan Hoffmann, researcher in forest operations and digitalization at NIBIO.

Another example is autonomous brush cutters that could, over time, assist forest owners in clearing smaller areas in connection with tree planting. The long-term goal is for the tractor to navigate the terrain using its onboard sensors, like a self-driving car.

In the EU project *Small4Good*, coordinated by NIBIO, the aim is specifically to assist smaller forest owners in Europe with the management of their properties.

Through so-called “Living Labs” across Europe, and in collaboration with local forest owners, researchers are exploring ways to manage forests sustainably. This could include more varied, multifunctional management of forest properties, digital innovation, and opportunities to generate income from ecosystem services beyond timber harvesting.



Purpose:	To develop technology for sustainable forestry.
Collaboration:	Forestry industry, forest owners, forest owner organisations, and research institutions in Europe
Funding:	The Research Council of Norway and Horizon EU
Contact:	Research Scientist Steffan Lloyd, Division of Forest and Forest Resources. Email: steffan.lloyd@nibio.no Phone: +47 455 05 896



Photo: Therese With Berge



Patch spraying of weeds in cereals with AI

Precision spraying with a high-tech sensor system not only reduces the use of herbicides in winter cereals but also maintains, or even improves, crop quality.

In the *PresiHøstkorn* project, NIBIO has investigated how winter cereal yields are affected when using the DAT Ecopatch sensor system from Dimensions Agri Technologies AS. The system is mounted on a field sprayer and distinguishes between crops and weeds, so spraying occurs only where necessary.

Dr Therese W. Berge explains that the camera uses artificial intelligence to control the sprayer according to a chosen damage threshold.

The project has studied how effectively weeds are controlled, the quality of the cereal crop, and how much herbicide can be saved.

“The good news is that yields are maintained compared with conventional practice, where the entire field is sprayed at the standard dose. The yield is at least as good, and in two out of six fields, we achieved higher yields,” says Dr Berge.

The trial has shown that it is possible to save very large amounts of herbicide with camera-controlled spot spraying in cereals – up to 90 percent, depending on the threshold setting.

“The use of AI has made the system much more robust. It has been difficult to get classical machine vision to work reliably and consistently,” she says.

Several farmers have already adopted the system. The sensor can also be purchased integrated into new sprayers via Kverneland.

Dr Berge emphasises that precision spraying is important in integrated pest management: chemicals are applied only where needed, which can reduce resistance while providing resources for beneficial organisms. It can be highly useful for farmers who want to combine efficient crop production with improved environmental stewardship.



Purpose:	To develop and test AI-driven precision spraying that reduces herbicide use while ensuring high yield and quality in cereal fields.
Collaboration:	Dimensions Agri Technologies AS (DAT), Norwegian Agricultural Advisory Service
Funding:	“Action Plan for Sustainable Use of Pesticides,” administered by the Norwegian Agriculture Agency
Contact:	Research Scientist Therese With Berge, Division of Biotechnology and Plant Health. Email: therese.berge@nibio.no Phone: +47 922 93 927



Photo: Erling Fløistad

New sensor tackles uneven fertilising

Norwegian farmers face challenges with non-uniform spreading of mineral fertiliser, particularly on undulating fields. This has consequences for both the economy and the environment. NIBIO is collaborating with entrepreneurs on new solutions.

Measurements show that centrifugal fertiliser spreaders often apply too much fertiliser along slopes and too little over hilltops, leading to reduced yields and greater risk of runoff.

Entrepreneurs Ole Kind and Ole Mørch have developed a simple sensor that measures the tilt angle between spreader and tractor, sending results to an app. Together with NIBIO, they mapped the extent of the problem and found that large areas of Norwegian farmland may be at risk of uneven fertilisation.

“The more we worked on this, the more convinced we became that these angles can have major consequences for both farmers’ economy and the environment,” says Ole Kind from Soilmate. The sensor lets farmers adjust the spreader and tractor angle in real time, ensuring more even distribution – also on steep terrain.

NIBIO has contributed advanced terrain analyses.

“According to our model, 35 percent of agricultural land in Nannestad and 30 percent in Rakkestad has uneven terrain that may affect fertiliser spreading,” says researcher Svein Olav Krøgli. He sees great potential in combining terrain data with knowledge about environmental effects.

The innovation shows how cooperation between industry and research can improve precision, strengthen farmers’ finances, and reduce environmental impacts.

Kind and Mørch are not finished in their quest for more knowledge. Several future projects may explore spreader settings, fertiliser type, and application rates to further improve precision, strengthen farmers’ finances, and minimise environmental impact from Norwegian agriculture.



Purpose:	To develop and test new technology for more precise and environmentally friendly fertiliser spreading in Norwegian agriculture, in collaboration with industry partners.
Collaboration:	Norwegian Agricultural Advisory Service, Yara, Felleskjøpet, Norwegian University of Life Sciences
Funding:	Forregion Vestfold Telemark
Contact:	Research Scientist Svein Olav Krøgli, Division of Survey and Statistics. E-mail: svein.olav.krogli@nibio.no Telefon: +47 469 20 837



Photo: Erling Fløistad



Boosting Norwegian food wheat requires action

A scenario analysis shows that increasing Norway’s production of wheat for human consumption requires active efforts from both the value chain and policymakers to avoid stagnation.

There is broad political agreement on raising Norway’s food selfsufficiency from 40 to 50 percent, driven by geopolitical instability, climate change, and technological change.

Domestic cereals for human consumption typically cover 40–80 percent of demand, with wheat as a key crop.

“The share has reached almost 80 percent in years with good wheat quality, but last year it fell into the 30s due to weather,” says Einar Strand, Senior Adviser at NIBIO.

Strand is among the authors who, for the Norwegian Partnership for Food Grains and Plant Proteins (Matkornpartnerskapet), contributed to a scenario analysis of possible development paths for Norway’s wheat production for human consumption.

Risk of stagnation

Matkornpartnerskapet aims to increase the overall share of domestically produced food grains to 90

percent by 2040. Achieving this will require alignment between the value chain and political decision-making.

The partnership has developed and analysed six scenarios exploring how geopolitics, climate change, technological advances, industrial development, and local farm structures may affect Norway’s production of wheat for human consumption. Based on these factors, researchers assessed alternative futures for increasing, environmentally adapted, and more robust Norwegian wheat production.

A key finding is that current driving forces are likely to lead to stagnation unless the value chain – industry, market actors, and policymakers – take coordinated, proactive steps to shift development in a more positive direction.

“Increased Norwegian wheat production must be marketdriven, based on stronger demand for Norwegian food grains,” Strand concludes.



Purpose:	The Partnership for Norwegian Food Grains and Plant Proteins highlights how the use of Norwegian food grains and plant proteins for human consumption can be increased.
Funding:	Matkornpartnerskapet
Contact:	Senior Adviser (Retired – consultancy agreement) Einar Strand, Division of Food Production and Society. Email: einar.strand@nibio.no Phone: +47 452 86 870



Photo: Hege Ulfeng

New maps reveal Norway's veggie potential

New, detailed maps from NIBIO show where in the country it is best to grow carrots, beans, and lettuce. The maps reveal a considerable potential for increasing Norwegian vegetable production, both on cereal areas and grassland.

“These are Norway’s most detailed maps for showing natural growing conditions for vegetables. They provide a solid knowledge base for the entire value chain, from the idea of growing a crop to it reaching the shop shelves,” says Siri Svendgård-Stokke, Head of Department at NIBIO.

The maps are based on updated climate data, soil information and a new terrain model. NIBIO has mapped around 60 percent of Norway’s fully cultivated land, with detailed information on soil type, stone content and drainage needs. The vegetable maps show the areas best suited for different crops, and which soil and terrain properties may pose challenges.

Steep land, or areas with high stone and gravel content, are poorly suited to efficient vegetable production – as are very small plots. Even so, large areas now used for cereals and grass could have been used for vegetables.

Analyses show that only 0.8 percent of Norway’s fully cultivated land is used for vegetables today, even though far larger areas have favourable conditions. For beans, which need a long season, over 600,000 decares have good natural conditions – almost ten times today’s total open-field vegetable area.

“It is incredibly valuable that we now have detailed maps showing the potential for Norwegian vegetable production. The next step is motivating people to choose healthier, greener diets,” says NIBIO researcher Anna Birgitte Milford.

Even with good growing conditions, the market remains a bottleneck. Profitable production requires buyers.



- Purpose:** To provide a knowledge base for increasing vegetable production in Norway through detailed opportunity maps for vegetables.
- Collaboration:** The Norwegian Agricultural Advisory Service and the Norwegian Meteorological Institute. BAMA Gruppen AS, Gartnerhallen AS and Felleskjøpet have also contributed input to the work.
- Funding:** The Research Council of Norway
- Contact:** Head of Department Siri Svendgård-Stokke, Division of Survey and Statistics.
Email: siri.svendgard-stokke@nibio.no | Tel: +47 478 14 011.



Photo: Ragnar Våga Pedersen



Potential to double fruit and veg

Norwegian producers sell fruit, berries and potatoes worth around NOK 7.3 billion annually, accounting for 17 percent of value creation in Norwegian agriculture. The horticultural sector is more market-driven than the rest of farming and receives only 2.7 percent of the agricultural agreement funds.

According to the new dietary guidelines from the Norwegian Directorate of Health, we should ideally eat eight portions of fruit and vegetables a day.

“And what we eat should be as Norwegian as possible,” says Inger Martinussen, Head of Research at NIBIO.

She believes Norway can double its fruit and vegetable production.

“Only 23 percent of the apples we consume are Norwegian. For cucumbers the share is 78 percent. Potatoes are largest in both volume and share, at 87 percent,” Martinussen says.

The world's best tomato growers

NIBIO researchers have examined available land and where different vegetables can grow. For example, 45 percent of Norway's fully cultivated land is suitable for carrots. And Norwegian tomato growers produce more tomatoes per unit area than anyone else in the world.

Work is underway to make production more sustainable. Studies show a 45 percent reduction in emissions per kilo of tomatoes. Growers can use waste heat, nutrient-rich waste and CO₂ from other industries.

Knowledge, technology and the market

NIBIO's Director General, Ivar Horneland Kristensen, says the institute's goal is to develop the knowledge and technology needed to enable a doubling of fruit and vegetable production.

“This can involve anything from variety testing and production development to greenhouse technology. Our task is to bring new knowledge and methods to the forefront. The reason we are the best at producing tomatoes isn't natural conditions—it's the use of knowledge and technology,” he says, adding that a strong value chain is essential.



Purpose: Increase both the consumption and production of Norwegian fruit and vegetables.

Contact: Head of Department/Head of Research Inger Martinussen, Division of Food Production and Society. Email: inger.martinussen@nibio.no | Phone: +47 976 78 488.



Photo: Anne Marthe Lundby



Many options with faba beans and peas

New research shows that it is the seed's water content and developmental stage that determine how protein and carbohydrates are stored in faba beans and peas.

Through her doctoral research, Anne Marthe Lundby at NIBIO has provided valuable insights into seed development, the accumulation of protein and carbohydrates, and the maturation process in peas (*Pisum sativum* L.) and faba beans (*Vicia faba* L.) at northern latitudes. The study included both field trials and controlled climate experiments.

Her findings support the most common cultivation practice in Norway, where neither *Rhizobium* inoculation nor starter fertilisation is used when crops are grown in well-managed soils. Such soils already contain sufficient populations of *Rhizobium* bacteria. These bacteria form a symbiotic relationship with legume crops and fix nitrogen from the air.

Both faba beans and peas developed a higher number of nodules when supplied with *Rhizobium*. However, this had limited effects on yield and protein content in both crops. In faba beans, between 80 and 90 percent of the nitrogen came from atmospheric fixation.

Searching for the best varieties

Lundby's results show, among other things, that temperature affects the time needed for maturation, but the nutritional content of the seeds is the same when compared at similar developmental stages. In other words, seed quality remains stable, and this is good news for Norwegian growers.

"One of the biggest challenges in Norway, especially for faba beans, is the short growing season. It is therefore important to continue evaluating varieties through field trials in different parts of Norway, so we can identify those best adapted to various environments," says Lundby.

Breeding stable, medium-late varieties suited to Norwegian conditions may help expand the country's cultivation potential.



Purpose: To investigate and identify the best possible cultivation techniques for broad beans (*Vicia faba*) and peas in Norway.

Funding: The Research Council of Norway

Contact: Research Scientist Anne Marthe Lundby, Division of Food Production and Society.
Email: anne.marthe.lundby@nibio.no | Telephone: +47 995 74 752.



Photo: Kathrine Torday Gulden

54 tonnes of waste wood show reuse potential

Each year, large quantities of wood are discarded in Norway. How much of it could have been given a new life? Researchers in CircWOOD have investigated this by analysing 54 tonnes of post-consumer wood from three recycling stations in Eastern Norway and Trøndelag.

“Every single piece was sorted and assessed by type and quality,” says Kristina Bringedal Gedde, PhD candidate at NIBIO and NTNU. The aim was to determine how much of the material is suitable for reuse or material recycling – either by being used again as is or turned into new products.

The results show significant potential. At two industrial recycling stations, between 49 and 64 percent of the wood was structural timber or other untreated solid wood – materials that can, in principle, be used again.

At the household recycling station, the proportion was lower, around 32 percent. A clear trend is that wood from households tends to be of lower quality than industrial waste.

The researchers also encountered challenges with incorrectly sorted pressure-treated wood containing heavy metals, fibreboard, and wood painted with

lead paint, all of which cannot safely be used in new products without posing risks to health and the environment.

“This highlights an important area for improvement: better information and sorting systems for waste wood,” says Gedde.

Today, most used wood in Norway is sent for energy recovery through incineration. This produces energy, but the material resource is lost.

“By reusing more of the old wood, we can extend the lifespan of our resources and reduce the need for new, primary timber, which may become scarce in the future,” Gedde emphasises.

She believes there is considerable potential to make better use of waste wood – especially from industry – but this requires improved sorting, more knowledge and new systems.



Purpose: To identify the types of post-consumer wood delivered to Norwegian recycling stations and assess how much is suitable for reuse or material recycling.

Collaboration: Norwegian Institute of Wood Technology and Norwegian University of Science and Technology

Funding: CircWOOD (The Research Council of Norway, Green Platform scheme)

Contact: PhD Candidate Kristina Bringedal Gedde, Division of Forest and Forest Resources.
Email: kristina.gedde@nibio.no | Phone: +47 415 10 934



Photo: Kathrine Torday Gulden



Underutilised wood makes buildings greener

NIBIO is part of WoodStock that aims to develop climatesmart solutions for increasing the use of underutilised wood resources in Europe.

The construction sector accounts for around 40 per cent of global CO₂ emissions and consumes large amounts of nonrenewable resources. Traditional materials such as concrete and steel have a substantial climate footprint, whereas wood is renewable and stores carbon throughout its lifetime.

Despite this, wood is still rarely used as a building material in large parts of Europe, and both practices and regulations vary between countries. Resources such as broadleaved species and post-consumer wood are examples of materials that remain largely untapped.

To address this, NIBIO participates in the EU project WoodStock, a fouryear initiative launched in 2024 to boost the use of wood in construction and support a more circular economy. The project is linked to the European Commission's New European Bauhaus initiative for a greener built environment.

A key part of the project takes place in six "Living Labs" across Europe, where research and innovation are tested in real-life settings. The Norwegian lab is in Trondheim, with NTNU as the main partner.

"Here, researchers, industry, authorities and citizens work together on climatesmart ways to increase wood use in construction," says Lone Ross, acting division director at NIBIO.

The solutions will later be scaled up for use in different regions. Researchers will also study how countries use forest and wood resources and develop models showing the potential for greater use of wood in buildings.

"The project gives Norway a unique opportunity to help shape future climatesmart construction methods," says Ross.

"We will also learn a great deal from the experiences gathered in other European countries."



Purpose:	To develop knowledge and practical solutions that increase the use of wood in European buildings, helping reduce greenhouse gas emissions and promote a circular economy.
Collaboration:	Ghent University (Belgium), Delft University of Technology (Netherlands), Aalto University (Finland), University of Bordeaux (France), Norwegian University of Science and Technology NTNU (Norway), University of Galway (Ireland), Lodz University of Technology (Poland), University of Primorska (Slovenia), InnoRenew CoE (Slovenia), InnovaWood (EU), CEIBois (EU), WETA (Belgium)
Funding:	Horizon Europe (EU)
Contact:	Director Lone Ross, Division of Forest and Forest Resources. Email: lone.ross@nibio.no Phone: +47 911 97 268



Photo: Erling Fløistad

Measures that could make Norway more circular

In May 2025, the government-appointed expert group delivered the report *Not Straightforward*, containing 79 proposals aimed at reducing resource use and making reuse and sharing the norm in Norway.

“We have to bring consumption down, and we cannot subsidise our way to lower consumption,” says Thomas Hartnik, member of the expert group and Division Director at NIBIO.

According to the UN International Resource Panel, current consumption accounts for more than 90 per cent of biodiversity loss and depletion of water sources, and for half of global climate impacts.

In the report, the expert group proposes 79 policy instruments to make circular solutions profitable:

- **Taxes and incentives:** A levy on emissions from aquaculture combined with refunds for collected fish sludge, a plastics tax based on recycled content, and a textile tax.
- **Construction sector:** Requirements for circularity in public procurement, a tax on the extraction of sand and gravel, and maximum greenhouse gas emissions per m².

- **Product requirements:** Extended warranties of three years and requirements for recycled materials.
- **Repair scheme:** For electronics, white goods and textiles, financed by industry and public authorities.

“Many biological resources are currently underutilised because there are no economic incentives,” says Hartnik.

A clear example is the aquaculture industry, where there is currently no driving force to collect fish sludge. As a result, resources that could have been used for biogas, feed and fertiliser are lost.

In line with this, the expert group recommends, among other things, introducing requirements for the use of recycled phosphorus in fertilisers, improving oversight of biological resource flows, and steering agricultural support schemes more strongly towards climate-friendly solutions.



Purpose: Identify measures that contribute to reduced resource use and increased reuse and sharing.

Collaboration: Statistics Norway, SINTEF Ocean, University of Stavanger, Norwegian School of Economics, Borgarting Court of Appeal, Omtre AS

Funding: The Norwegian Government

Contact: Director Thomas Hartnik, Division of Environment and Natural Resources.
Email: thomas.hartnik@nibio.no | Telephone: +47 926 94 021



Photo: John Olav Oldertrøen



From Greenhouse Gases to sustainable energy

Using thin layers of microorganisms, known as biofilms, greenhouse gases can be converted into green bio-methane – a renewable energy source.

Carbon-containing gases are often associated with pollution, but researchers have shown that they can be transformed into useful energy carrier. Dr Lu Feng has contributed to a method that produces biomethane with over 96 percent purity, documented in five scientific articles.

A biofilm is a layer of microorganisms that work together to convert gases such as CO₂ and CO into green biomethane.

“The biofilm retains the microbes, improves gas–liquid transfer, and greatly increases the contact area for the reaction. In addition, the biofilm tolerates toxic substances that would otherwise inhibit biogas production,” he says.

The biofilm helps to control high levels of ammonia and hydrogen sulphide. These substances are often found in industrial gas streams and can be problematic in conventional bioreactors.

“In one of the studies, we tested how biofilm reactors handle hydrogen sulphide, a toxic gas that can significantly reduce methane production,” Dr Feng explains.

The results showed that systems without biofilm lost up to 30 per cent of the methane, while the biofilm reactors maintained high methane quality even at elevated concentrations of hydrogen sulphide.

The researchers also investigated the effect of the biofilm process on ammonia, which normally inhibits methane production. In this study, they used a type of reactor called an AnMBBR (Anaerobic Moving Bed Biofilm Reactor) and found that the biofilms were able to produce methane even at high ammonia concentrations.

The method also works on synthesis gas (syngas) from plastic waste and wood-based biomass, opening new feedstocks. The addition of hydrogen increased production but requires precise control.



Purpose: Develop methods using biofilm to convert greenhouse gases such as carbon dioxide and carbon monoxide into green biomethane.

Collaboration: Norwegian University of Life Sciences

Funding: The Research Council of Norway, BioSynGas and Bio4Fuels

Contact: Research Scientist Lu Feng, Division of Environment and Natural Resources.
Email: lu.feng@nibio.no | Telephone: +47 458 35 202



Photo: Silje Kvist Simonsen



Climate-resilient cultivation of winter cereals

In the ProHøst project, researchers from NIBIO have investigated how to achieve more stable production and better quality in Norwegian winter wheat.

Winter wheat can produce higher yields than wheat sown in spring, particularly under favourable and stable growing conditions.

“An increasingly unstable climate is just one of the challenges affecting wheat production,” Dr Annbjørg Kristoffersen. She leads the ProHøst project.

Wheat varieties must meet the industry’s quality requirements and be suited to grow under Norwegian conditions. Since each season varies, it is not always possible to achieve either an acceptable quality or successful overwintering. Part of the work has therefore involved identifying and testing varieties that are better adapted to Norwegian conditions.

Low temperatures and good light availability in autumn increase the plants’ chances of surviving the winter. Snow protects against cold, but if snow remains for a long time on unfrozen ground, the risk of fungal infection increases, particularly if the plants are large at the onset of winter.

“Trials have shown that spraying in autumn to control snow mould can increase both yield and quality in winter wheat,” says Dr Ingerd Skow Hofgaard.

Among the trials in ProHøst, minimal soil cultivation was tested through strip tillage and direct drilling when establishing winter cereals.

“Both methods produced good results and higher yields than ploughing in most cases. We also see that for good establishment it is crucial that the straw is chopped and evenly distributed prior to sowing,” says Dr Till Seehusen.

“Moreover – we see that the timing of when growth ceases in autumn has shifted. Depending on conditions, new recommended sowing times for winter cereals have therefore been established, Dr Kristoffersen concludes.



Purpose: Achieve more stable production and better quality in Norwegian winter wheat.

Collaboration: Norwegian University of Life Sciences, Nofima, Graminor, University of Minnesota, University of Hohenheim, Swedish University of Agricultural Sciences

Funding: The Research Council of Norway, Yara Norway, Strand Unikorn, Norgesmøllene, Fiskå Mølle Moss, Felleskjøpet Agri, Felleskjøpet Agri – Department of Agricultural Policy and Market Regulation, Norwegian Agro Machinery

Contact: Research Scientist Annbjørg Kristoffersen, Division of Food Production and Society.
Email: annbjorg.kristoffersen@nibio.no | Telephone: +47 406 30 331.



Photo: Jørgen Lervik

Cover crops are the key to healthier soils

A new study shows that cover crops with vigorous root systems improve soil structure, increase nutrient cycling and enhance carbon storage – without compromising yields.

Cover crops strengthen soil health and contribute to carbon sequestration, but until now little has been known about how these processes function under Nordic conditions.

A study led by NIBIO research scientist Dr Thiago Inagaki shows that the roots of cover crops are crucial for building stable organic matter in the soil, known as mineral-associated organic matter (MAOM). This forms when carbon from plant residues binds to minerals in the soil. When carbon is bound in this way, it breaks down more slowly and can be stored for many years – an important contribution to slowing climate change.

Trials at the Tuv experimental farm in Steinkjer show that cover crop mixtures with high root biomass, such as ryegrass and clover, store the most MAOM. More complex mixtures with species such as chicory and birdsfoot trefoil improve soil structure and support a greater abundance of microorganisms,

but the effects on carbon storage take longer to materialise.

“Instead of only measuring carbon content, we should promote biological activity that forms stable types of organic matter,” says Dr Inagaki.

The study showed that cover crops did not reduce barley yields, which may reassure farmers concerned about competition for nutrients.

Biochar had no noticeable effect on soil quality or yield but did not cause any negative effects. The work continues in the AgroMixNorth project, which examines how mixed cropping systems affect the nitrogen cycle and plant development. The aim is improved soil health and more sustainable cultivation systems in Nordic agriculture.

“We hope our findings can change the way we think about soil management in the Nordic region,” says Dr Inagaki.



Purpose: Investigate how cover crops affect soil quality under Nordic conditions.

Funding: NordForsk (via The Research Council of Norway) and the Norwegian Agriculture Agency

Contact: Research Scientist Thiago M. Inagaki, Division of Environment and Natural Resources.
Email: thiago.inagaki@nibio.no | Telephone: +47 922 65 448



Photo: Kathrine Torday Gulden

How do we ensure good soil health in Norway?

Soil health is about how well soil supports ecosystem services such as food production, nutrient recycling and biodiversity.

Soil in good health is physically, chemically and biologically balanced. However, erosion, soil compaction and the loss of organic carbon threaten this balance.

“We see erosion leading to the loss of valuable agricultural land, and soil compaction from heavy machinery that damages soil structure,” says Dr Frederik Norheim Bøe, who defended his PhD at Wageningen University in September 2025.

Dr Bøe has investigated how soil health can be assessed and improved under Norwegian conditions and has developed the first region-specific reference curves for Eastern Norway and Central Norway.

“The curves provide a basis for assessing the potential to improve soil health on a farm, by comparing it with others in the same region,” he says.

The assessments of soil health must be made within a local context, as the potential for improvement varies greatly depending on soil type, production system and regional conditions.

Documentation of measures such as diverse crop rotations, cover crops and reduced tillage under Norwegian conditions is limited. On-farm trials showed that such measures result in better soil structure and more life in the soil.

“In fields using these practices, four times as many earthworms were recorded compared with the conventionally managed field,” he says.

Plot trials with cover crops show that they can be established as far north as 64°N without reducing yields. A pure stand of ryegrass had a positive effect on phosphorus dynamics, while a diverse cover crop mixture led to more fungi in the soil.

“To ensure good soil health, it is necessary to identify the most important soil challenges on each individual farm. The next step is to make use of the potential in measures such as reduced tillage, cover crops and diverse crop rotations.”



Purpose: Determine how soil health can be assessed and improved under Norwegian conditions.
Collaboration: Wageningen University
Funding: The Research Council of Norway
Contact: Research Scientist Frederik Bøe, Division of Environment and Natural Resources.
Email: frederik.boe@nibio.no | Telephone: +47 958 71 316



Photo: Erling Fløistad



Grazing reduces climate footprint

A recent doctoral study shows that grazing has a positive effect on milk production and that grazing reduces the climate footprint of dairy cows.

In early 2025, Quentin Lardy at NIBIO Steinkjer defended his PhD on the impact of grazing on methane emissions from digestion – so-called enteric methane (eCH₄) – and performance in ruminants. The study found that a high intake of pasture reduced eCH₄ emissions when compared with silage feeding, while maintaining milk production. Maintaining grazing and increasing pasture intake during the growing season can potentially reduce the climate footprint of milk production in Scandinavia.

Lardy investigated that optimising summer grazing can affect milk production and eCH₄ emissions by replacing indoor silage with grazed grass in the diet. The findings show that grass quality influences fermentation patterns. Less digestible grass led to higher eCH₄ emissions per unit of feed intake.

Cows milked twice daily were split into a grazing period and an indoor period each day. There was no difference in milk performance or eCH₄ emissions

whether pasture access was provided during the day or at night. However, eCH₄ emissions were lower during the hours the animals were on pasture compared with the hours spent indoors, regardless of the time of day.

Overall, the two dairy cow trials showed that replacing silage with fresh grazed grass reduced eCH₄ emissions by 20–28 per cent while maintaining milk yield. This indicates that the climate footprint of milk production is likely overestimated during the grazing season.

The research also showed that in a year-round grazing system with strip grazing, where pasture constituted a significant part of the total diet during the summer months, milk yield and milk protein content were significantly improved by allocating a new strip in the evening compared with the morning.



Purpose: Greenhouse gas emissions from grazing animals: Which measures can bring us closer to climate-friendly (or climate-neutral) meat and milk production.

Collaboration: Swedish University of Agricultural Sciences

Funding: Trøndelag County Council, County Governor of Trøndelag and Steinkjer Municipality, Swedish University of Agricultural Sciences, NIBIO

Contact: Senior Research Scientist Vibeke Lind, Division of Food Production and Society.
Email: vibeke.lind@nibio.no | Telephone: +47 934 99 436



Photo: Erling Fløistad



Healthy seed potatoes combat Potato virus Y

Potato virus Y (PVY) is a major challenge for Norwegian potato cultivation. The virus can halve yields if it spreads uncontrolled.

At Reddal Fellespakkeri in Grimstad, 13 producers collaborate on packing and selling early potatoes. Around 2007, they encountered serious problems with PVY in the Juno variety. The potatoes grew poorly and split, and it took a long time to identify the cause.

“Today we send all samples of seed potatoes to NIBIO for virus testing, and it makes an enormous difference. If you start with virus-free seed potatoes, you avoid major losses,” says Knut Salve Lunden, managing director of the packing facility.

“Ideally, we don’t use seed potatoes with more than 2–3 per cent infection, and 10 per cent is an absolute limit. I don’t understand how anyone dares not to test. The risk is high, and the consequences can ruin the entire crop,” says Lunden.

Seed potato quality is crucial when it comes to potato viruses. PVY is transmitted by aphids. If a field has some virus initially, aphids can spread it so that infection increases from 2 to 20 per cent during a season. In cool summers, spread is limited, while in warm summers the infection pressure rises rapidly.

Early varieties such as Juno are particularly sensitive to PVY. When Juno develops excessive splitting, the potatoes end up as waste, causing economic losses for the farmer. The Asterix variety may be infected without showing obvious symptoms yet still act as a source of infection. If PVY spreads freely, yield losses can be substantial (40–70 per cent), in addition to quality problems.



Purpose: The Plant Clinic at NIBIO offers winter testing of seed potatoes for all potato producers in Norway to prevent uncontrolled virus spread when using home-grown seed potatoes.

Collaboration: Norwegian Agricultural Advisory Service

Contact: Research Professor Dag-Ragnar Blystad, Division of Biotechnology and Plant Health.
Email: dag-ragnar.blystad@nibio.no | Telephone: +47 908 72 588.



Photo: Silje Kvist Simonsen



Hunting for genetic variation in strawberry

In modern times, strawberry breeding has focused primarily on yield and appearance. Important traits such as disease resistance have been given lower priority. Researchers are now investigating how these traits can be efficiently reintroduced.

Developing strawberry varieties with new traits is a time-consuming process. In traditional breeding, two different strawberry varieties are crossed, producing hundreds of offspring. These offspring are genetically different, containing a mix of genes from both parent plants. To determine which traits the offspring have, they must be grown and evaluated. Only the offspring with the greatest potential are selected for further breeding. This is a lengthy process, taking at least 10 years before a new strawberry variety with the desired traits reaches the market.

Dr Jakob Junkers has investigated whether this time can be reduced using molecular methods.

In the project, Dr Junkers studied resistance to powdery mildew in different strawberry varieties and linked it to genetic markers in the plants' DNA. He identified specific regions of DNA associated with

powdery mildew resistance. This information was used to create a model that can predict disease resistance based on DNA markers. As a result, it is possible to quickly analyse offspring from many crosses and select the most promising plants for further breeding, potentially reducing breeding time by 2–3 years.

Dr Junkers' work showed that there is considerable genetic variation in current strawberry varieties.

"This means we have the foundation to breed strawberries that are resistant to powdery mildew, allowing cultivation with reduced use of pesticides."

Combining a faster breeding process with the existing genetic variation provides opportunities to develop a wide diversity of strawberries, in terms of disease resistance, colour and flavour.



Purpose:	Use molecular methods to reduce the time required to breed new strawberry varieties with disease resistance.
Funding:	Part of the BreedingValue project – EU Horizon 2020 programme for research and innovation
Contact:	Research Professor May Bente Brurberg, Division of Biotechnology and Plant Health. Email: may.brurberg@nibio.no Telephone: +47 926 09 364.



Photo: Erling Fløistad



More accurate date labelling cut food waste

Large amounts of food are discarded in Norway because the expiration date has passed, even though the food is often still safe to eat. Now food producers will receive guidance to set more accurate date labels.

Through the Industry Agreement on Food Waste Reduction, established in 2017, authorities and private actors have committed to reduce food waste at all stages of the food chain by 2030. Norway is currently behind this target. NIBIO, together with Matvett and Nofima, will now investigate how Norwegian food producers determine the expiration date and type of date labelling and whether better guidance on these matters can help reduce unnecessary food waste.

“We will map how food producers determine date labelling today, what challenges they face, and whether they can receive better guidance. The aim is to make it easier to avoid discarding edible food,” says researcher and project leader Dr Anlaug Ådland Hansen at Nofima.

Different rules in different countries

A 2015 study published in the TemaNord series shows that practices for determining date labelling vary across the Nordic countries.

“As part of the project, we will provide an overview of the guidance materials available in Norway. At the same time, we will compare materials from the Norwegian Food Safety Authority with those issued by similar authorities in other countries,” says Pia Borg, Senior Adviser at NIBIO.

She points out that it will be particularly interesting to see whether authorities in comparable countries interpret the rules and built-in flexibility in the same way as in Norway, or whether interpretations are flexible.

Through surveys and interviews with food producers, the researchers aim to identify where the main challenges lie and what could be improved, providing new insight into how date labelling is determined and whether more accurate date labelling could reduce food waste.



Purpose: Map and understand how food producers determine date labelling to prevent edible food from being discarded.

Collaboration: Nofima, Matvett, NHO Food and Drink, and the Norwegian Food Safety Authority

Funding: Research funds for agriculture and the food industry

Contact: Senior Adviser Pia Borg, Division of Food Production and Society.
Email: pia.borg@nibio.no | Telephone: +47 906 39 224.



Photo: Siri Elise Dybdal



Prevent pesticides from reaching groundwater

Today, farmers have limited ability to assess the risk of pesticides leaching into groundwater. NIBIO has now developed a tool with risk tables to support better environmental choices.

When spraying fields, pesticides can be washed away with surface water into streams and ditches, or they can move downward through the soil – in the worst case, reaching groundwater and wells. The level of risk varies with soil type and climate.

To make it easier to choose safer alternatives, NIBIO has developed tables showing the risk of pesticide leaching under different soil and climate conditions. The tables currently cover all pesticides approved for potatoes, carrots, cereals, winter oilseed rape, apples, and strawberries as of spring 2024. They show the calculated risk of leaching in the main soil types across Norwegian farming areas.

The goal is for farmers to use the tables to identify the most environmentally friendly option among the available pesticides for each crop.

The project arose because farmers have had little ability to assess leaching risks. Few measures exist to

prevent such leaching, and some products carry only very general warnings, for example, to avoid spraying on sandy soils.

The first risk tables were published in 2022. Previously, data existed for five of ten soil types down to 2 m depth and only for cereals and potatoes. Feedback suggested that results at 1 m depth – the typical drainage depth – would also be useful. The models have now been recalculated with a stronger data basis to account for combinations of soil, climate, and pesticide use.

Overall, the picture shows that leaching risk is significant in many areas, especially in regions with low temperatures and high rainfall. Farmers are free to use the results in their decisions and can benefit from choosing the safest solutions.

The plan is to update the risk tables annually.



Purpose:	Provide Norwegian farmers with a tool to assess the potential for pesticide leaching into groundwater under their soil and climate conditions.
Funding:	Action Plan for Sustainable Use of Pesticides, Norwegian Agriculture Agency
Contact:	Research Scientist Roger Holten, Division of Biotechnology and Plant Health. Email: roger.holten@nibio.no Telephone: +47 915 92 762



Photo: Siri Elise Dybdal



Hunting cancer-inhibiting compounds at sea

Researchers at NIBIO are investigating whether microalgae could become a new source of medicines against cancer and viruses that can lead to cancer.

Throughout history, nature has been an important source of new medicines. At NIBIO, scientists have now turned their attention to the sea, where microalgae produce unique chemical compounds to survive in demanding environments. Extracts from such microalgae show promising effects against both cancer cells and virus-related cancer mechanisms, but the path to an approved medicine is long.

Microalgae exist in great diversity, and species and strains vary significantly depending on their environment. This variation makes the microalgae particularly interesting – especially those living under extreme conditions such as cold temperatures and high light levels. These conditions can trigger the production of bioactive compounds with potential health effects.

Since 2013, NIBIO has tested microalgal extracts on various cancer cell lines. The aim is to identify compounds that inhibit cell growth or affect key proteins

involved in cancer development. Head of Department Dr Hanne Skomedal says early results indicate that extracts from microalgae may have effects against cancer cells and viruses that can lead to cancer, but it is still unclear which compounds are responsible and whether the effects can be reproduced.

This work is at an early stage. The compounds are first tested in cell cultures and then, potentially, in animal studies. The entire process can take more than ten years. Collaboration with chemists and the use of advanced analytical methods now make it possible to identify which compounds are present in the extracts.

Although the likelihood of discovering a new medicine is small, the potential is significant. Microalgae may contain previously unknown compounds that could be important for future cancer treatment.



Purpose:	To identify bioactive compounds in microalgae that can inhibit cancer cells or viruses that can lead to cancer, with the aim of developing new medicines.
Funding:	Two projects: The Research Council of Norway and NordForsk
Contact:	Head of Department/Head of Research Hanne Skomedal, Division of Biotechnology and Plant Health. Email: hanne.skomedal@nibio.no Phone: +47 920 10 068.



Photo: Morten Günther



Forever chemical detected in water sources

A new study has detected the unwanted and persistent PFAS compound trifluoroacetic acid (TFA) in Norwegian groundwater and surface water – particularly in areas affected by agriculture.

TFA is a synthetic acid belonging to the PFAS group, known as “forever chemicals” as many PFAS do not break down in the environment. TFA is water-soluble and highly stable, meaning it follows the water cycle, is transported over long distances and persists in the environment for extended periods, in water, soil and plants. Conventional water treatment methods are largely ineffective for TFA, making management challenging.

A NIBIO study shows that TFA is present in streams, lakes, groundwater and drinking water in Norway, with concentrations ranging from 160 to 1300 nanograms per litre. The lowest levels were found in drinking water, while the highest were measured in streams in agricultural areas.

“TFA has been proposed for classification as presumed human reproductive toxicant, and work is underway in the EU to clarify this,” says Dr Astrid

Solvåg Nesse. “However, at the levels we have detected, the substance is not currently considered harmful to health.”

TFA is formed, among other ways, when PFAS-containing refrigerants break down in the atmosphere and are dispersed through precipitation, resulting in a background concentration across the globe. In addition, local sources such as industry and wastewater treatment can lead to higher levels.

In agricultural areas, PFAS-based plant protection products are a known source, and the use of livestock manure and sewage sludge is also suspected to contribute to elevated TFA levels.

Although TFA does not bioaccumulate in the food chain, it can accumulate in plants. Plant-based beverages such as fruit juice, tea, beer and wine contain far higher levels of TFA than drinking water.



- Purpose:** NIBIO has conducted preliminary investigations of TFA (trifluoroacetic acid) in streams and groundwater in areas with intensive agriculture.
- Funding:** Norwegian Food Safety Authority, the Norwegian Agriculture Agency and the Norwegian Environment Agency
- Contact:** Research Scientist Astrid Solvåg Nesse, Division of Environment and Natural Resources.
Email: astrid.nesse@nibio.no | Phone: +47 915 39 494.



Photo: Morten Günther, edited.



Effective measures against nitrogen runoff

Balancing fertiliser use, sowing catch crops and avoiding autumn tillage are among the most important measures farmers can adopt to reduce nitrogen losses to watercourses. For the Oslo Fjord, which receives more nitrogen than it can tolerate, such steps could make a substantial difference.

The Oslo Fjord faces serious environmental challenges, due to excess nitrogen and phosphorus from agriculture, wastewater and industry. Nutrient losses from agricultural areas is one of the largest sources.

“First and foremost, it is about practising good agronomy and managing nitrogen resources properly,” says Dr Marianne Bechmann.

She explains that phosphorus follows soil particles during erosion, while nitrogen in the form of nitrate is water-soluble and is mainly lost through drainage systems – regardless of erosion risk.

A fertiliser surplus relative to the crop yield increases the risk of leaching. Therefore, split fertiliser applications adjusted according to growing conditions is an important measure.

“GPS-controlled precision fertilisation also provides better distribution and less surplus,” says Dr Bechmann.

Catch crops such as ryegrass absorb nitrogen after harvest. The effect depends on avoiding soil tillage in autumn. Ley in the crop rotation and buffer zones have a similar effect. Overwintering in stubble can reduce nitrogen losses by 20–40 per cent.

Early autumn ploughing combined with mild autumn conditions result in a long period of nitrogen mineralisation and increased losses. If ploughing is necessary, it should be done as late as possible.

In Denmark, wetlands and treatment systems for drainage water are being tested.

“Preliminary results are promising, but we need more knowledge about Norwegian conditions,” she says.

Nitrogen is a valuable resource. With the right measures, we can balance food production and environmental considerations – and secure a healthier future for the Oslo Fjord.



Purpose: Provide an overview of measures that can help reduce nitrogen runoff from agricultural land.

Contact: Research Professor Marianne Bechmann, Division of Environment and Natural Resources.
Email: marianne.bechmann@nibio.no | Phone: +47 412 19 506.



Photo: Trond Mæhlum



New guidance on leachate management

Commissioned by the Norwegian Environment Agency, NIBIO, NGI and NIVA have developed a new web-based guidance document on monitoring, risk assessment and measures to address contaminated landfill leachates.

From the 1950s onwards, ravines, sand pits and peatland areas were filled with waste. Before the introduction of a vehicle scrappage scheme in 1978, end-of-life cars often ended up in landfills or were dumped in fjords and mines.

Today, waste is regarded as a resource, and strict regulations apply to what may be disposed of in landfills.

“It was during the 1970s that people began to understand that leachate – that is, rainwater, surface water or groundwater that has been in contact with waste – can be heavily contaminated,” says Dr Trond Mæhlum of NIBIO.

Some is directed to treatment plants, but a lot flows into the natural environment. Concentrations of pollutants can be high and vary according to the type of waste.

The first guidance on leachate management was published in 2005, before the Water Framework Direc-

tive was implemented in 2006. Knowledge about leachate pollutants and treatment has since improved, and the new guidance provides advice on tailored monitoring and measures to protect surface water, groundwater and municipal sewer networks.

“We know that there is considerable variation in substances and concentrations in leachate. The scope of monitoring should be assessed based on the pressure placed on the aquatic environment,” says Dr Sissel Ranneklev of NIVA.

NIVA has been responsible for ensuring that the requirements of the Water Framework Directive for monitoring lakes, rivers and coastal waters receiving leachate have been incorporated into the new guidance.

Project manager Erlend Sørmo of NGI emphasises that the guidance offers a clear and straightforward process for assessing leachate. New parameters such as PFAS have been included, and each assessment is described in an accessible manner.



Purpose:	The purpose of the new guidance is to ensure better protection of the aquatic environment by providing clear advice on monitoring, risk assessment and measures to address contaminated leachate from landfills.
Collaboration:	Norwegian Geotechnical Institute (NGI), Norwegian Institute for Water Research (NIVA)
Funding:	Norwegian Environment Agency
Contact:	Research Scientist Trond Mæhlum, Division of Environment and Natural Resources. Email: trond.maehlum@nibio.no Phone: +47 412 38 270



Photo: Lars Sandved Dalen

Agriculture drives value and jobs in the north

A robust and adaptable agricultural sector is essential to sustaining communities in northern Norway. A recent report presents the economic significance of farming and forestry in the region.

Agriculture in northern Norway is crucial for settlement, value creation and employment, despite a challenging climate and dramatic landscapes. A report from NIBIO and Østlandsforskning shows that farming and forestry in the north together generate over three billion Norwegian kroner in value creation.

At the same time, the number of farms has declined: from 2013 to 2022, the number of agricultural holdings in Nordland, Troms and Finnmark fell by 24, 22 and 20 per cent respectively. However, the total farmland in use has not decreased correspondingly, as the remaining farms have grown larger. In 2013, the average farmland per holding was 255 decares, while in 2022 it had increased to just over 320 decares across the three northern counties.

The trend is similar for milk and meat production: fewer farms, but more animals per farm. Invest-

ments in modern barns and equipment have helped maintain production. The number of dairy cows per farm has increased significantly, and the number of adult sheep per farm has grown in all three counties.

Agriculture employs thousands: in 2022, 1,976 people were employed in Nordland, 983 in Troms and 728 in Finnmark. Including those indirectly employed by agriculture, there are almost 6,000 jobs in the region. This includes activities such as food processing, machinery operation, firewood production and tourism.

Although agriculture faces challenges such as land pressure, climate change and high investment costs, supplementary industries like tourism and small-scale food production provide new opportunities. With targeted investments and support, northern agriculture can continue to grow and secure sustainable employment.



Purpose: To highlight the importance of agriculture for value creation and employment in northern Norway.

Collaboration: Østlandsforskning at the Inland Norway University of Applied Sciences (ØF)

Funding: County administrations in northern Norway through the initiative Sustainable food production and value creation in the north

Contact: Senior Adviser Siv Karin Paulsen Rye, Division of Survey and Statistics.
Email: siv-karin-paulsen.rye@nibio.no | Phone: +47 911 62 865



Photo: Siri Elise Dybdal



How Malawi farmers get plant health advice

Access to reliable information is a major challenge for smallholder farmers in Malawi, especially in areas with low literacy and limited internet access. The MaDiPHS project, led by NIBIO, is developing new ways to deliver vital plant health guidance.

A key aim is to ensure that farmers receive clear and practical advice to protect their crops, using communication formats beyond smartphones. Interactive voice messages, radio jingles, animations and locally rooted materials are tested to make information accessible to all.

A central tool is VIAMO's "321" service, which offers short voice messages on pests, diseases and agronomy via basic mobile phones in local languages such as Chichewa. With around five million users and up to one million active each month, it provides roundtheclock information ranging from agriculture to health. Content is developed with researchers,

extension staff and communication specialists, and tested with farmers to ensure clarity and relevance.

Within MaDiPHS, 30 key message trails were launched on the 321 platform in June 2025. Around 30,000 unique callers now use the plant health content monthly, confirming strong demand. Messages are also designed for radio and TV, ensuring broader access for farmers, advisers and stakeholders.

The next step is to add visual tools such as illustrations, graphics and short videos, helping farmers better understand and act on plant health advice regardless of location.



Purpose:	Establish a digital plant health service that supports targeted, effective pest and disease management, increases yields and reduces reliance on pesticides.
Collaboration:	Malawi Ministry of Agriculture, Ministry of Natural Resources and Climate Change, LUANAR, international research partners and the Norwegian Meteorological Institute.
Funding:	Norad.
Contact:	Research Scientist Karl Thunes, Division of Biotechnology and Plant Health. Email: karl.thunes@nibio.no Tel: +47 456 00 856.



Photo: Ragnar Våga Pedersen



SRI boosts rice yields for Tanzania farmers

Three years after its launch, the SRI Tanzania project has given smallholders a major boost. Around 2,880 farmers have increased their rice yields by 30–40 percent, while their seed use is reduced by 75–80 percent. The result? Higher incomes, the ability to send children to school, renovate homes, and invest in transport.

Agriculture in Tanzania is dominated by smallholders who are vulnerable to drought, uneven rainfall, and poor soil health. The SRI Tanzania project has introduced climate-friendly methods that deliver both higher productivity and increased resilience to climate change.

The System of Rice Intensification (SRI) involves a set of techniques that allow rice to be grown with better yields and more efficient water use. These include planting younger seedlings, transplanting a single seedling in widely spaced rows, alternating between flooding and drying during irrigation, mechanical weeding with push hoes, reduced water use, and the application of organic fertilisers and soil management.

The aim of these measures is to create better physiological conditions, promote healthier root and plant development, and thereby achieve higher yields.

“Integrating such environmental measures strengthens farmers’ productivity and climate adaptation capacity,” says project leader Dr Udaya Sekhar Nagothu.

The project has also developed a toolkit for climate-friendly rice cultivation, with guidance on soil, nutrients and pests, and robust rice varieties.

NIBIO Director General Ivar Horneland Kristensen is impressed:

“This project gives farmers the knowledge and capacity to create lasting solutions. If all two million rice farmers in the country adopt SRI, Tanzania could secure its own food security and help feed six neighbouring countries.”



Purpose: Provide smallholder farmers in Tanzania with knowledge and methods that increase rice yields, reduce resource use, and strengthen resilience to climate change, enabling them to secure food security and better livelihoods.

Collaboration: Tanzania Agricultural Research Institute (TARI)

Funding: NORAD

Contact: Senior Research Scientist and Director of NIBIO’s Centre for International Development (CID), Dr Udaya Sekhar Nagothu, Division of Environment and Natural Resources.
Email: nagothu.udayasekhar@nibio.no | Phone: +47 990 15 621.



Photo: Hannu Aaltonen



Cabbage root flies threaten Arctic agriculture

The unique conditions in Northern Norway make it possible to grow swede and turnip on a large scale despite a short season and low temperatures. Pests such as cabbage root fly, turnip fly and diamondback moth, however, create challenges for production.

The unique conditions in Northern Norway, with the midnight sun and low temperatures, allow the cultivation of swede and turnip rich in sweetness and crispness. A warming climate gives longer growing seasons but also increases pressure from pests such as turnip fly, cabbage root fly and diamondback moth.

Cabbage root flies and turnip flies overwinter in the soil, and populations build up with repeated swede and turnip cultivation. The diamondback moth arrives to Northern Norway via air currents. It is appearing increasingly earlier and is becoming a growing problem in Northern Norway.

Fleece covers, used to promote early growth and root establishment of swede and turnip, also protect crops from pests by forming a physical barrier that prevents turnip and cabbage root fly egg-laying.

“Based on swede growth models, the covers should preferably be removed when root swelling begins, as cooler temperatures give better root quality,” explains Dr Anne Muola. However, if the egg-laying by turnip and cabbage root flies continues, the removal of covers can result in considerable damage on marketable yield.

In addition, if the diamondback moth arrives early and gets under the cover, it benefits from warmer temperature, and the population can grow fast. Chemical control of diamondback moth is challenging under the covers.

Thus, effective pest control requires a holistic approach, including crop rotation, plant growth models, pest monitoring, weather forecasts, and providing habitats for the pests’ natural enemies. In Northern Norway, developing warning systems and monitoring relevant pests is a priority.



Purpose: Integrated control methods for diamondback moth, cabbage root fly in Arctic agriculture.
Funding: Arctic Agriculture (KU funds)
Contact: Research Scientist Anne Muola, Division of Biotechnology and Plant Health.
 Email: anne.muola@nibio.no | Phone: +47 413 74 516



Photo: Hege Ulfeng



Good apple trees start underground

An apple tree is in fact two trees. The root, or rootstock, comes from a completely different variety than the trunk and branches. When a rootstock and a main variety are combined, it is called grafting. The rootstock not only determines how large the tree can grow, but also how many years it takes before it bears fruit, how the tree adapts to different soil conditions, and how well it tolerates cold.

NIBIO research scientist Dr Darius Kviklys is an expert on rootstocks. He coordinates a European trial programme under the auspices of EUFRIN (European Fruit Institutes Network), where the focus is apples.

The rootstock is crucial for successful apple cultivation.

“It influences the uptake of water and nutrients and is important for the hormonal balance of the entire tree. This has consequences for both yield and quality,” explains Dr Kviklys.

The rootstock and the variety must be suited to each other. Too weak a rootstock for low-vigour varieties gives poor results. Conversely, vigorous varieties on a strong rootstock can produce very large trees.

In professional cultivation, almost only weak rootstocks are used. The trees must be supported and

carefully managed to grow well. In return, they produce early and high yields with much less labour input than larger trees.

“Low-vigour trees are more sensitive to pests. Stronger trees will survive an attack better and recover. They can also compete better with weeds for both water and nutrients because they have a more extensive root system,” explains Dr Kviklys.

In Norway, as in almost all apple orchards in Western Europe and the USA, a rootstock called M.9 is used. It was developed in England around 100 years ago. One of its disadvantages is that it is not particularly winter hardy, which is important for Norwegian apple production.

At present, NIBIO is involved in testing 24 different rootstocks.



Purpose: Improved rootstocks for apple trees.
Funding: EUFRIN (European Fruit Institutes Network)
Contact: Research Scientist Darius Kviklys, Division of Food Production and Society.
 Email: darius.kviklys@nibio.no | Phone: +47 413 24 561



Photo: Morten Günther

Prevents inbreeding in rare cattle breeds

It is now easier to avoid inbreeding in rare Norwegian cattle breeds. NIBIO has developed a web-based tool that allows farmers to check the level of inbreeding between their own cows and one or more breeding bulls.

Previously, individual livestock owners could not carry out such simulations themselves. Farmers had to submit a request to NIBIO, which performed the calculations manually – a time-consuming process.

“Farmers can now simulate matings themselves,” says Anna Caroline Holene, senior adviser at the Norwegian Genetic Resource Centre.

The dominant cattle breed in Norway is Norwegian Red (NRF). Before this breed became almost synonymous with cattle production, there were many local and smaller cattle breeds. However, they produced less than NRF.

By the late 1980s, these breeds had become so rare that they were close to extinction. A comprehensive conservation effort was launched, and in 1989 the pedigree registry *Kuregisteret* was established. This forms the foundation of conservation work for Nor-

way's rare cattle breeds. Today, none of the conservation-worthy breeds are critically endangered.

The greatest threat to a small breed is a rapid increase in inbreeding. With the information in *Kuregisteret*, it is possible to monitor both population size and inbreeding trends in the herds.

Kuregisteret is also used as a breeding tool, enabling simulations of matings between cows and potential breeding bulls, whether farm bulls or artificial insemination sires.

“A simulated mating shows the inbreeding level in the expected offspring, and the producer receives advice on whether it is a suitable or unsuitable combination. Combined with a focus on using many different bulls in breeding, this makes it possible to minimise inbreeding in these small populations,” Holene concludes.



Purpose: Prevent inbreeding among rare Norwegian cattle breeds.

Contact: Senior Adviser Anna Caroline Holene, Division of Survey and Statistics.
Email: anna.holene@nibio.no | Phone: +47 948 27 598.



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.

www.nibio.no

Facebook: @Nibio.no / Instagram: @nibio_no
Search for NIBIO on LinkedIn and YouTube

