



NIBIO

NORWEGIAN INSTITUTE OF
BIOECONOMY RESEARCH

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Green knowledge

40 examples from NIBIO's activities in 2023



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Foreword

We are pleased to present the eighth edition of Green Knowledge. Here you will find 40 articles from the past year, providing a glimpse into the vast array of professional activities at NIBIO. These articles can be considered as samples from our extensive portfolio, which includes around 1500 ongoing projects across our five specialised divisions.

NIBIO's professional divisions collectively represent a unique diversity of expertise. Units across the country also provide the institute with a strong regional anchor. Together, this gives NIBIO a solid foundation in meeting the knowledge needs of the green industries for sustainable value creation, alongside significant expertise in environmental science and resource management. As NIBIO has gradually become a significant international player, it provides both us and our national clients and partners with the opportunity to draw on perspectives and knowledge development spanning local, national, and global issues. This also gives NIBIO a good starting point for filling the concept of sustainability with tangible and meaningful content, encompassing all three dimensions: economy, environment, and social conditions.

We hope this year's edition of Green Knowledge provides you with a glimpse into this, and that it inspires you to seek more information about the many exciting activities NIBIO is involved in.

Happy reading!

Per Stålnacke
Director of Research

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. 750 (December 31, 2023)

Estimated turnover for 2023 was 930 mill.

Number of international projects: approx. 100, of which approx. half are EU or EEA (20 are Horizon Europe projects).

Present in all regions of Norway

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Photo: Erling Fløistad



Photo: Jørgen Mølmann



Bright future for arctic food production

In many parts of the world, climate change has a negative impact on agriculture and global food security. However, rising temperatures also present new opportunities for food and fodder production in the north.

Unstable winter conditions and increased autumn rainfall may pose challenges. Nevertheless, higher temperatures and a longer growing season offer new opportunities in Arctic regions. The natural light above the Arctic Circle provides unique growing conditions. Low sun angles, long periods of daylight, and the absence of dark nights affect plant growth and metabolism in distinctive ways. Plants grown at high latitudes develop faster than those further south due to the midnight sun.

Increased temperatures due to global warming are expected to lead to earlier spring thawing. This is expected to extend the growing season in the north, with peak growth in May and June when light conditions are optimal. This could result in larger yields, more harvests, and the ability to cultivate new, more productive varieties and species. It also means an extended grazing season.

However, climate change also presents new challenges. Milder and more unstable winters increase the risk of plants being more susceptible to damage. Wetter soil conditions in autumn will also make some tasks more difficult for Arctic farmers, such as soil preparation and harvesting potatoes and vegetables.

“In light of the global situation with climate change and food security, we believe it is important to look towards Northern Norway. Here, the effects are expected to be more positive than further south,” says senior adviser Marianne Vileid Uleberg at NIBIO’s Centre for Arctic Agriculture. “Arctic regions have significant potential to play a greater role in our food production and can and should become an important area for the sustainable utilisation of our natural resources.”



Purpose:	The Centre for Arctic Agriculture promotes knowledge and activities that support Northern Norwegian farmers. The centre coordinates NIBIO’s activities related to agriculture in Northern Norway.
Funding:	NIBIO’s core budget. Area-specific efforts for sustainable food production and value creation in the north are funded through agricultural agreements.
Collaboration:	Northern Norwegian Agricultural Council, the county municipalities in Troms, Finnmark and Nordland, the County Governors, and other supporters of the Northern Norwegian agricultural industry.
Contact:	Senior Adviser Marianne Vileid Uleberg. Email: marianne.uleberg@nibio.no , telephone: (+47) 414 33 744. Division of Food Production and Society



Photo: Siri Elise Dybdal

CRISPR and NGS can help control plant viruses

Through applying novel, cutting-edge techniques, Norwegian and Chinese scientists are creating cereals that are resistant against wheat dwarf virus and gaining new knowledge on the plant proteins and genes involved with the virus.

CRISPR and Next Generation Sequencing (NGS) are being utilised by Norwegian and Chinese researchers for sustainable control of the devastating wheat dwarf virus. The project focuses on developing genetically edited, resistant cereal plants by understanding the molecular interactions between the virus, the vector (carrier of infection), and the plant.

Cereals are among the most important crops globally but are affected by diseases, pests, and weeds. Cereal viruses pose the most significant challenge, as viral diseases cannot be controlled with conventional means. Over 200 virus species can attack cereals worldwide. Wheat dwarf virus is particularly harmful in China, and with climate change, the threat from flying insect vectors is increasing.

NIBIO, in collaboration with the Chinese Academy of Agricultural Sciences, is currently employing CRISPR and NGS to identify plant proteins and

genes associated with virus infection. The CRISPR system is used to make small, targeted genetic changes to confer resistance to the plants against the virus. This has the potential to revolutionise agriculture by creating genetically edited plants better adapted to combat diseases, explains Dr Carl Spetz at NIBIO.

Additionally, the researchers are exploring new applications for CRISPR, attempting to eliminate viruses from plant cells. This opens the possibility of producing cleaner plant material and safeguarding crops from diseases.

Increasingly advanced biotechnological tools provide new opportunities to strengthen food production and ensure global food security.



Purpose: Developing sustainable wheat virus control in China and Norway through the application of CRISPR technology and Next Generation Sequencing

Collaboration: Chinese Academy of Agricultural Sciences (CAAS)

Funding: The Research Council of Norway

Contact: Research Scientist Carl Spetz. Email: carl.spetz@nibio.no, phone: (+47) 920 43 685. Division of Biotechnology and Plant Health



Photo: Siri Elise Dybdal

Wildlife damage centre prevents predator harm

Wild animals can cause great damage to forests, cultivated land, and crops, and livestock attacks cause conflict in several areas. The Norwegian Wildlife Damage Centre provides expertise on effective solutions.

Predation harm to sheep and reindeer, crop loss, and grazing damage are some challenges encountered in the interface between agriculture, forestry, and wildlife. Human-made infrastructure like roads and railways can also lead to harm to domestic reindeer and cervids. A good balance between industry and the protection of wild animals requires effective preventive measures and solutions, says Dr Inger Hansen, leader of the Norwegian Wildlife Damage Centre and researcher at NIBIO.

At the centre, NIBIO has gathered broad expertise in the fields of sheep farming, reindeer husbandry, pasture quality and utilisation, cervids, predators, economics, social research, mapping and statistics, and electronic monitoring. The purpose is to provide advice, research, development work, and information on preventive measures against predator damage to sheep and reindeer, grazing damage, crop loss, and causes of losses.

A main cause of predator conflict is loss of livestock on rangelands. In Norway, agriculture with rangelands is important for access to fodder resources, animal welfare, and landscape management. Simultaneously, there is national and international laws to maintain sustainable populations of predators.

Hansen admits that dealing with the predator challenge can be like sticking one's hand into a "hornet's nest."

"Most people want predators, but not where they live. Some are very supportive. Others tolerate it but do not want such high populations," says Hansen. "I have been in this for 30 years. It's challenging but exciting to try to find good solutions. Knowledge and information are important. Solutions must be based on expertise."



Purpose: The Norwegian Wildlife Damage Centre provides expertise on effective solutions in conflicts between wildlife and the agricultural industry.

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Photo: Roger Roseth

Nitrogen purification from blasted rock

NIBIO has assisted in establishing a full-scale nitrogen runoff purification plant from blasted rock in Nordlandsdalen. Results showed effective purification in spring and summer 2022, but diminishing purification with increased water flow during autumn and winter.

As part of the E16 Bjørum - Skaret expansion, a full-scale purification plant has been established to cleanse nitrogen runoff from a blasted rock fill in Nordlandsdalen in Hole municipality. The facility comprises a forechamber, a sedimentation pond, and two purification filters. There is also a system of wells, overflow channels, and valves. The amount of water directed to the purification filters can be adjusted, and the filters are designed to purify up to 130 m³ per day.

The facility has been operational since late 2021. So far, the results are promising – at least for relatively dry periods.

“From January to September 2022, the average purification effectiveness was just above 80 percent,” says Roger Roseth, project leader at NIBIO.

Autumn 2022 saw intense rain and floods, along with several subsequent precipitation events. With

increased water flow during that autumn and winter, the purification rate in the nitrogen filters decreased to between 20 and 60 percent.

He says they are now exploring options to improve purification results in wet periods, including controlled leaching of nitrogen from the fill during the summer to match the filters’ purification capacity. This can be done for example by irrigating purified water back onto the top surface of the landfill.

“The results and experiences provide new and valuable knowledge that can be used to optimise an enhanced nitrogen purification solution. We are well underway in developing the concept to achieve more efficient nitrogen purification while minimizing the leaching of organic matter and phosphorus from the filter.”



Purpose: Establish a purification plant on a blasted rock fill to reduce nitrogen runoff.
Collaboration: The Norwegian Public Roads Administration, Skanska, and ViaNova
Funding: The Norwegian Public Roads Administration
Contact: Senior Research Scientist Roger Roseth. Email: roger.roseth@nibio.no, phone: (+47) 926 16 344. Division of Environment and Natural Resources



Photo: Lieke Vermaat



Can we achieve a sustainable bioeconomy?

Results from BIOWATER indicate that increased extraction of biomass from agricultural and forestry areas could pose a serious threat to our watercourses if effective environmental measures are not implemented.

The green shift is the transition from an economy based on fossil energy to one based on renewable resources – referred to as bioeconomy. In such a world, we will increasingly use biomass from agriculture for energy, food, feed, and materials, which could mean significant changes in land use.

In BIOWATER, researchers alongside various stakeholders have examined how five scenarios in a future with bioeconomy could affect land use. Based on catchments in four Nordic countries, the researchers modelled how the scenarios could result in the loss of soil and nutrients to water. The scenarios were also used in socio-economic analyses, considering that catchments provide a range of ecosystem services to society, including drinking water supply and recreational opportunities.

The results showed that the introduction of a bioeconomy with increased biomass extraction could

lead to nutrient loss to watercourses and therefore an increased risk of harmful algal blooms.

“Of the five scenarios, the sustainable one is best for achieving good waterbody conditions. This scenario is based on investing everything in a sustainable future, with environmentally friendly farming practices and the implementation of all possible environmental measures to prevent runoff into water,” says project leader Dr Eva Skarbøvik.

The researchers also modelled the effect of climate change up to the year 2050. They found that changes in land use are likely to have a greater impact on water quality in watercourses over the next 20-30 years than climate change.

“In other words, it is urgent to implement local environmental measures in agriculture to reduce nutrient loss to our watercourses,” says Dr Skarbøvik.



Purpose: BIOWATER (2017-2022) was a Nordic Centre of Excellence in Research whose main purpose was to investigate the consequences of the bioeconomy on land use, freshwater, and society. Website: biowater.info

Collaboration: Norwegian University of Life Sciences, NIVA (NO), University of Aarhus (DK), SYKE (FI), LUKE (FI), University of Oulu (FI), Swedish University of Agricultural Sciences

Funding: Nordforsk

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Photo: Morten Günther

Ten facts about soil conservation in Norway

Since World War II, 120,000 hectares of cultivated and cultivable land have been transformed into residential areas, roads, and commercial areas in Norway.

Access to enough high-quality agricultural land is necessary for social sustainability. In recent years, Norwegian authorities have actively worked to limit the conversion of agricultural land.

Here, are some facts describing the status and challenges of preserving Norwegian agricultural land.

- 1 Only 3.5 percent of Norway's land area is cultivated land, including infield pastures – approximately 1.1 million hectares.
- 2 The largest conversion of agricultural land takes place near cities and urban areas where there is a lot of good soil in a favourable climate. Enclosed areas are particularly vulnerable.
- 3 Around half of Norwegian agricultural land is leased land.
- 4 Only one-third of Norway's agricultural land is suitable for cereal crops human consumption. The cereal area is very important for food security.
- 5 Overgrowth is a challenge that receives less attention. Overgrown agricultural land can be cultivated again, but it is resource intensive.
- 6 Potatoes can be grown in most of Norway. However, production has decreased from around 90000 hectares during World War II to nearly 12000 hectares in 2019. The vegetable area is just over 8000 hectares.
- 7 A population growth of 600,000 inhabitants is expected in Norway by 2050. If the agricultural land per capita is to be maintained, it requires both new cultivation and strict soil conservation.
- 8 Soil relocation is a costly option to preserve land from development projects on agricultural land. Many fear that soil relocation could be used as an excuse for more conversion.
- 9 Over 560 of Norway's endangered species are linked to agricultural land and cultural landscapes.
- 10 A national soil conservation award has been introduced in Norway to promote soil conservation.



Purpose: NIBIO provides important knowledge foundation for soil conservation in Norway. NIBIO has also developed the knowledge basis for an updated national soil conservation strategy.

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Photo: Liv Jorunn Hind



Grazing impact on climate

Little is known about the climate accounts for grazing animals in Norwegian pastures. Many of today's calculations for greenhouse gas emissions in agriculture are based on foreign data, and several factors have not been considered.

Norway differs from many other countries due to the northern latitude, the use of pasture for livestock grazing, and the unique terrain. Therefore, research findings from countries with different agricultural policies and ecosystems may not necessarily be relevant.

At NIBIO in Tjøtta, Nordland, research is being conducted on the amount of methane released by sheep and cows during digestion.

In the barn, there are controlled trials with sheep in respiration chambers. On pasture, GreenFeeder - an advanced feed station - measures methane from sheep and cows during grazing. In another trial, sheep are equipped with methane collectors on their backs while grazing. The researchers study how methane emissions are affected by the animals' diets, and if it is possible to reduce emissions by, for

example, adding seaweed to their diet. This is groundbreaking work in Norway.

"We're starting to collect data that eventually can be incorporated into the Norwegian models. This will give us a more accurate picture of greenhouse gas emissions from livestock under Norwegian conditions. By taking measurements both in the barn and on pasture, we get more precise figures," says Dr Vibeke Lind.

Eventually, the plan is to measure both greenhouse gas emissions and other climate-related effects from grazing. Amongst other things, the researchers will study the relationship between grazing and the albedo effect. This is when large bright surfaces, like pastureland, reflect light out of the atmosphere. It helps cool the planet and is one of the effects that haven't been included in the agricultural climate accounts yet.



Purpose: To focus on greenhouse gas emissions from ruminants on pasture.

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Photo: Lars Sandved Dalen

Status of protected forests

More forests are being protected, and a larger portion of the primary forest is in areas where logging is forbidden. However, protection of highly productive forests with good growing conditions is lacking.

In 2009, the Norwegian Environment Agency started work on a monitoring system for protected areas. In 2012, it was decided that the monitoring should be coordinated with the National Forest Inventory (NFI). NFI has a network of a total of 22,000 sample plots distributed throughout the country. Additional sample plots have been established for protected forests, enabling monitoring of the development over time.

The NFI survey results show that the area of protected forest in Norway has increased by over 20 percent, covering 600,000 hectares, nearly 5 percent of the total forest area. More primary forest is being protected. Today 1.8 percent of the forest area is classified as primary forest (forest with no traces of forestry or other human influence). The NFI records show that 21 percent of Norway's primary forest are now located in protected areas, a slight increase from the previous survey.

A significantly smaller proportion of the productive forest is protected, compared to the unproductive forest areas. Productive forest refers to forest that can produce at least 1 m³ of timber (with bark) per hectare per year on average. While 3.7 percent of the productive forest is protected, with no logging allowed, 7.9 percent of the unproductive forest is protected. Thus, there is a shortage of protection for forests in areas with good growth conditions, even though the area of productive forest has increased.

NFI-measurements show that there is more deadwood in protected forests for all site quality classes compared to non-protected areas – even in unproductive forest. A larger proportion of large-diameter deadwood, i.e., tree trunks with more than 30 cm in diameter, has also been recorded.



Purpose: The National Forest Inventory's 22,000 sample plots are used to monitor the status of forest protection in Norway.

Collaboration: Norwegian Environment Agency

Funding: Norwegian Environment Agency

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Photo: Erling Fløistad



Norwegian carrot – a success story at risk

Carrot production has nearly doubled in the last 15–20 years. Today, Norwegian carrots are available in grocery stores throughout the year. However, a nematode pest could potentially ruin the entire crop if new measures are not found.

Carrot cultivation in Norway has become more specialised and efficient over the past decades. The production currently covers 90 percent of the Norwegian market. However, specialisation has led to monoculture, which has caused an increase in crop pests and diseases such as plant-parasitic nematodes.

Farmer Øystein Fredriksen in Arendal specialises in early carrot production. His fields look green and healthy, ready for harvesting, but when the roots emerge, nearly half are damaged by nematodes, preventing them from reaching grocery stores. In the worst parts of the fields, the loss is above 50 percent, deteriorating each year. He is now a key partner in a new research project led by NIBIO.

“We lack knowledge about the extent and significance of harmful nematodes in carrots. The intensive production with increasing monoculture needs to be further investigated,” says Dr Solveig Haukeland at NIBIO.

The main nematode species (*Meloidogyne* spp.) that causes damage to carrots have many host plants and are difficult to manage. There are no available pesticides, and the effectiveness of other measures is not well documented in Norway.

Some products, such as biochar, chicken manure, and chitin-rich substances that have shown promising results abroad will now be tested under Norwegian conditions. Additionally, limited research has been done on the mechanisms behind nematode infection.

“We will examine the interaction between plants, nematodes, and other organisms in the soil, aiming to understand what happens in the root zone of plants with and without nematode attacks.”

The farmer in Arendal is not the only one struggling with nematodes. Therefore, the project will assess the extent of nematode damage to carrots across the country.



Purpose: Mapping and gathering new knowledge to manage nematode pests in carrots.

Collaboration: Gartnerhallen Sa, Norwegian Agricultural Advisory Service, Soil Steam International AS, Grønn gjødsel AS, Borregaard AS, Scanship AS, Aarhus University (DK), Norgro, and Grofondet

Funding: The Research Council of Norway

Contact: Research Scientist Solveig Haukeland. Email: solveig.haukeland@nibio.no, phone: (+47) 922 59 431. Division of Biotechnology and Plant Health



Photo: Pierre-Adrien Rivier

Biodegradable plastic can reduce pollution

Research shows that biodegradable plastic breaks down under Norwegian conditions, but only if it ends up where it should.

In the project “DGRADE – Constraints to degradation of biodegradable plastics in terrestrial systems”, researchers have investigated the actual degradability of biodegradable plastic.

Results from field trials with biodegradable plastic mulch in soil, and composting trials with biodegradable beer glasses from the Øya festival in Oslo, show that the plastic breaks down as long as the conditions are favourable.

“If the conditions are not good enough, biodegradable plastic products can also contribute to plastic pollution”, says Dr Claire Coutris from NIBIO.

“Much depends on where the products end up: if it is in industrial compost or in an environment where microorganisms thrive, degradation will occur.”

In 2020, researchers buried pieces of biodegradable plastic mulch in soil on six farms with different soil and climate conditions and monitored its degradation for two years.

The results showed significant variations amongst farms, with between 8 and 44 percent mass loss of the buried mulch during the period. The higher the soil temperature and the organic matter content, the faster the degradation occurred.

The researchers also investigated what happens to biodegradable plastic bags used for collecting food waste for biogas production. Figures from Statistics Norway show that 20 percent of household food waste goes for composting, while 80 percent goes for biogas production.

The results showed that the bags were only marginally degraded during the biogas process and likely to end up in biogas digestate and then in agricultural soils, unless digestate is treated to remove plastic residues.



Purpose: Investigate degradation of biodegradable plastic under Norwegian conditions.
Collaboration: Norwegian Institute for Sustainability Research (NORSUS), Green Dot Norge, SIMAS IKS, Norwegian Agricultural Advisory Service, Agri Råd
Funding: The Research Council of Norway and the Norwegian Retailers’ Environment Fund
Contact: Research Scientist Claire Coutris. Email: claire.coutris@nibio.no, phone: (+47) 954 28 281. Division of Environment and Natural Resources



Photo: Tove Vaaje-Kolstad



National urban vegetation map

By Easter 2024, NIBIO aims to have developed and published a national urban vegetation map that covers build up areas. The mapping project will be named FKB-Green structure.

Currently, the public map database in Norway lacks detailed information on vegetated areas within urban regions. Recognizing its importance, the Geovekst Forum has designated FKB-Green structure as a new dataset. This national urban vegetation map will offer essential services to a wide array of professional communities in both the public and private sector.

Green spaces are multifunctional, providing a range of services as versatile hubs that absorb rainwater, store carbon, support biodiversity, regulate temperature and promote recreation and public health.

“Numerous urban green spaces, along with often overlooked areas such as gravel roads and surfaces covered with asphalt and stone, are yet to be integrated into the mapping system,” Dr Hildegunn Norheim at NIBIO emphasizes.

NIBIO has already successfully delivered urban vegetation maps for municipalities such as Oslo, Drammen, and Tønsberg.

To ensure uniform access to information on green areas in urban regions for all municipalities, NIBIO will establish a nationwide urban vegetation map through the Geovekst collaboration. This includes not only urban areas but also buffer zones and areas around cabins. The Geovekst collaboration guarantees a standardized dataset and procedures, facilitating the creation of a comprehensive national dataset. The resulting map will be accessible on GeoNorge, Kilden and as a WMS service, and it will also be available for download. This accessibility will support different services including the development of thematic maps.



- Purpose:** Develop a new map showing green areas within urban areas.
- Collaboration:** Geovekst collaboration
- Funding:** NIBIO's basic funding - Future initiatives
- Contact:** Senior Engineer Bjørn Tobias Borchsenius. Email: bjorn.borchsenius@nibio.no, phone: (+47) 410 71 073. Division of Survey and Statistics



Photo: Finn Måge



Climate-adapted raspberries and blackberries

Climate change is a reality that food producers are already experiencing. This also applies to raspberry and blackberry growers, who had a challenging season in 2023.

The growing season started off very warm and sunny. Then it suddenly shifted to much colder temperatures and less sun. Such changes require rapid adaptation of growing conditions, as well as berry cultivars that are resilient to changing weather.

Now, researchers are collaborating with producers to find solutions for a more climate-adapted production of raspberries and blackberries, without compromising on berry taste. The aim is to extend the season by using plants ready to be harvested ('long canes') from June to October. This could increase the share of Norwegian-produced berries in the stores.

Dr Anita Sønsteby has 16 different varieties of raspberries and blackberries for testing at NIBIO Apelsvoll.

Climate change makes it timely to consider the possibility to grow the berry plants in pots and move them into plastic tunnels to gain better control over precipitation and temperature, thus achieving better control over yield and berry quality.

Researchers are testing various berry cultivars for taste and shelf life. They are also looking at how hot water vapor works as an alternative to pesticides and are testing alternative growing media that could eventually replace peat. However, there is one fundamental cultivation factor that Sønsteby emphasises as particularly important: the balance between water and nitrogen.

When it is hot and sunny, water frequently and reduce the amount of fertiliser dissolved in the water. If the weather turns cooler, water less often and increase the amount of fertiliser. It sounds simple, but it can be difficult to find the perfect balance that ensures good berry shelf life and taste throughout the entire season.

“The goal of the project is to find resilient berry cultivars that taste so good that you just have to buy another basket,” says Sønsteby.



- Purpose:** The goal of the project 'RobustRubus' is to develop economic and sustainable solutions for growing raspberries and blackberries from June to October.
- Collaboration:** Producers from Østfold, Agder, Sogn, and Nordfjord. Graminor, NJØS, BAMA, NORGRO, Gartnerhallen, Plantsauna (Moleda), Sagaplant, NMBU, Norwegian Agricultural Advisory Service, James Hutton Institute (Scotland), and University of Arkansas (USA)
- Funding:** Grofondet and Research Funds for Agriculture and Food Industry
- Contact:** Research Professor Anita Sønsteby. Email: anita.sonsteby@nibio.no, phone: (+47) 406 25 739. Division of Food Production and Society



Photo: Aksel Granhus

No quick fix for clear-cutting methods

To test alternatives to clear-cutting, NIBIO and partners are conducting new trials with old harvesting methods.

In Norway spruce, even-aged management with clear-cutting and replanting has been dominant in Norwegian forestry for 80 years, leading to much greater growth than a century ago. However, the downside is sudden changes in the forest landscape, with new clear-cut areas and dense, single-layered forest - which can be perceived as both monotonous and unattractive for recreational purposes.

Are there alternatives to current methods that can create more variation in the forest landscape while delivering good economic results to the forest owner and ensuring high timber production?

Recent analyses of older trials with selective cutting have shown that productivity can be equal to even-aged management, provided that sufficiently high standing volume is retained after the selective cutting. However, successful selective cutting requires a multi-layered forest structure, which is

lacking in much of the Norwegian spruce forests established after the introduction even-aged management in the mid-20th century.

In collaboration with partners, NIBIO is therefore testing new methods aiming to gradually convert young spruce stands towards a forest with a structure suitable for the selection system. The starting point is the concept of “Variable Density Thinning,” previously tested in the state of Oregon, USA.

The project is unique in Nordic context. Long-term trials and demonstration plots are being established, where the concept is tested under Norwegian conditions. The aim is to create space for the development of smaller trees and regeneration, thereby also creating a multi-layered forest suitable for using the single-tree selection system in the long run.



Purpose: To find alternative harvesting methods to clear-cutting
Collaboration: Norwegian University of Life Sciences, Statskog, and forestry industry organizations
Funding: The Norwegian Forestry Fund and The Development Fund for Forestry
Contact: Head of Department/Head of Research Aksel Granhus. Email: aksel.granhus@nibio.no, phone: (+47) 977 14 873. Division of Forest and Forest Resources



Photo: Silje Kvist Simonsen



Quarantine pest discovered in tomato seeds

Many people enjoy growing plants in their kitchen garden, but these lush growths can also pose a problem. Seeds can be carriers of harmful organisms, and recently, researchers at NIBIO have discovered a new quarantine pest in tomato seeds.

All forms of plant material can contain several types of potentially harmful organisms, such as fungi, viruses, insects, bacteria, and nematodes. Importing plant material into Norway therefore poses a risk of introducing new, harmful organisms to the country.

Through the StopPest project, researchers at NIBIO are working to assess this risk. They have looked at possible diseases found in seeds sold at garden centres.

In tomato seeds, an unwelcome surprise was hidden: the quarantine pest “potato spindle tuber viroid.” The viroid can cause significant yield losses in both potato and tomato production but is primarily considered a threat to tomato production in greenhouses. According to the Norwegian Food Safety Authority, it has not yet been detected in either tomato or potato production in Norway.

“This is a serious finding,” says Dr Dag-Ragnar Blystad and Dr Zhibo Hamborg, who work with plant viruses at NIBIO.

“We also found seeds with tomato mosaic virus. Although this virus is not a quarantine pest, it causes significant damage to the plants. Both diseases spread easily on contact. Thus, even a low infection rate in a greenhouse can be serious.”

Although the finding of “potato spindle tuber viroid” was not made in seeds sold to professional tomato growers, we must take the finding seriously. It has been documented that tomato seeds were tested for the viroid before being imported into Norway. This suggests that current testing of seeds before sale is not adequate.



Purpose: To investigate what kinds of foreign harmful organisms accompany imported plants and seeds and to create a knowledge base to develop an effective management system for the import of plants and seeds.

Collaboration: Swedish University of Agricultural Sciences

Funding: The Research Council of Norway

Contact: Research Scientist Martin Pettersson. Email: martin.pettersson@nibio.no, phone: (+47) 908 70 706. Division of Biotechnology and Plant Health



Photo: Erling Fløistad

How nitrogen can be utilised better

Nitrogen is crucial for food production but has a negative impact on climate and water environments if it goes astray. NIBIO has summarised a range of measures to improve the utilisation of nitrogen in agriculture.

Mineral fertilisers are the greatest source of nitrogen in agriculture, but there are also large amounts of nitrogen in manure. Measures that improve the utilisation of this resource are beneficial for both food production and the environment.

The biggest losses of nitrogen occur as ammonia from livestock manure during spreading in barns and during storage.

“Strip spreading and mixing with water significantly reduce ammonia losses compared to broad spreading of manure with high dry matter content,” says Dr Synnøve Rivedal at NIBIO.

Sealing roofs where manure is stored is another measure that helps reduce losses. In addition, spreading manure during the growing season reduces runoff and increases nitrogen utilisation. Other relevant measures in livestock farming include tailored protein feeding, operational optimisation, reduced roughage waste, use of pasture, and new recycled protein sources.

Any conditions that provide better growth conditions for plants, such as irrigation, drainage, improved soil health, and less weeds, will result in increased nitrogen utilisation.

“At the same time, it is important to have a fertilisation plan that takes into account local growth conditions,” says Dr Randi Berland Frøseth.

A measure that reduces leaching of nitrogen from fields is to cultivate catch crops that can absorb nitrogen after the grain is harvested. This will increase nitrogen efficiency if combined with reduced use of mineral fertilisers in subsequent years.

“Another measure for increased nitrogen efficiency and reduced nitrogen losses to water, which also has a good effect on soil and phosphorus loss, is to avoid ploughing in the autumn,” says Marianne Bechmann.



Purpose: Provide a knowledge base for the development of an action plan for efficient nitrogen utilization in agriculture.

Funding: Norwegian Agricultural Agency and Norwegian Environment Agency

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



Photo: Hege Ulfeng

User-friendly web client for map updates

AR5web has made it super easy to register changes in the map of Norway’s forest and agricultural areas. Users report that the client is easy to use, reducing the risk of registration errors.

Jørn Storholt, lead engineer at NIBIO, has been instrumental in the development and implementation of AR5web in Norwegian municipalities. The web client AR5web became available to all municipalities in the spring of 2022. So far, 274 municipalities have completed mandatory training courses, and 216 municipalities have implemented the web client.

“We have come closer to the goal of bridging the gap between map and terrain,” says Storholt.

AR5web is a small piece in an extensive mapping collaboration serving Norwegian administration. The most detailed map data is managed in the Common Map Database (FKB). This includes AR5, or Land Resource Map 1:5000, which contains information about Norway’s land and forest resources, as well as other undeveloped areas below the tree line.

Map data from FKB is essential for municipal and regional land use planning. Effective processing

requires that the maps used reflect reality as accurately as possible. For this, the map database must be updated. NIBIO is responsible for AR5 and collaborates with municipalities to keep the dataset updated.

AR5web makes it much easier for municipalities to register changes in AR5. Previously, all changes had to be entered using advanced software. Now, employees without such expertise can enter the changes directly into the original AR5 in FKB. The next day, the changes become visible to everyone, for example, in the mapping solutions of NIBIO, Gårdskart, and Kilden.

Although the web client is easy to use, it has been developed using advanced programming that has received international attention.



- Purpose:** The web client for updating AR5 makes it easier and faster for municipalities to update AR5. This ensures that the area resource map aligns even better with the terrain than before.
- Funding:** NIBIO’s core funding
- Contact:** Lead Engineer Jørn Petter Storholt. Email: jorn.petter.storholt@nibio.no, phone: (+47) 902 33 524. Division of Surveys and Statistics



Photo: Liv Jorunn Hind



Harvesting seaweed for the dinner table

Seventy percent of the Earth's surface is covered by oceans. However, only around 2 percent of the world's food energy comes from the sea. Researchers believe that if we are to increase global food security, we should more extensively utilise the opportunities provided by the ocean.

Globally, there are between 10,000 and 20,000 different described species of seaweed, or macroalgae. In Norwegian waters, there are around 500 species. Most can be classified into three groups based on colour: red algae, green algae, and brown algae.

In Europe, the consumption of macroalgae as food is very low, even though historically it has been part of both diets and animal feed. Seaweed as food is most common in East Asia, but we are now seeing greater interest in harnessing the diversity of the ocean also in Europe," says Dr Hanne Mæhre from NIBIO.

However, it is important to exercise caution when harvesting seaweed for food as it absorbs harmful substances such as iodine and heavy metals from seawater. Generally, it is the brown algae that accumulate the most of these harmful substances. Yet, there are significant variations between species, growing locations, age, and seasons. Oarweed is a good example of a brown algae that should not be harvested for food.

As the use of seaweed has decreased, much of the knowledge about these resources has also been lost. To increase their use in the right way, it is therefore important to increase public knowledge about these raw materials.

"Since macroalgae grow in the ocean, they require neither agricultural land nor freshwater to grow. This makes them more sustainable alternatives for food and feed than many terrestrial plants," says Mæhre.

In the ALGEBRA project, NIBIO, in collaboration with Tuvsjyen AS, has developed prototypes of various products with the aim of facilitating increased use of locally harvested seaweed for the dinner table.



Purpose: In the ALGEBRA project, researchers at NIBIO have highlighted the most common macroalgae species found in Norwegian waters. The goal is to convey how edible algae in Norway taste, where they grow, and what they look like.

Collaboration: Tuvsjyen AS

Funding: Nordland County Council

Contact: Research Scientist Hanne Mæhre. Email: hanne.maehre@nibio.no, phone: (+47) 993 89 778. Division of Food Production and Society



Photo: Kathrine Torday Gulden

Educating tomorrow's experts on wood recycling

Most of the waste wood in Norway is sent for energy recovery. One of the key deliverables in CircWOOD is the education of Master and PhD candidates who, through research and development, can contribute to a more circular utilisation of our wood resources.

Every day, container loads of wood waste are dumped at Norwegian recycling facilities.

“Currently, nearly ninety percent of our wood waste goes for energy recovery. Even though the amount of reclaimed wood is approximately equal to the amount of wood used in new construction,” says Dr Lone Ross from NIBIO who leads CircWOOD.

The CircWOOD project explores the potentials and benefits of improved circular use of wood in Norway. Researchers are looking at resource availability of reclaimed wood, material flows, digitisation, environmental and climate impacts, economic effects, and policy frameworks.

“To succeed in an efficient and circular use of our wood resources, we need to increase knowledge and educate individuals with skills tailored to future tasks,” explains Dr Ross.

Therefore, one of our most important deliverables is the education of Master and PhD candidates who can

lead the research and development further in this area, even after the project is completed.

CircWOOD has employed three doctoral candidates affiliated with various research institutions. Several master's students are also working within the field.

Kristina Bringedal Gedde evaluates the quantities and qualities of reclaimed timber delivered to various recycling stations and is mapping the material flows of wood based on existing buildings and waste fractions.

Tom Erik Thorkildsen studies the overall socio-economic impact of transitioning from a linear value chain where wood waste is managed and incinerated, to a circular value chain where wood is systematically reused at its most valuable level.

Shumaila Khatri maps current regulations and attitudes that consumers and businesses have towards circularity.



Purpose: CircWOOD is part of the Green Platform project SirkTre with an aim to explore aspects of wood use in the Norwegian economy, with a particular focus on reusing reclaimed wood in construction projects, and reclaimed wood as raw material in today's wood industry.

Collaboration: NTNU, NMBU, Inland Norway University of Applied Sciences, Norwegian Institute of Wood Technology, Trefokus, Ragn-Sells, Oslo, Norwegian Wood Cluster, Omtre, Norwegian Forest Owners Association, Veidekke Entreprenør, the Norwegian Directorate of Public Construction and Property, and Construction Products Norway.

Funding: The Research Council of Norway

Contact: Head of Department / Head of Research Lone Ross. Email: lone.ross@nibio.no, phone: (+47) 911 97 268. Division of Forest and Forest Resources



Photo: Siri Elise Dybdal

Tools predicting pesticide leaching

Pesticides applied on fields can end up in unintended places, posing negative consequences for water and the environment. New tables are now set to assist farmers in predicting the likelihood of pesticide leaching in soil.

Chemical pesticides used on fields can be diverted and transported away from the intended area through surface runoff or leaching down into the soil. Studies have found numerous occurrences of such substances in both surface water and groundwater in Norwegian agricultural areas. This contributes to soil and water pollution.

The path taken by pesticides in soil depends on factors such as weather, soil type, and the chemical properties of the substances. However, farmers have few tools to assess the likelihood of such pollution on their own farms.

Commissioned by the Norwegian Agriculture Agency, NIBIO has developed tables over a three-year project showing the probability of leaching of a pesticide sprayed on cereals and potatoes under specific soil and climate conditions. The aim is for farmers to use these tables to identify the most environmentally friendly option among the available pesticides.

The tables will be updated annually, and by 2023, similar tables will be created for several of the important agricultural crops in Norway.

“We have collected significant amounts of data on climate, soil, and crop development for potatoes/new potatoes and cereals (autumn and spring) in the four major agricultural regions in Norway, as well as data on all approved pesticides for these crops. Together, this forms the basis for model simulations that provide an indication of whether a pesticide can leach into groundwater and, if so, at what concentration,” says Dr Roger Holten, project leader.

The results are summarised in tables showing pesticide concentrations down to two meters depth in all soil types for the cultivation of cereals and potatoes.



- Purpose:** Develop tables showing the probability of leaching of a pesticide sprayed on cereals and potatoes under specific soil and climate conditions.
- Collaboration:** Norwegian Agriculture Agency
- Funding:** Norwegian Agriculture Agency under the Action Plan for Sustainable Use of Pesticides (2021-2025)
- Contact:** Research Scientist Roger Holten. Email: roger.holten@nibio.no, phone: (+47) 915 92 762. Division of Biotechnology and Plant Health



Photo: Siri Svengård-Stokke

How does topography affect erosion?

The loss of soil particles and nutrients from agricultural areas, known as erosion, is considered one of the world's major environmental challenges, partly because it degrades water quality. Robert Jan Barneveld has investigated the relationship between the topography of agricultural landscapes and the erosion process.

Erosion has long been considered a significant problem in agriculture. This is because the nutrient-rich topsoil is most easily displaced by rainfall, snowmelt, and wind.

“Nutrient-rich topsoil runoff can reduce the water quality in freshwater bodies and degrade yield levels, soil quality, and soil structure,” says Dr Robert Barneveld.

He has explored the relationship between topography, which refers to the terrain conditions of a land area, and the erosion process. Using digital elevation models, laser scanners, and drones, he has examined how erosion affects the morphology of the soil surface, i.e., the external shape of the terrain, both before winter and after spring snowmelt.

The researcher's analyses show, among other things, that none of the most used methods for representing topography in erosion models work well enough.

“Most of the methods used today to measure the effect of topography on erosion stem from an equation developed in the 1960s, called the Universal Soil Loss Equation (USLE). Compared to a process-based model, none of them work particularly well, partly because most are limited to slope lengths of a maximum of 50 meters,” he explains.

With better methods it will be easier to assess where it will be effective to implement erosion control measures.

“This is important, especially considering that warmer and wetter weather is expected in the future, along with more frequent episodes of extreme weather. All of this brings increased erosion risk,” says Barneveld.



Purpose: Investigate how erosion affects the morphology of the soil surface before winter and after spring snowmelt in connection with a doctoral thesis completed at NIBIO and Wageningen University, Netherlands.

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Photo: Lars Sandved Dalen

Arctic GHG accounting: Holistic approach

Farmers in Northern Norway are faced with conflicting national goals of reducing greenhouse gas (GHG) emissions and increasing food production. In the project “Arktisk klimaregnskap” researchers propose a more holistic approach to mitigating climate change in agriculture in the north.

The natural growing conditions in the north can lead to higher GHG emissions from agriculture. Ruminant production, scattered parcels of agricultural land, lower yield potential, and cultivated peatlands are important factors.

Are Johansen from the Norwegian Agricultural Advisory Service advises Northern Norwegian farmers in mitigation measures. He says many farmers in the north perceive the focus on GHG emissions as demotivating due to a lot of negative publicity and few opportunities to make changes. The feedback led him to contact NIBIO in 2020. This resulted in the initiation of the pilot project “Arktisk klimaregnskap”.

The project is based on national guidelines stating that agriculture in Northern Norway should be maintained and strengthened, while also reducing GHG emissions.

“We have investigated how natural conditions in the north can be better considered in GHG accounting by using data derived by vegetation mapping and soil survey. Much of what we describe in the project can be transferred to other parts of the country as well,” explains Dorothee Kolberg, from NIBIO.

The project proposes using a two-step approach to mitigating climate change in agriculture. Step one focuses on the production types which are possible, considering the local natural growing conditions and national needs and goals. After that, a range of considerations are described for each individual farm as a basis for planning a more climate-friendly production.

“On a farm suitable for ruminant production with a lot of peat soil, there will be fewer possibilities to reduce emissions. Other farms may have the potential to do more,” Kolberg says.



Purpose: Data from soil survey and vegetation mapping can contribute to a more holistic approach to mitigating climate change in agriculture in Northern Norway. This approach is useful for the Norwegian Agricultural Advisory Service in providing advice on mitigation measures to farmers.

Collaboration: Norwegian Agricultural Advisory Service

Funding: The County Governor of Troms and Finnmark and Nordland County Municipality

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Photo: Endre Mogstad Ananiassen



The bumblebee whisperer

Many animals have fantastic noses. Dogs sniff out drugs, pigs unearth truffles, and rats search for landmines. Insects, too, can excel with a keen sense of smell.

In Norway, we rely on greenhouses to cultivate tomatoes, but not only tomato plants thrive in the warm and humid climate of the greenhouse. A greenhouse also provides favourable conditions for certain plant-harming fungi, which can lead to significant economic losses. Rapid detection and treatment of infected plants could be effective in preventing the spread of the fungus. However, identifying infected plants is challenging.

In the HumleSans (BumblebeeSense) project, researchers train bumblebees to sniff out infected plants. The bumblebees are trained to associate the scent of diseased tomato plants with food.

The researchers select the most active bumblebees in the colony. These are put into hibernation and secured in a “bumblebee chair.” Here, they are presented with the scent and sugar water. They use their antennae to smell and their tongues to lick up

the sweet liquid. This presentation of scent and sugar water is repeated ten times. Eventually, the bees will stick out their tongues only when they detect the scent, and the reflex is established.

Initially, the bumblebees are trained to respond to classic scents associated with flowers. Over time, the researchers will see if they can teach the bumblebees to recognize scents associated with fungus-infected tomato plants. If successful, there is hope that tomato producers can use bumblebees in greenhouses to sniff out infected plants.

The bumblebees can also leave traces on the plants they visit. They get a little paint on their legs, allowing them to mark the plants they touch. Large amounts of paint spots on a plant can be a sign that it is infected. This way, one can detect infected plants early and take measures to prevent the spread of the infection.



Purpose: Innovative concept with high potential providing a basis for future-oriented solutions to current issues.

Funding: FS-Pilot, NIBIO

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Photo: John Yngvar Larsson

Gathering knowledge about old trees

Knowledge about old trees is crucial for making informed decisions in the forestry sector in the future.

Old trees in the forest serve as vital habitats for many birds, insects, lichens, and mosses, thus playing a significant role in the biological diversity of the forest. However, there is relatively little research on how the composition of species changes as trees age. How many more rare species exist in ecosystems associated with old trees? And do we actually know where the oldest trees in Norway grow? They might not necessarily be the tallest or largest. Some trees may have grown slowly throughout their entire lifespan or remained suppressed in the forest when young.

This information is important because it informs us about the age of the forest when deciding what can be harvested and what should be preserved.

These are questions that concern Eivind Handegard. He is a PhD student at the Norwegian University of Life Sciences (NMBU) and NIBIO, with a specialisation in old trees. In his doctoral work, he addresses some of the knowledge gaps related to old forests.

“How long does it take for different species to appear? How significant is the difference between younger and older trees? These are some of the questions I am trying to find answers to. I particularly study different species of mosses and lichens on trees, saprotrophic fungi on deadwood, ground-dwelling plants in the forest floor, and mosses and lichens on rocks,” he says.

Handegard explains that, in general, old forests tend to have more variation in biodiversity because there are usually more old trees, trees of different sizes, clearings, and, not least, deadwood. Deadwood is an important habitat for several forest species, ranging from insects and fungi to various types of lichens. Standing deadwood, for example, becomes a home for cavity-nesting birds such as woodpeckers and owls.



Purpose: Studying old trees provides knowledge to make informed decisions in the forestry sector in the future.

Collaboration: Norwegian University of Life Sciences (NMBU)

Funding: The Norwegian Forestry Fund, Norwegian Agriculture Agency, and NIBIO

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Photo: Siri Elise Dybdal



New riskmodel for leaf blotch diseases in wheat

Starting this year, a new risk model for leaf blotch diseases in spring wheat is available for cereal producers on the VIPS website (www.vips-landbruk.no).

Leaf blotch diseases in wheat, such as *Septoria nodorum* blotch, *Septoria tritici* blotch and, tan spot can lead to significant reductions in yield and quality. These diseases survive on plant residues in the soil between growing seasons. *Septoria nodorum* blotch and tan spot can also be transmitted to seedlings through infected seed.

These fungal diseases are highly climate-dependent, with temperature and humidity playing a crucial role in the development of symptoms and spread in the field. Risk models that predict disease attacks can make it easier to assess the need for fungicides to manage leaf blotch diseases before symptoms appear in the field. The goal is to increase the farmer's financial return on input factors, such as time, energy, fuel and pesticides.

Now, a new risk model for leaf blotch diseases in wheat is available on the VIPS website. NIBIO researcher Dr Andrea Ficke explains that the risk model for leaf blotch diseases was developed based

on Norwegian field data collected over 15 years, cross-validated, and included in field trials in 2022 and 2023.

“The accuracy has been very good, and the model is available to advisors and cereal growers through the VIPS website. The model assesses the risk of leaf blotch attacks based on moisture and temperature during tillering and booting stages,” she says.

Another risk model from SEGES in Denmark, based solely on hours of high humidity, has been available on VIPS since 2020.

Integrated management of leaf blotch diseases, by using crop rotation, tillage, healthy seeds, less susceptible varieties, and risk models to optimize fungicide applications, has the potential to increase yields and the return on pesticide and fertilizer input, making farming more sustainable and economically attractive.



Purpose: Decision support for leaf spot diseases in wheat.
Collaboration: Norwegian Agricultural Advisory Service
Funding: Co-financed by SmartCrop (The Research Council of Norway) and knowledge development funds for IPV.
Contact: Research Scientist Andrea Ficke. Email: andrea.ficke@nibio.no, phone: (+47) 924 31 557. Division of Biotechnology and Plant Health.



Photo: Trond Knapp Haraldsen



New soils with reduced carbon footprint

Researchers and industry have collaborated to develop soil mixtures based on locally sourced waste from construction and demolition. The new soil mixtures are designed for green roofs and as topsoil for landscaping. Their properties are on par with commercial solutions.

In the project “Circular Soil Mixtures,” NIBIO has collaborated with Asplan Viak and the College for Green Development. NIBIO has contributed with expertise on soil and vegetation, as well as material assessments, design, and testing of soil mixtures.

Soil with bricks, compost, and biochar

In the project, two circular soil mixtures were developed for use on roofs, and two for use in landscaping. The mixtures are different but are based on components such as local surplus masses from construction sites, various, compost, crushed bricks, and biochar.

“A crucial part of the project has been to reduce carbon emissions from soil production,” says NIBIO researcher Dr Hans Martin Hanslin.

“Calculations in the project clearly showed that the incorporation of biochar and reduced transport were important to achieve this.”

More than 20,000 buildings are demolished annually in Norway, and in 2021, the construction and demolition industry accounted for 25 percent of all waste in the country. Increased local reuse will reduce the carbon footprint in the construction and demolition sector.

Tested for six months

The mixtures have been thoroughly tested for six months, however large-scale trials remain.

“We are pleased to have identified soil mixtures that seem to work well for the desired vegetation and meet the requirements for physical and chemical properties for both roofs and landscapes,” says Dr Hanslin.

The main challenge is finding recycled materials that either directly or after refinement comply with regulations while contributing to good growth conditions. High pH in the materials has been particularly challenging to address.



Purpose: Develop circular soil mixtures with a low carbon footprint.
Funding: Green Fund in the Ministry of Climate and Environment managed by Statsbygg.
Contact: Research Scientist Hans Martin Hanslin. Email: hans.martin.hanslin@nibio.no, phone: (+47) 404 75 239. Division of Environment and Natural Resources.



Photo: Erling Fløistad

Success for national livestock breeds

Native Norwegian livestock breeds are no longer critically endangered. Thanks to the systematic efforts of enthusiasts across the country, the story of Norwegian breeds of cattle, equine, sheep and goat has become a success story.

In the late 1980s, the status of 17 national livestock breeds was either unknown or “critically endangered.” Some of them were on the brink of disappearing forever. On the initiative of the Ministry of Agriculture and Food, the Genetic Resources Committee for Animal Genetic Resources was established in 1988, and thirty-five years later, conservation efforts have reached a significant milestone: none of the national livestock breeds are considered “critically endangered” anymore.

The success story is well-documented in the book “The Livestock Breeds That Wouldn’t go extinct,” published in 2023. Dr Nina Svartedal, at NIBIO Norwegian Genetic Resource Centre, was the editor along with Professor Odd Vangen at the Norwegian University of Life Sciences (NMBU).

“The best way to preserve livestock is to use them,” Dr Svartedal says. Today, traditional Norwegian livestock breeds have found their natural place on many small and medium-sized farms throughout the

country. They contribute to production of meat, milk, wool, and farm tourism by extensively utilising local feed resources.

Although the situation now looks brighter, it is crucial that the good work continues. “We see that some farmers are replacing Norwegian Red Cattle (NRF) with old native breeds. They seek a smaller cow while contributing to the conservation of our national livestock breeds.”

“People must be allowed to try and fail to find their way. Not all farming methods suit everyone. However, politicians must ensure conditions so that young farmers dare to invest in the future. If the conditions are right, the endangered livestock breeds native to Norway can look forward to a bright future,” Dr Svartedal says.



- Purpose:** To highlight that none of the national livestock breeds of cattle, sheep, goats, or horses are critically endangered anymore; they are only considered endangered.
- Funding:** NIBIO’s basic allocation.
- Contact:** Senior Adviser Nina Svartedal. Email: nina.svartedal@nibio.no, phone: (+47) 993 89 469. Division of Survey and Statistics.



Photo: Liv Jorunn Hind



Hunting for grassland fungi

Have you heard of honey waxcap, olive earthtongue or smoky spindles? These are among a large diversity of fungi that can be found in a traditional grazing landscape on the coast of Helgeland.

In the northern part of Norway on the coast of Helgeland, we find Tjøtta Farm. Here are particularly good examples of semi-natural grasslands that are traditionally managed, making them ideal for exploring fungal diversity.

Large parts of this grassland have been continuously grazed by sheep and cattle since the Viking Age, without fertilisation, ploughing, or reseeded. In this landscape, a significant diversity of grassland fungi has been found. Many are rare and red-listed for endangered species.

Modern agriculture has led to the abandonment or intensification of many traditionally managed pastures. As a consequence, semi-natural pastures are becoming increasingly rare, along with the diversity of grassland fungi related to them.

The diversity can survive a few years without livestock grazing. However, when trees and shrubs take over, the rare grassland fungi are outcompeted by more common woodland mycorrhiza fungi.

The situation becomes even more critical if the pasture is fertilised. Grassland fungi are highly sensitive to nitrogen, and with fertilisation, the rich diversity will be lost, possibly for ever.

Research Scientist Thomas Holm Carlsen regularly surveys the pasture on Tjøtta. In his experience, a single field visit is not sufficient to assess the diversity of fungi in an area.

“Fungi are mainly a network of hyphae that branch out underground. On the surface we merely see the fruits. The fungi only produce fruits when conditions are right. Therefore, we are in the field several times during the season to capture the diversity of grassland fungi,” he says.

“It’s pretty cool that an apparently dull mushroom can turn out to be a completely unique discovery if you just take a closer look.”



Purpose: To register vulnerable and rare species that have been poorly surveyed in natural pastures before.

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Photo: Inger Sundheim Fløistad

Preparing the ground for forest planting

The appetite of the pine weevil poses a significant risk to planted trees, especially in newly planted, steep, and warm hillsides on the western Norwegian coast. New research now demonstrates how soil preparation can contribute to providing protection for young spruce seedlings.

The pine weevil (*Hylobius abietis*) gnaws on the bark of small spruce seedlings, making plantations in western Norway particularly vulnerable to weevil attacks. Here, the weevils thrive especially well, leading to considerable seedling mortality.

To protect the seedlings from weevil damage, they are either treated with the chemical substance *Imprid Skog* or coated with wax or other types of coverings. Mechanical soil preparation, exposing the mineral soil, also proves effective against weevils. However, this can be challenging to implement along the coast due to steep terrain, lack of specialised equipment, and expertise. Excavators, on the other hand, are readily available in most places.

New research shows that soil preparation using an excavator, combined with effective plant protection, has a positive impact on preventing weevil damage, even in Western Norway.

In collaboration with AT Skog, NIBIO researchers established three experimental fields in the municipalities of Voss and Ullensvang in Vestland county. After planting in the spring of 2020, they explored the growth and survival of spruce seedlings under various combinations of soil preparation using an excavator and plant protection in the form of wax or *Imprid Skog*.

The conclusion after three years is that the results of soil preparation are promising. Soil preparation, combined with appropriate plant protection, yielded the best results for both growth and survival. While the costs of soil preparation increase with slope and branch quantity after harvesting, the method is worth considering where the terrain is not too steep, and other conditions are favourable.



Purpose: New research reveals how soil preparation can contribute to providing protection for young spruce seedlings against the pine weevil.

Collaboration: AT Skog

Funding: The Development Fund for Forestry and The Norwegian Forestry Fund

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Photo: Erling Fløistad



Electronic nose detects plant pests

Foreign plant pests pose a significant threat to plant health and safe food production. In a new Horizon Europe (HEU) project, researchers aim to develop an electronic nose capable of sniffing out pests during the import of plants, thus preventing their spread.

Various types of plant pests often accompany imported plant material as stowaways. They can be challenging to detect and spread quickly, posing a substantial risk to native food production system and natural ecosystems. In the new HEU project 'PurPest', researchers from across Europe collaborate to develop a sensor platform that makes aims to accelerate identification of plant pests during import. The sensor will function as an electronic nose, capable of detecting the pests through volatile compounds, commonly referred to as odors or scent.

"All plants emit volatile compounds, a kind of plant odour or scent," explains Dr Andrea Ficke, who coordinates the 'PurPest' project.

"The scent profile, i.e., the composition of the compounds emitted by the plant, changes when the plant is attacked by a pest. Attacks from different pests result in different scent profiles."

This principle will be used to create a user-friendly sensor capable of detecting a selection of five pests on their respective hosts. The sensor will facilitate the detection of pests during import control and in the field. If a pest is detected, users can implement targeted measures, precision application of pesticides in the field.

The project will also work on establishing new guidelines related to plant import, crucial to preventing the spread of plant pests across borders.

"In the project, we collaborate across multiple disciplines and work closely with plant producers and plant importers. The goal is to develop technology and guidelines relevant to the users," Dr Ficke says.



- Purpose:** The project aims to prevent the import of serious plant pests and control outbreaks in the field by developing a sensor platform that can quickly and easily detect infected plants.
- Collaboration:** SINTEF AS, NTNU, Plant and Import Control AS, and several international universities and research institutions.
- Funding:** EU program Horizon Europe, National Research Councils from the United Kingdom and Switzerland.
- Contact:** Research Scientist Andrea Ficke. Email: andrea.ficke@nibio.no, phone: (+47) 924 31 557. Division of Biotechnology and Plant Health.



Photo: Kathrine Torday Gulden

Higher yields for Indian smallholders

The smallholders participating in the NIBIO-coordinated Resilience project in India are experiencing improved water productivity, higher yields and increased income.

The purpose of Resilience project was to contribute knowledge and capacity building that can make the agricultural production of Indian smallholders more sustainable and resilient to climate change. The project, ongoing since 2018, is being implemented in the states of Odisha and Assam, located in the east and northeast of India, respectively.

Various types of climate-smart agricultural technologies have been demonstrated from the project. For instance, a rice variant called Ranjith sub-1, which is resistant to climate change and flood-tolerant, is now cultivated and produced by thousands of farmers in Assam state. Climate smart seed production systems, led by smallholders through a public-private partnership model, has been successful with the support from Assam Agricultural University and project partners including NIBIO.

“So far, the smallholders trained in the project have produced more than 2000 tonnes of flood-tolerant rice seeds,” says Dr Udaya Sekhar Nagothu.

“They have also produced the purple rice variant, which has high market value and is easily marketable due to its high nutritional content.”

He adds that alternate wetting and drying irrigation and direct-seeded rice systems has yielded good results in terms of increased water productivity and reduced methane emissions compared to conventional paddy rice systems where seedlings are planted in water-saturated soil.

In addition to cultivating new rice varieties, smallholders have received assistance in growing legumes, fruits, and vegetables, either in rotation or parallel to rice production. To promote precision agriculture, several digital tools have been developed in the. Additionally, locally run Village Knowledge Centres ensure that information ranging from weather conditions to plant diseases is conveyed to farmers via smartphones and social media.



Purpose:	To contribute to more sustainable and climate-resilient food production among smallholders in India.
Collaboration:	NIBIO (Coordinator), Assam Agricultural University, National Rice Research Institute, Orissa University of Technology and Agriculture, International Water Management Institute, M. S. Swaminathan Research Foundation.
Funding:	Ministry of Foreign Affairs through the Norwegian Embassy in New Delhi, India.
Contact:	Senior Research Scientist Udaya Sekhar Nagothu. Email: nagothu.udayasekhar@nibio.no , phone: (+47) 990 15 621. Division of Environment and Natural Resources.



Photo: Hege Ulfeng

Map portal for climate-smart farming

The growing season of 2023 saw too much water in the north and too little in the south. The map portal Kilden assists farmers and advisors who want to prepare for unpredictable precipitation amounts.

“Kilden has a variety of maps that are not found in Gårdskart. On Kilden, I find most of the maps I need, along with good drawing and measuring tools,” says Torgeir Tajet, advisor for vegetables and hydrotechnics at the Norwegian Agricultural Advisory Service.

Tajet uses the map portal, among other things, to plan measures that protect against erosion. This is both to retain soil in the field and to avoid poor water quality in watercourses. One of the projects he has worked on is an action plan for parts of the Ramnes River in Tønsberg municipality. The riverbank here has collapsed in several places. As a result, farmers lose soil and particles and nutrients pollute rivers and lakes.

Old aerial photos and soil maps provide important background information. From Kilden and a couple of other map portals, Tajet finds old aerial photos, information about soil, elevation data, the size of the riverbed, and precipitation data. This forms the basis for calculations and proposals for measures.

“Last but not least, it is important to have good working drawings. Kilden has a good drawing tool, and various aerial photos and maps can be used as a background. This makes it easy for those implementing measures to know what needs to be done where. It can also be used by farmers. For example, it can be useful in connection with applications for SMIL grants,” says Tajet.

Kilden provides a substantial collection of relevant map data for agriculture and forestry. Tove Vaaje-Kolstad explains that one of the advantages of Kilden is that multiple theme maps can be layered, making it easier to see connections and conflicts when planning measures and changes in land use.



- Purpose:** The map portal Kilden contains map data from NIBIO and other stakeholders that are useful for the agricultural industry and management.
- Collaboration:** Norwegian Agriculture Agency (Field of Forestry Portal and Reindeer Husbandry)
- Funding:** NIBIO, Norwegian Agriculture Agency
- Contact:** Head of Department Tove Vaaje-Kolstad. Email: tove.vaaje-kolstad@nibio.no, phone: (+47) 930 08 377. Division of Survey and Statistics



Photo: Siri Elise Dybdal



2023 saw mixed maturity in cereal fields

The dry period in early summer followed by a wet autumn in 2023 led to multi-generational cereal growth in many places, posing a challenge for cereal farmers.

Challenging weather conditions in the growing season of 2023 resulted in what is technically known as mixed maturity. In simpler terms, many fields had different generations of cereal crops growing at the same time in various stages of development.

Mixed maturity can make it difficult for the farmer to determine when to harvest. The second generation is often superior to the first, but achieving this requires a sufficiently long growing period to wait for it to mature. Therefore, the farmer must assess whether he has the time to gamble on the second generation. If so, he cannot thresh when the first generation is ripe. Should he choose to focus on the first generation, the immature second generation creates problems during harvest.

In 2023, there was significant variation in the fields, both locally and between regions. We still have no definitive answer on how the season went. Final figures will not be available until later in 2024.

“We received some early predictions in September. At that point, the consequences of the wet autumn began to emerge. The prospects for this year’s yield were estimated at 67 percent of last year’s, and there was an estimated need to import over 203,000 tons of food grain,” says Einar Strand.

It was bad, but it got worse. Persistent and heavy rainfall throughout the autumn resulted in poor quality of both the first and second generations. Additionally, there were fields that either weren’t harvested or had such low quality that the produce couldn’t be sold.

“In the predictions as of 15 November, they have adjusted down the yields to 57 percent of last year, estimating an import need of over 218,000 tons of food grain. At the same time, the Norwegian Agricultural Agency reports receiving almost 7,500 applications for compensation for crop damage,” says Strand.



Purpose: Every year, NIBIO provides estimates of grain areas, and Norwegian Agricultural Advisory Service gives yield forecasts commissioned by Felleskjøpet Agri, which is the market regulator for grain. The market regulator is responsible for optimising the use of Norwegian grain and thus needs early forecasts on yield and quality to determine import quotas, among other things.

Collaboration: Norwegian Agricultural Advisory Service and Felleskjøpet Agri

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Photo: Dan Aamlid

Birch in growth

Birch is more than just firewood. This tree species is used for furniture, paneling, knife handles and can play a more important role in Nordic design. A new report from NIBIO highlights the potential for more quality-adapted use of birch.

“People need to be less afraid of planting and using birch,” says Dr Katrin Zimmer.

As one of the authors behind the most comprehensive report on birch in Norway to date, Dr Zimmer is clear, and the conclusion is evident: in a design context is birch the smaller and less famous sibling to ash and oak can be utilised for a lot more than just firewood.

She explains that the potential is large. Birch is traditionally important, but it is also our third most important tree species – after spruce and pine. As a raw material, birch timber can be used for various applications, including packaging and furniture, but also as carpentry material or in load-bearing structures.

Dr Zimmer sees significant potential for the development of more birch-related industries.

“But we need more knowledge. Among other things, we lack accurate figures for strength grading and sorting of birch timber.”

Even forest owners have become more aware of birch. It grows quickly, is not susceptible to root rot and is aesthetically pleasing. Moreover, birch is a robust tree with regard to climate change.

Geir Korsvold at Glommen Mjøsen Skog says that most birch timber is sold as firewood, but they also export some as pulpwood to the Swedish cellulose industry. He thinks more birch could be sold as saw timber. Knot-free birch with straight trunks can be achieved through good forest management.

The report “Birch in Norway” provides an overview of the amount of birch, predictions for volume and growth, current uses of birch, potential uses, bottlenecks, and barriers for increased birch utilisation. Additionally, it reviews existing knowledge on birch regeneration and management.



Purpose: Acquire more knowledge about the characteristics of birch.

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Photo: Siri Svendgård-Stokke



More roots for more sustainable agriculture

Growing plants for food production generally leads to a net loss of carbon from soil in the form of carbon dioxide, which is the greenhouse gas contributing most to climate warming. Now, researchers are investigating what it takes for more carbon to remain in agricultural soils.

For a long time, the aim of plant breeding was to provide highest possible yields. Much of the roots were bred away because the plants did not require as many when supplied with nutrients from artificial fertilisers. As it turns out, smaller root systems can have negative consequences for the climate.

In 2005, a group of researchers discovered that carbon from roots remains in the soil for a longer time than originating from above-ground plant residues.

“We examined a whole range of studies that compared the ability of roots and shoots to store carbon in the soil,” says Dr Daniel Rasse. “We found that carbon originating from roots, on average, remains in the soil more than twice as long as carbon from shoots.”

There are several reasons for this. Roots break down more slowly due to substances resistant to decomposition. Additionally, root material adheres better to

mineral particles in the soil, protecting against microbial breakdown.

NIBIO has several on-going several research projects investigating the size of root systems in field crops and how this affects carbon sequestration in Norwegian agricultural soil. One of these is the European project MaxRoot C, where NIBIO examines the root systems of 13 wheat varieties.

“Our field is the northernmost in the project. We investigate the size and depth of the root systems of the wheat varieties and how well the varieties are adapted to Norwegian conditions. The goal is to find varieties with larger root systems without compromising aboveground yields,” says Dr Teresa Gómez de la Bárcena.

More knowledge about the ability of root systems to store carbon in the soil is a significant contribution to a more climate-smart Norwegian agriculture.



Purpose: Investigate how the root systems of field crops and catch crops affect carbon sequestration and carbon supply in Norwegian agricultural soil.

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Photo: Morten Günther

E-bells for insight into outfield grazing

While half of holidaying Norwegians ventured abroad this summer, almost two million Norwegian sheep embarked on a domestic vacation. Around five percent of them wear e-bells, providing a unique source of knowledge on the use of forest and mountain pastures in Norway.

E-bells, also known as radio bells, enable farmers to monitor the summer adventures of their sheep. Marit Mjøen Solem is both a sheep farmer and the managing director of the company FindMy, which produces e-bells. She explains that e-bells offer valuable information about where the sheep spend their vacation.

“Sheep are creatures of habit. Ewes with adult daughters and lambs form small family flocks that visit the same grazing areas year after year. Grazing areas are passed down from ewes to lambs for generations. Within the grazing area, weather conditions significantly influence their choice of location. E-bells also help farmers keep better track and, for example, assist sick animals,” she says.

The sheep’s summer holiday is, in many ways, a food journey. Analyses conducted by NIBIO show a strong

correlation between pasture quality and sheep grazing, but there can be significant individual differences. If the e-bells indicate that family flocks are staying in poorer parts of the grazing area, farmers can use salt licks or implement other measures to guide the sheep to the best areas.

Michael Angeloff has conducted analyses comparing e-bell data with results from vegetation mapping. His focus is on how the various data sources about sheep and grazing quality can contribute to increased knowledge about outfield grazing.

“E-bell data opens up an entirely new field of research. Now we can study the behaviour of freely roaming animals. In addition to being a useful tool for livestock owners, e-bells provide knowledge that can help solve challenges related to outfield grazing,” he says.



Purpose: By combining information from e-bells with the results of vegetation mapping, valuable insights into the use of outfield areas by grazing animals can be gained. This is useful for farmers and municipal land planning.

Collaboration: Grazing cooperatives

Funding: NIBIO’s core funding (CU funds) and various other sources of funding

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Photo: Siri Elise Dybdal

How can forest expectations be met?

Forests face conflicting social, economic, and ecological demands. Researchers have now employed optimisation to identify the best combination of forest management regimes.

Forests are crucial for biodiversity, economic growth, and ecosystem services such as carbon storage. They also play a crucial role in the bio-based economy. However, these conflicting objectives have often led to different policy responses nationally and within the EU. In the MultiForest project, researchers sought to analyze the impacts of policies and management practices to gain new insights into forest policy, forest management, and land-use planning across Sweden, Finland, Norway, and Germany.

“Different policies often emphasise conflicting societal needs and are developed without sufficient coordination. This may lead to inefficient management and varying levels of forest ecosystem benefits.” says Dr Clara Antón Fernández from NIBIO.

To identify best combination of forest management regimes, researchers combined simulation and optimisation to analyse how the current policies

cause incoherence between diverse forest functions and how to improve the interaction between diverse policy goals.

The results showed that Norway can meet the demand for timber by 2093, but the provision of ecosystem services will be significantly influenced by policy objectives. Bioeconomic and national forest policy goals resulted in similar forest management programs. However, guidelines for biodiversity led to an increase in protected areas, continuous cover forestry and multispecies management regimes. The increase in protected areas, however, could be offset by higher management intensity elsewhere.

Increased logging has potential as a climate measure in Norway but affects other ecosystem services and biodiversity. Therefore, it is important to avoid placing excessive emphasis on the role of forests as climate change mitigation strategy.



Purpose: To identify the optimal combination of forest management regimes in Sweden, Finland, Norway, and Germany.

Collaboration: Several European institutions

Funding: Horizon 2020

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Photo: Tommi Nyman

Transnational efforts to save Caspian seals

Pollution, illegal hunting, global warming and disease pose a serious threat to the Caspian seal. NIBIO's genetic experts have teamed up with the Caspian Seal Research and Rehabilitation Center (CSRRC) in Kazakhstan to help save this endangered species.

The Caspian seal exists solely in the Caspian Sea, the world's largest inland sea located between Europe and Asia. For centuries, it has been hunted, and since the beginning of the 20th century, the population has declined from around one million individuals to just over 70,000.

In 2018, the Caspian seal was red-listed. Nevertheless, illegal hunting persists. The seal's existence is also jeopardised by oil spills, pollution, disease, and climate change.

Geneticist Dr Tommi Nyman has worked with the Saimaa ringed seal found only in the Finnish lake Saimaa. His studies indicate low genetic variation in the Saimaa seal population, suggesting a high degree of inbreeding.

Now, he aims to determine whether inbreeding poses a threat to the Caspian seal.

“Genetic variation is crucial for the survival of endangered species. A declining population com-

ined with increased isolation can lead to reduced adaptability,” he says.

Dr Nyman conducts genetic analyses on seal parasites, namely lice, which are transmitted between seals through close contact. If louse pairs found on seal individuals have a similar genetic makeup, it implies that the lice and their hosts likely mate exclusively within their subpopulations.

Aselle Tasmagambetova, founder of CSRRC, states that NIBIO's analyses on seal parasites can provide valuable information about the Caspian seal's origin, health, and life cycle.

“Currently, there are few unified regulations in the countries around the Caspian Sea to protect the Caspian seal. Research can lay the foundation for common guidelines and actions to ensure the seal population survives and eventually increases in size,” she says.



Purpose: Genetic analyses of endangered seal species and their parasites to uncover the level of inbreeding and movement patterns.

Collaboration: Rare Pinniped Conservation Network (RAPCON)

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Photo: Siri Elise Dybdal



From lawn to weed garden

On Thursday June 8, 2023, a weed garden was opened at Campus Ås. The garden is based on the legacy of Emil Korsmo, the pioneer of weed research in Norway.

Korsmo's modernised weed garden is a collaboration between NIBIO, NMBU, and Vitenparken. It will be used for educational purposes and public outreach.

63 different weed species will adorn the weed garden, designed by landscape architects at NMBU's Property Department.

While biology and weed control play a central role in outreach efforts, it is important to note that weeds can also be useful. They act as essential sources of pollen and nectar, supporting beneficial insects for both pollination and pest management. This aspect will be emphasised in the weed garden.

Research Professor Ingeborg Klingen states that along with Korsmo's beautiful weed illustrations and informative books, the weed garden will be an attraction for visitors, courses held for education of national governmental bodies, agricultural industry and students at Campus Ås.

NIBIO owns "Korsmo's weed illustrations" - a series of beautiful and detailed botanical illustrations from the 1930s, produced by Emil Korsmo and the artist Knut Torkildsen Quelprud, and a few other illustrators. The illustrations are well-known and used as educational tools in several countries.

Professor Lars Olav Brandsæter at NMBU, says that Korsmo systematised weeds in a new way, grouping them biologically based on their lifespan, method of reproduction, and type of root system. Understanding these aspects is crucial to comprehending how various weeds can be controlled.

Weed researcher at NIBIO, Dr Wiktorija Kaczmarek-Derda, explains that many of the species are part of research projects. Having the garden nearby is practical for in-depth discussions with collaborators and other visitors. The garden also serves as a valuable source for small reference collections related to various research activities.



- Purpose:** Establishment of a weed garden for teaching of students, industry professionals, and authorities, as well as public outreach.
- Collaboration:** Norwegian University of Life Sciences (NMBU) and Vitenparken
- Funding:** NIBIO and NMBU
- Contact:** Head of Department/Head of Research Ingeborg Klingen. Email: ingeborg.klingen@nibio.no, phone: (+47) 930 92 211. Division of Biotechnology and Plant Health



Photo: John Yngvar Larsson

Warmer climate yields more heat-loving trees

What do trees do when the climate changes, and the weather gets warmer? The trees' temperature requirements provide us with the answer.

Trees are at the mercy of the local conditions they grow in. They need sun and warmth to germinate and thrive, and summer temperatures affect how far north and how high up the mountains they can grow. However, some types of trees, such as dwarf birch, are not so picky about temperature. As long as the mean temperature of June, July, August, and September is above 4.3 degrees, dwarf birch will grow.

The dwarf birch has the lowest summer temperature requirement of all Norwegian tree species. More heat-loving tree species like elm, ash, beech, oak, hazel, lime, maple, and black alder demand higher summer temperatures. Precisely this high temperature requirement is the reason why species like ash, oak, and beech are only found in certain areas in the southern part of Norway.

But what happens if the average summer temperatures increase?

Increased temperatures over the past century have allowed different tree species to grow further into the country and higher up in the mountains than before.

Therefore, when forest owners plan for the future, knowledge is needed about how temperature changes affect the growth and development of trees. The tree species we choose to plant today – whether it is spruce, pine, birch, black alder, or beech – will have to grow and thrive in an entirely different climate than today.

Climate researchers at NVE and NIBIO have thus produced maps showing changes in mean summer temperatures over the last 60 years. Changes in mean temperature of the four summer months are relevant for forestry, in that heat-loving trees like beech, for example, might extend further into the country – if other important requirements are also met.



Purpose: Develop maps illustrating changes in temperature during the growing season as a basis for selecting future tree species.

Collaboration: The Norwegian Water Resources and Energy Directorate (NVE)

Funding: The Research Council of Norway

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Photo: Anette Tjomsland Spilling



Book on Norwegian wildflower meadows

Many natural habitats and species closely linked to the cultural landscape are currently under threat. In a new book on Norwegian wildflower meadows, the authors aim to inspire the public to participate in preserving our biodiversity.

Approximately 47,000 plant and animal species have been identified in Norway. Of these, 2,752 species were listed as endangered in the “Norwegian Red List for Species 2021.” Almost 30 percent of these endangered species are culturally influenced, meaning they thrive in habitats shaped by traditional agricultural practices such as logging or leaf harvesting of trees, mowing or grazing of pastures and regular bush burning.

Researchers collaborate with authorities and landowners to conserve these species-rich habitats, but the rate of decline is outpacing restoration efforts.

In the book *Norwegian wildflower meadows: role models, seed mixtures, establishment, and management*, the authors aim to provide each of us with more knowledge about the landscape’s history, combined with practical advice on how to contribute to increased biodiversity.

“Old hay meadows should serve as role models in establishing new wildflower meadows. Norwegian wildflower meadows cannot be established using imported seed mixtures,” says Dr Ellen Johanne Svalheim.

Throughout history, hay meadows have evolved into “living gene banks.” Each hay meadow has its characteristics where different flowers and plants produce seeds at different times throughout the season. The authors want to foster a more conscious approach to the type of wildflower meadow that should be established in different locations.

“When establishing your own wildflower meadow, it’s best to collect plants or seeds locally where you live. A good tip is to find a hay meadow nearby and use it as a model. You can also purchase regionally adapted seed mixtures from NIBIO,” says Dr Svalheim.



Purpose: In the book “Norwegian Wildflower Meadows,” the authors aim to inspire each of us with knowledge about the landscape’s history of use, combined with practical advice on how to contribute to increasing biodiversity.

Collaboration: Western Norway University of Applied Sciences, University of Oslo, and Norwegian University of Life Sciences.

Funding: The Savings Bank Foundation DNB

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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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