

Annual Review 2021



NordGen



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INTRODUCTION



Lise Lykke Steffensen, Executive Director, NordGen, sums up the year of 2021. See the video [here](#).

Society faces major challenges with climate change, biodiversity loss, development of bioeconomy and an agenda that requires new plant-based solutions. Genetic resources are the biological basis that will help us ensure future climate-smart solutions, resilience in our ecosystems and secure competitiveness in the Nordic countries. In 2021, we have noticed an increasing demand for our knowledge, services and not least seeds from the genebank.

Fundamental Elements

Biological and genetic diversity is one of the fundamental elements in the work for a sustainable future. Climate change is currently happening faster than nature's ability to adapt, that is why our mission is more important than ever. Genetic diversity is a prerequisite for sustainable food production and for achieving several of the global sustainability goals.

Specifically, our task means that we handle a genebank with around 33,000 different seed samples that must be constantly analyzed, tested, propagated and distributed to researchers and plant breeders. We make conservation plans for the endangered livestock breeds and work for genetically strong and resilient forests. We participate in countless projects and networks related to genetic resources at both Nordic, European and international levels, and we bring together industry professionals in the Nordic countries.

The Nordic Council of Ministers' vision of a green, competitive and socially sustainable Nordic region is thus high on NordGen's agenda.

COVID-19 Response

The year 2021 has been strongly marked by the Covid-19

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pandemic's influence on the work of NordGen. NordGen's management chose to maintain restrictions when necessary. The work of conserving the genebank's material and the distribution of seeds has worked almost normally, whereas, the pandemic made other operations more difficult. Nevertheless, the continued usage of online webinars and similar digital solutions have been very useful and the experiences from the pandemic has shown that our crisis management is working and that NordGen staff has made an extraordinary effort that allowed us to continue the operations nearly as usual.

Strategy 2020-2022

NordGen is in the middle of its strategic period 2020-2022, and in 2021, continuing efforts with conservation activities was emphasized with a high fulfillment of strategic goals. Special attention has been paid on the project "No regeneration backlog by 2024" and the base warehouse in Denmark. The year 2021 also accelerated the work with utilization of the genetic resources within documentation, characterization and evaluation of the genetic resources.



New Main Office

In 2021, the construction of NordGen's new main building and knowledge center began – a house that is better adapted to a genebank's operations. The new building will be of great importance for the general operations and have a positive impact on the work environment. This building will have a Nordic expression that fits NordGen's high sustainability goals – a wooden building including features such as sedum roof promoting local biodiversity and solar panels for more sustainable energy production. The relocation is supported by the Swedish Ministry of Trade and Industry.





ABOUT NORDGEN

Nordic Genetic Resource Center (NordGen) is the Nordic Knowledge Center for plant, animal and forest genetic resources as well as the Nordic genebank for seeds and plants. The institution was established in 2008 as a merger between the Nordic Genebank (established 1979), Nordic Genebank for Farm Animals (established 1983) and the Nordic Council for Forest Reproductive Material (NSFP) (established 1970).



As a knowledge center and genebank, NordGen's mission is to safeguard the Nordic genetic resources and facilitate the sustainable use for agriculture, horticulture and forestry, for current and future generations. The mission also includes providing knowledge and genetic material to facilitate sustainable food and feed production and other biobased solutions in the Nordic region's changing climate.

As a knowledge center, NordGen also promotes collaboration between farm animals, plants, forest and the environmental area as well as disseminates knowledge and raises awareness about genetic resources. NordGen also promotes management and competences within the three disciplines.

NordGen provides technical advice and information to decision makers in the Nordic countries in national and Nordic collaborations and international negotiations on the conservation and sustainable use of genetic resources.

NordGen has a special responsibility for conserving and documenting genetic variation of Nordic material to ensure biodiversity and sustainable use of genetic resources. As early as 1979, the Nordic countries decided that a joint Nordic genebank for plants should conserve and facilitate the utilization of national plant genetic resources.



In the 2004 Kalmar Declaration, the Nordic countries have

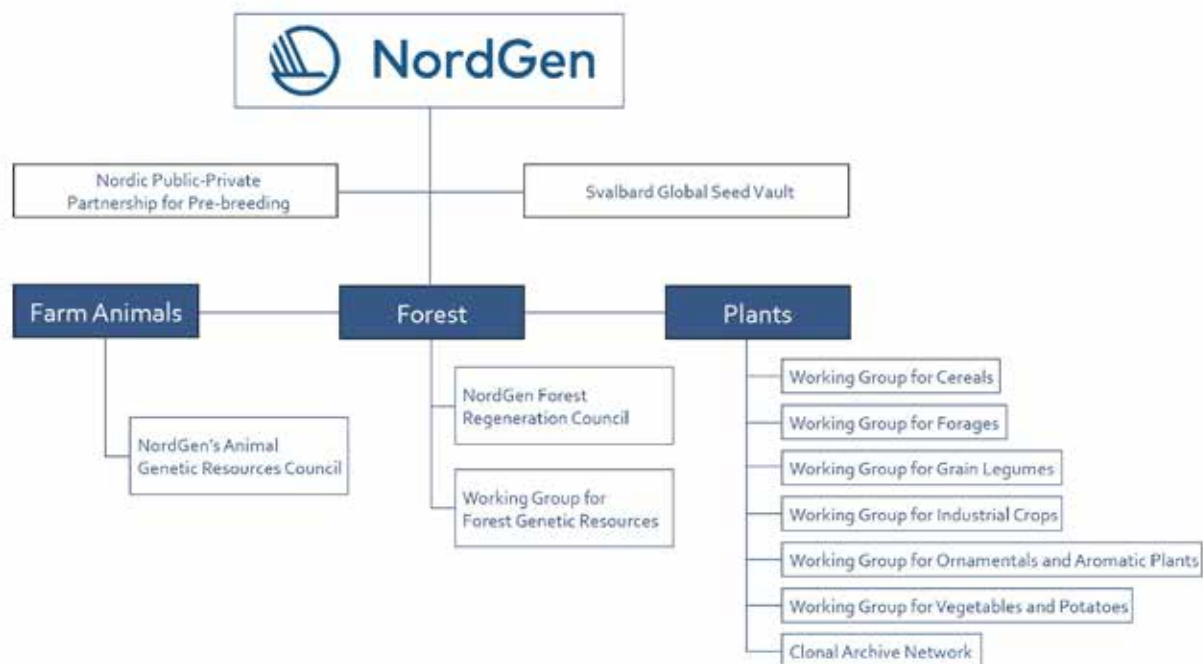
adopted the basis for how NordGen should manage access and rights to genetic resources. All accessions in the genebank, except for collections held by NordGen for other genebanks, are under joint Nordic management and are a common good.

The genebank's seed collection should contribute to more resilience and new solutions to avoid biodiversity loss and contribute to increased use of genetic resources to achieve sustainable climate solutions, robust food and feed supply including new protein sources, better health and sustainable ecosystem services. At the same time, efforts will be made to improve documentation by characterizing and evaluating the seed collection, so that more data becomes available to the Nordic community.

NordGen manages the program Nordic Public Private Partnership for Pre-breeding (PPP), which aims to support the development of Nordic plant pre-breeding.

NordGen has the operational responsibility for the Svalbard Global Seed Vault in a partnership with the Ministry of Agriculture and Food in Norway and the Global Crop Diversity Trust.

Figure 1: Organogram - NordGen

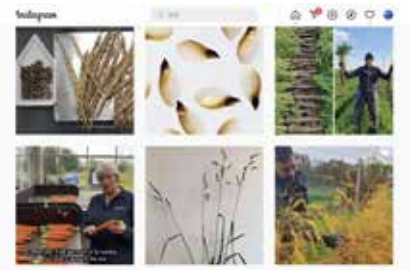




KNOWLEDGE CENTER

As the Nordic knowledge center for genetic resources, NordGen participates in and leads projects, arranges outreach activities and shares information with relevant stakeholders concerning conservation and sustainable use of genetic resources important for food and agriculture. NordGen is also participating in several Nordic, European and International networks and commissions.

Our most important tools for exchanging knowledge within the Nordic countries are our working groups and councils. The different working groups of NordGen Plants, the working group and the council of NordGen Forest and the council of NordGen Farm Animals are vital advisory groups consisting of experts within each field from all the Nordic countries. The Board of NordGen also provides valuable input and knowledge exchange. Information is disseminated through our website nordgen.org, social media, project reports, press releases, arranged events, network meetings and targeted e-mails.



Followers Social Media	2020	2021
Instagram	1.592	2.156
Facebook	3.192	3.563
LinkedIn	1.050	1.175
Twitter	779	1.287

Table 1: Social media statistics

In 2021, NordGen continued developing its competence within digitalization considerably. Video online meetings and seminars has increased the bridgebuilding over country borders, both internally and externally. Externally, our digital competence has enabled us to reach a wider audience that can take part in

important knowledge sharing events concerning genetic resources without having to spend time and resources on travelling. It is expected that NordGen will continue to use these digital options at future events, after the pandemic.

During the year the work with the new website continued. The site is now easier to navigate, more visually appealing and in accordance with the new European web accessibility rules. It also has, apart from a Scandinavian and English version, a Finnish version enabling us to reach members of a very important target group in their native tongue.

During 2021, NordGen also conducted a digitization of the library in Alnarp and ensured a successful migration from the old system SESTO to the library system Koha. A classification system of international standard was also introduced and the catalog of the collection is now available online.

New Main Building and Knowledge Centre

In May, the groundbreaking ceremony of NordGen's new main building and knowledge center was held. The house consists of 1,700 square meters spread over two floors filled with offices, modern lab premises and a 300 square meter big seed storage.

NordGen's old main building is an old warehouse, originally used for storing apples. The new facilities are adapted to a genebank's operations and will give NordGen's staff better conditions to carry out their work – at a time when these activities are more important than ever.

NordGen has high sustainability goals and in order for the building to have as small a climate footprint as possible. Therefore, the house is built of wood. The roof will also be equipped with both green sedum and solar cells that will generate around 60,000 kWh of green electricity each year and correspond to 100 percent of the building's property electricity and 35 percent of the business's energy use.

The construction of the new house was made possible thanks to the Swedish government, the Nordic Council of Ministers and Akademiska Hus.

In the following pages, our different sections and their activities in 2021 will be introduced in more detail.



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Knowledge Centre – NordGen Plants

We live in a time when climate change is affecting our ability to grow our own food. Drought, floods and higher mean temperatures means that developing new plant varieties that can withstand the new challenges are more important than ever. But no plant breeding is possible without the green infrastructure stored in the DNA of seeds. And not even advanced gene technology can replace the natural genetic diversity that we find in our wild, semi-wild and cultivated crops. The most important task of NordGen Plants is to safeguard and facilitate the sustainable use of plant genetic resources that are important for agriculture in the Nordic countries. By doing so, we create conditions for a more environmentally friendly agriculture that can better withstand diseases, climate change and at the same time produce more nutritious food that corresponds to the consumers' demands.



Key Activities

The research conducted at NordGen Plants is mostly carried out within different projects. Read more about this under the section "Projects".

Development of a State-of-the-Art Facility

To ensure the establishment of a new infrastructure for backup storage of the Nordic plant seed collection, NordGen was granted more than 8 million DKK from the Danish Novo Nordisk Foundation. The infrastructure will improve conservation, long-term viability and characterization of plant seeds and can contribute to scientific progress in future crop production as it will allow for an extensive overview and description of plant seeds for the benefit of researchers, educators, and breeders in the Nordic countries and worldwide.



A project plan has been prepared for repackaging and quality assurance of all samples and work on this is expected to be completed by the end of 2023. The project activities that continued in 2021 will lead to an increased value and a considerable improvement of the Nordic seed collection and its safety. During the year, the transfer of all back-up copies from the old base stock to the new walk-in freezer was completed.

Nordic Collaboration

Under normal circumstances, NordGen is part of and arranges several different meetings and seminars for the Nordic stakeholders concerning plant genetic resources. But just as in the previous year, 2021 was not a normal year and many of the

planned activities had to be postponed, or reorganized to digital meetings, due to the pandemic. One of the exceptions was the stakeholder workshop within the Crop Wild Relatives project that was possible to arrange on site in Oslo in November. However, during 2021 NordGen continued to experience an increased demand for knowledge on utilization of the plant genetic resources from public and private research programs, that reaches out to NordGen for collaboration within utilization of the genebank collection.



International Collaboration

Preserving and distributing genetic resources requires international collaboration, and the foundation for this work is laid out in the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) and the Convention on Biological Diversity (CBD), ratified by all the Nordic governments. To NordGen, as part of the global genebank community, international collaboration is crucial. Forums for this work is the Governing Body to the ITPGRFA and the Commission on Genetic Resources for Food and Agriculture (CGRFA), The European Cooperative Programme for Plant Genetic Resources (ECPGR) and the Conference of the Parties (COP) to the CBD.

NordGen Plants is the largest department. It is divided in two, with the genebank maintaining the Nordic seed collection of 33 000 seed samples and the research department working in a close relationship with public institutions, plant breeding companies and other organizations in order to identify green solutions for a more sustainable society.

A central part of NordGen Plants is the seven different Working Groups on plant genetic resources that together with the national programs constitute the very core of NordGen's network of Nordic experts. They are an important link between the Nordic and the national technical work within a specific species group. The working groups contribute with insights to each Nordic country's operations with genetic resources and is also important for knowledge exchange and network contacts.

Knowledge Centre – NordGen Farm Animals

The genetic diversity that our Nordic native farm animal breeds carry is invaluable. Over hundreds of years, they have developed desirable traits that make them robust and well adapted to the Nordic climate and way of life. Native breeds have a wider genetic base than commercial breeds and great potential for future food production in a sustainable way. For example, research shows that milk from Nordic native cattle breeds is among the best in the world when it comes to cheesemaking, and also contain valuable nutrients that could be used to develop bioactive food components. If further investigated, the genetic diversity of the native breeds can help adapt the Nordic agriculture to the needs of the market, climate change and new production systems. However, many of the about 140 farm animal breeds native to the Nordic countries are today at risk of becoming endangered. NordGen Farm Animals is working to reverse that trend.



Key Activities

During 2021, NordGen Farm Animals has worked in several projects, networks and increased communications on its activities and established several networks that serve as a platform for discussing joint research applications and projects. The increased communication and knowledge sharing with stakeholders supports the current strategic goal to proactively strengthen NordGen as a Nordic knowledge center for genetic resources.

Cryoconservation Manual

An important receipt on the successful revitalization process is the fact that FAO has asked NordGen Farm Animals to co-coordinate and contribute to an updated version of their cryopreservation guidelines.

NordGen gathered the results from each work package in the EU-project "Innovative Management of Animal Genetic resources" (IMAGE) and processed the material as recommendations. In 2021, the FAO cryopreservation guidelines was finalized and NordGen Farm Animals continued working on a webinar series based on the FAO guidelines that will be arranged in 2022.

Breed Stories

In 2021, NordGen Farm Animals continued the ambitious task of creating portraits of all the Nordic native animal breeds. The portraits contain information about each breed and its current status and are being written with support from the different breeding organisations in the Nordic countries. As we have some

140 different animal breeds this is a time-consuming and resource demanding project, but it fills a void and constitute information asked for as there is no other place where information about our Nordic native animal breeds can be found all in one place. During 2021, 15 breed stories was published on NordGen's website, 8 cattle breeds and 7 horse breeds from all Nordic countries.

Mountain Cattle Project

Much of NordGen Farm Animal's resources in 2021 were devoted to work in the project "Nordic Mountain Cattle – Cultural heritage and Genetics" (3MC). The project utilizes an innovative approach for combining several academic disciplines to give us a more nuanced picture of the history, culture and heritage of the mountain cattle breeds in the northern parts of Finland, Norway and Sweden. For example, the 3MC-team worked on preparing a museum exhibition for display in 2022 and [paper was published in the journal Animal](#). In this study a questionnaire was sent to all registered keepers of native breeds in Finland. This survey clarified their reasons for keeping native breeds and their ideas for improving governance structures and practices. The results show that genetic and cultural values are recognised in several documents and programmes, but farmers need to be engaged more in the design of support schemes and practices. The project is co- funded by Interreg Nord, Lapin liitto and Region Norrbotten and running 2020-2022. Read more in "Projects".



Photo: Alma Rackauskaite



Photo: Suvi Tiainen

NordFrost Network and new horse project funded

In 2021, The NordFrost Network was started with two seminars. The network includes a broad group of stakeholders enabling people from different backgrounds to meet, share experiences and create joint efforts to the conservation of native farm animal and fish breeds. This will contribute to Nordic food security and self-sufficiency, as well as conserving the unique biodiversity of the

numerous native breeds found in the Nordic region. Read more in "Projects".

New funding was also granted for the horse project: "Genomic Characterization as a Tool Towards Sustainable Breeding of the Nordic Native Horse Breeds". This project will be running 2022-2024 and is in collaboration with SLU, NMBU and the Norwegian Horse Center.

NordGen Farm Animals is a service and knowledge centre working to conserve and promote sustainable management of the animal genetic resources in the Nordic region. Contributing to the Nordic countries' own work by promoting the genetic, economic, cultural, historical and social values that come with a wide variety of different animals in Nordic agriculture.

NordGen Farm Animals' activities are providing tools and advice to preserve the genetic variation in living populations (*in situ*) but also to establish cryo-storage of genetic material (*ex situ*). Through a variety of projects, NordGen Farm Animals are working to initiate research and development projects related to categorization, conservation, management and sustainable use of animal genetic resources.

NordGen Farm Animals also organizes workshops, seminars and courses for various Nordic stakeholders and promotes good collaboration between them. Actively distributes information about animal genetic resources and partake in international networks. Works to promote sustainable breeding practices and good principles for fair trade in animal genetic material.

Knowledge Centre – NordGen Forest

Nordic forests provide wood and bioenergy, protection against wind and erosion, biodiversity and is a carbon dioxide sink. The trees planted today will grow for decades to come but climate change can hit our forests hard, and we must deal with the emergence of new pests and diseases that haven't existed in the Nordic region before. Within the forest industry there is a need for strong, resilient forests in the future and an important key to this resilience is genetic diversity. Since different trees carry different genes, chances are that some of them can resist the new threats. For example, the ash dieback disease is today threatening the Nordic ashes. But by identifying particular trees that carry resistance genes, the species could be saved. NordGen Forest is working to exchange knowledge about these kind of issues in the Nordic forest community.



Key Activities 2021

2021 was as the previous year marked by the covid-19 pandemic. All plans for meetings on site had to be held as digital events. During the year, NordGen Forest extended the experience in the digital arena and published a statistics report giving an overview of the use of seeds and seedlings in the Nordic region.

Thematic day, Anniversary and Seminar

The first NordGen Forest event in 2021, thematic day *"New Technology in Forest Plant Production"*, was organized on the 24 of March. Just as in 2020, the thematic day was held as a video conference due to the covid-19 pandemic. Four lecturers were invited from SLU, the company ARBOS and the foundation Det norske Skogfrøverk. The presentations evolved around cuttings propagation and plant production using the method somatic embryogenesis. About 70 people joined the thematic day.

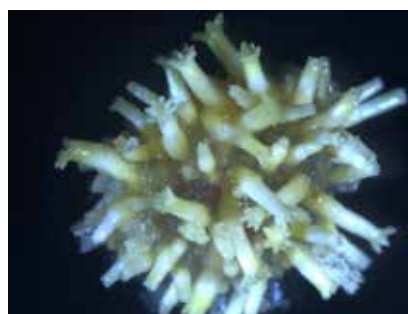


Photo of somatic embryogenic maturation. Photo: Sofie Johansson

The NordGen Forest 50 years anniversary conference (originally to be held in 2020) was planned for 2021 but the conference on site had to be postponed once again due to COVID-19. About 90 persons participated during NordGen Forest's digital conference which was arranged during 22 to 23 September 2021. Climate changes – and the major challenges in forestry – went like a red thread through the conference program gathering 15 lecturers. Presentations by young researchers were also given special attention in the conference program.

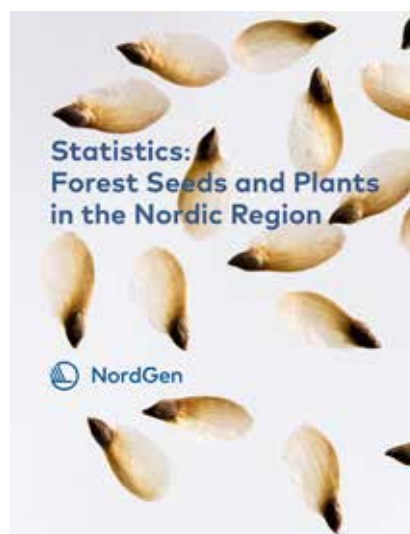
All meetings in the NordGen Forest Regeneration Council and in the NordGen Forest Working Group on Genetic Resources were held in a digital form. The Working Group meeting in November was held back-to-back with a seminar on forest genetic resources.

Publication

Access to statistics is needed to understand the development in forestry. In October 2021, NordGen Forest published the report *Statistics: Forest Seeds and Plants in the Nordic Region*. The report aims at giving an overview of the use of seeds and seedlings in the Nordic countries, with key statistics from Denmark, Finland, Iceland, Norway and Sweden. This statistics report is the first in a series that is expected to be published in the coming years.

NordGen Forest-SNS Scholarships

A total of 14 applications (6 male and 7 female and 1 NA) were received by the deadline on 15 February 2020. Eight of them were granted. The grants (in total NOK 100.000) were given to travels and field work, supporting activities in several Nordic countries. In 2021, a large part of the applications came from Iceland, five out of eight approved applications were Icelandic.



NordGen Forest addresses conservation and sustainable use of forest genetic resources, by being a forum for researchers, practitioners and managers working on forest genetic resources, seeds, planting stock and regeneration. We facilitate flow of scientific information and knowhow between these groups.

NordGen Forest is focusing on knowledge exchange about conservation and sustainable use of forest genetic resources, forest seed and plant production and regeneration of forests. By disseminating knowledge and experience between the various actors and to the public, we aim to support better plant production and better regeneration methods of forest, as well as conservation of forest genetic resources. We conduct various types of projects and information activities.

NordGen Forest consists of two bodies: The NordGen Forest Regeneration Council, which meets twice a year and the NordGen Forest Working Group on Genetic Resources, which meets once a year. The main activities arranged by NordGen Forest are our conferences and thematic days. In cooperation with Nordic Forest Research (SNS), NordGen Forest also grants scholarships to enhance knowledge and competences in the area of seed, plants and forest regeneration.



GENEBANK

NordGen's genebank is a joint plant genebank for all the Nordic countries. It conserves and documents seeds and living plant samples of Nordic heritage and of importance for the Nordic countries. The genebank ensures that the genetic resources that underpin our food supply are both secure in the long-term for future generations and available in the short term for use by farmers, gardeners, plant breeders, and for research and development.

The seed and plant collections of NordGen are important to ensure that agricultural and horticultural plants do not become endangered or extinct over time. Because these plants may contain genes which enables them to resist diseases, have enhanced nutrition composition or survive in changing or harsh climate environments. The services of the genebank are a common public good. The plant genetic resources stored in our genebank are available for research, education, and breeding purposes.



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Plant groups represented in the Nordic seed collection	Number of seed samples
Cereals	21.386
Grain legumes	2.864
Vegetables	2.118
Forages	4.811
Oil, fibre and root crops	1.607
Medicinal species	493
Ornamentals	274
Potatoes	99

Table 2: Plant Groups in Seed Collection

The genebank contains about 34.000 seed samples from 438 different plant species. These species carry a wide palette of different genetic traits that constitutes the green infrastructure for research and development of a sustainable agriculture and green growth.

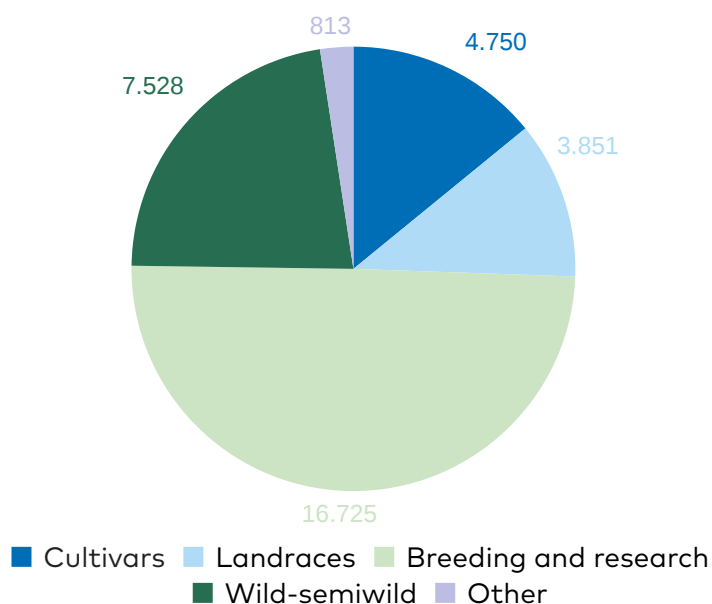


Figure 2: Plant groups represented in the Nordic seed collection

Laboratories

NordGen has a well-equipped seed laboratory for quality assessment of seed samples and follows the FAO's international genebank standards. This includes, among others, species identification, seed drying, seed cleaning, estimation of thousand grain weight and seed viability. The molecular laboratory provides facilities to prepare and conduct DNA extractions, do PCR-based marker analyses as well as prepare samples for more complex downstream analyses. The *in vitro* laboratory provides sterile working conditions and incubators for tissue culture or germination in controlled light and temperature. A room for cryo-preservation is planned for in the new building and will enable safe long-term storage of different kind of samples.

Growth Facilities

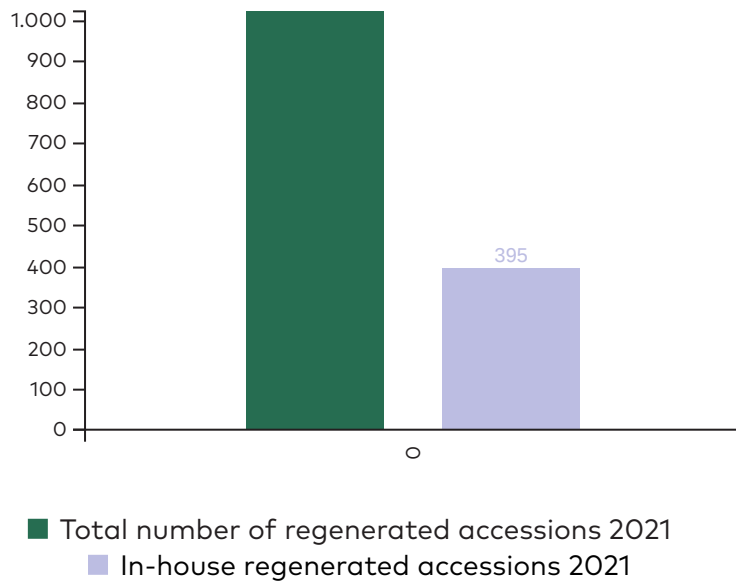
NordGen greenhouse and field team has experience with regeneration of a very broad variation of agricultural and wild plants. This includes valuable knowledge about specific requirements of sowing, transplanting, isolation, fertilization, watering, weeding, winter storage and seed harvest. The team can also assist in recording plant descriptors during the regeneration.

Reducing the Re-generation Backlogs

Due to historic accumulation of new material to the collection of plant genetic resources at NordGen, a backlog of accessions which needs handling to secure long-term conservation has been built up 2008 -2016. To further expand NordGen's regeneration activities to reduce the backlog, the Board of NordGen adopted in 2019 a

project plan to eliminate the backlog problem by end of 2024. The project named 'No regeneration backlog by 2024' is funded by an extraordinary grant from the Nordic Council of Ministers. In 2021 the project showed good progress and all expected goals were met.

Figure 3: Total number of regenerated accessions in 2021

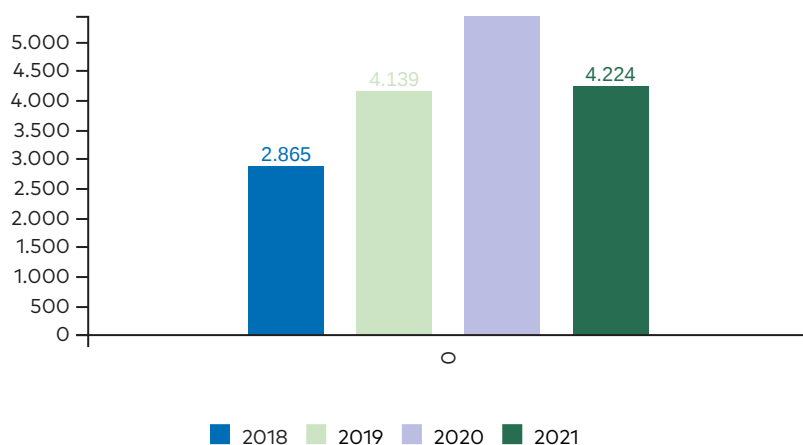


Genebank – Sustainable Use of Plant Genetic Resources

NordGen provides genetic material to facilitate sustainable food and feed production and other biobased solutions in the Nordic region's changing climate. The best way to preserve genetic diversity is to use it and the Nordic seed collection is no exception. Therefore, NordGen sends out thousands of seed samples annually to scientists, plant breeders, companies, museums, botanical gardens and home gardeners with an interest in old cultural plants.

From 2018 to 2020, NordGen noticed a considerable increase (+89%) in the number of requested seed samples and since then the number has stabilised at a high level, between 4.000 and 5.000 sent out seed samples per year. Seeds are primarily requested by Nordic and European countries, although requesters in a total of 30 countries have ordered seeds from NordGen in 2021.

Figure 4: Samples sent 2018-2021



The seed samples are mainly ordered by universities and research/breeding institutes while others interested in the material are seed saver organizations, museums, schools and municipalities for education or demonstration use.

The most ordered crop is cereals with more than 2.000 accessions ordered in 2020. Just above 1.000 accessions have been ordered respectively from the groups forage crops and grain legumes.

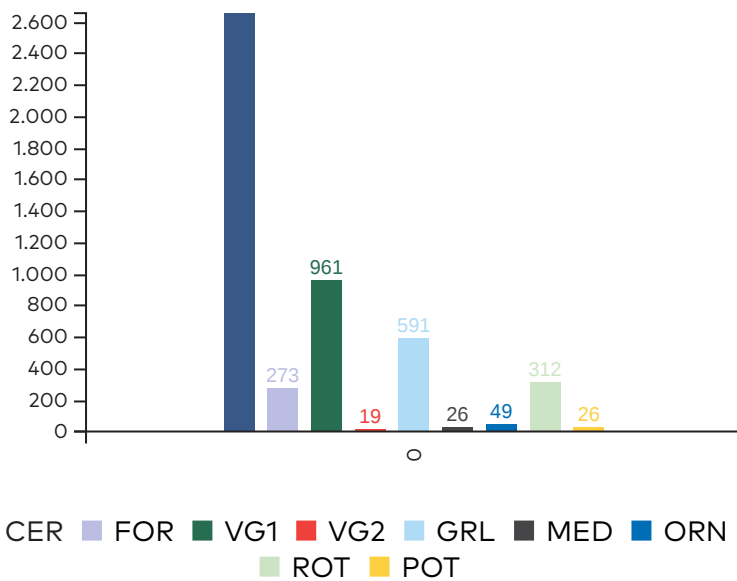


Figure 5: Crop of requested accessions in 2020 (number of bags)

CER: Cereals
 FOR: Forages
 VG1: Vegetables1
 VG2: Vegetables2
 GRL: Grain legumes
 MED: Medicinal plants
 ORN: Ornamentals
 ROT: Root tubers
 POT: Potatoes

In addition to the distribution of seed samples for scientific purposes, the seed lab also handles the seed orders in NordGen's online shop where the number of orders increased with 37% (1.063 to 1.458) from 2020 to 2021.

As one of the ways to promote the sustainable use of plant genetic resources to the general public, NordGen has established an online shop where we distribute our surplus of seeds for a small admin fee. During springtime, hobby growers and home gardeners with an interest in older varieties of vegetables, flowers and cereals can order seed samples and mini tubers of potatoes from NordGen.

In 2021 the website work with the online shop continued, for example the product range was expanded with new products.

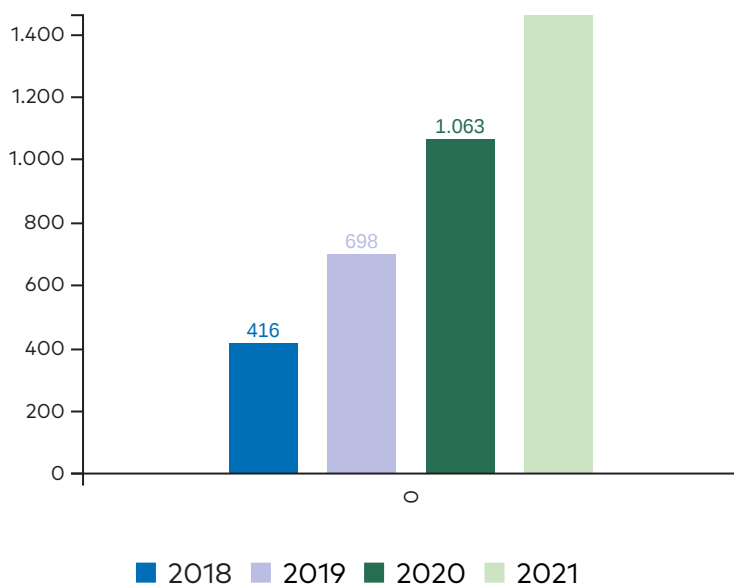


Figure 6: Number of orders in the online shop 2018-2021

Genebank – Digitalization

The very core of NordGen's genebank is the information system that contains all the data gathered over the years about the seeds and the plants in the Nordic seed and plant collection. This data is unique and invaluable for the research and development of new crop varieties needed to support future food production in the Nordic countries.

During the last few years, NordGen has been on an ambitious digitalization journey to secure that the genebank information system is future proof. In 2019, NordGen decided to implement the internationally well-known genebank data management software GRIN-Global.

The project reached a very important milestone in 2020 with the launch of the Nordic Baltic Genebanks Information System, GENBIS' which is built within the GRIN-Global data management system. This is a critical step bringing improved possibilities for strengthening documentation processes in the genebank, and will secure efficiency, security and accuracy in the seed handling and documentation as well as providing a more user-friendly interface for seed requesters.

GENBIS will serve not only NordGen but also enable users to explore data from eleven different genebanks, including the Nordic and Baltic national genebanks. This has in a positive way impacted collaboration between NordGen and the Nordic and Baltic national programs for plant genetic resources.

In 2021, the cooperation with the Baltic countries continued. During the year, the last implementation were also made in GENBIS, leading to a more user-friendly instrument. Within the digitalization area the work with optimizing the data servers continued and a new firewall was installed. The library catalog in Alnarp was also digitalized as described in the chapter Knowledge Center.





PROJECTS

To participate in and lead different projects is an important part of NordGen's operations. In close collaboration with public institutions, private companies and other organizations, the overall purpose of all projects is to conserve and promote the sustainable use of genetic resources for Nordic food and agriculture. The funding for the projects is granted by the European Union, the Nordic Council of Ministers, directly from the Nordic countries through its government bodies or from public and private foundations and other organizations. The funding is leading to solutions for a more sustainable society.

Below is a summary of some of our more high-profiled projects:

Arctic Pea

Finding suitable grain legume crops with traits that make them possible to cultivate in the Arctic region will give possibilities for a future local plant protein production. This will in the long-term strengthen Northern culture communities and help reducing import of plant protein. In our region, the low temperatures and long summer days however require specifically adapted accessions.

In 2021, the results from field trials conducted in 2018 and 2019 at four environmentally contrasting sites were published in the scientific journal **Frontiers in Plant Science**.

The aim of the trials, including 50 accessions from the NordGen pea collection, was to identify pea accessions suitable for future cultivation in the Arctic regions. The evaluated accessions represented a diverse material including different types of peas with origin in Sweden, Finland and Norway.

Differences were revealed in expression of phenological,



morphological, crop productivity and quality traits in the accessions. Overall, the results indicate that pea genetic resources are available, for breeding or immediate cultivation, which would aid expansion of pea cultivation further north. Predicted climate changes would further aid this expansion. It was concluded that agricultural practices and timing of sowing dates for pea cultivation in the Arctic will be extremely important to use available light and temperature as efficient as possible.

The Nordic cooperation project Arctic Pea was funded by Nordregio's Arctic cooperation program.

A Richer Agricultural Landscape

Cultivation of historical wheat species that are part of our cultural heritage favors biodiversity and provides a richer agricultural landscape. Einkorn and bucket wheat are historical wheat species that were previously grown on a large scale in Sweden. In recent years, mainly bucket wheat but also einkorn has generated interest by organic growers and in special bakeries.

The project carries out a detailed study of the einkorn and bucket wheat that are stored at NordGen in order to provide knowledge about their characteristics, disease resistance, and several quality parameters. In 2020, the collaborative partner Lantmännen conducted quality analysis on the four einkorn and four emmer wheat accessions that were grown in 2019 (these were selected from data on the 69 accessions grown in 2018). The quality data was used to select two einkorn and two emmer wheat further quality and baking analysis in 2021.

Ultimately, the aim is to be able to recommend the best varieties in regard to cultivation and baking properties. The study will be communicated to organic growers and bakeries in order to increase the interest and use of traditional plant genetic resources. The project is financed by the European Agricultural Fund for Rural Development.



Crop Wild Relatives

Crop Wild Relatives (CWR) are wild species that are closely related to crops. They are of importance to agriculture since traits in these wild species can be transferred to crops by traditional plant breeding approaches. In many cases, wild species have traits that are not present in modern crops, for example pest and disease resistance, tolerance to drought, waterlogging or heat stress. Such traits are of central importance when adapting crops to future climate conditions and diseases and are therefore

central for climate change adaptation and future food security.

The Nordic network on CWR was initiated in 2015 with the long-term aim to promote a well-functioning, climate- and environmentally friendly Nordic agriculture by strengthening CWR conservation and facilitating use of CWR. During 2019, the second phase of this network was finalized, and a report was published summarizing the results. The third phase of the project was initiated in 2020 with funding from NKJ (The Nordic Joint Committee for Agricultural and Food Research). Additional funding was granted from the *Nordic Committee of Senior Officials for the Environment and Climate* in December, which made it possible to expand the Nordic work on CWR during 2021-2024.



During 2021, several activities were carried out within the project. Inventory and/or seed collection of CWR were conducted in Iceland, Norway, Sweden and Finland during the summer and autumn. An outdoor exhibition was also produced in all the Nordic countries in their respective languages. In November, a stakeholder workshop was arranged in Oslo and later in the winter the Nordic Priority Crop Wild Relative Dataset was updated with additional information and **19 new species**.

NordFrost

In case of extreme events, entire animal populations can be wiped out, since farm animal and fish genetic resources are most often small and locally adapted populations. The native breeds show large adaptation potential and may become crucial for increased resilience of the Nordic agriculture.

Within the NordFrost project, stakeholders will develop a regional action plan for Nordic cryopreservation activities. It will develop common procedures for cryopreservation by describing the existing best practices, but also mapping weaknesses so that they can be developed. In the long term, these guidelines will help increase the resilience of the Nordic agriculture.

In 2021, the project started and had two seminars. The NordFrost project is building a network of Nordic key stakeholders with the aim of raising awareness among researchers, policy makers, genebank institutions and farmers about the importance of common guidelines and goals for cryoconservation.



Farmer's Pride

Plant genetic resources – our crop plants and their related wild species, and the genetic diversity they contain – are essential for our food, nutrition and economic security. In current times of global transformation, including the rapidly increasing human population and climate change, greater diversity is needed to sustain food supplies than ever before as the environmental conditions in which crops are cultivated become more extreme, changeable and uncertain.

The Farmer's Pride project is building a collaborative network for on-site conservation and sustainable use of Europe's plant diversity for food, nutrition and economic security throughout the region. The overarching objective of Farmer's Pride is to establish a network of stakeholders and conservation sites that effectively coordinates conservation actions to safeguard the wealth of Europe's *in situ* plant genetic resources (PGR) and integrates the user community to maximize their sustainable use. The aim is to significantly strengthen the European capacities for the conservation, management and sustainable use of *in situ* PGR as a foundation for increased competitiveness in the farming and breeding sectors, and ultimately for long-term food and nutritional security in Europe.

Funding for the project "Farmer's Pride – Networking, partnerships and tools to enhance *in situ* conservation of European plant genetic resources" has been granted from the Horizon 2020 Framework Programme of the European Union. During 2021 the project was finalized and the conference "*Ensuring Diversity for Food and Agriculture*" was arranged as part of the Farmer's Pride project in collaboration with EUCARPIA and ECPGR.



3MC – Nordic Mountain Cattle

The Finnish Northern Finncattle, The Norwegian Sidet Trønderfe and Nordlandsfe and the Swedish Fjällko are three closely related cattle breeds that have played an essential role in the history of the northern parts of Scandinavia. To promote conservation and a sustainable use of these northern mountain cattle breeds, this project utilizes an innovative approach for combining several academic disciplines to give us a more nuanced picture of the history, culture and heritage of the breeds.

The studied fields are historical references, cultural heritage survey and peer support platform, genetic relationships based on archaeological finds and pedigrees and finally game development



Photo: Suvu Tiainen

sector. The project will collect and distribute knowledge of Northern mountain cattle breeds in Finland, Norway and Sweden. Once gathered and consolidated, the information will be made available for everyone interested, for example, through an art vernissage, up-to-date education packages for schools, including a game application. The ultimate goal is to promote the native breeds and increase the opportunities for the local livelihoods and the conservation of genetic resources.

As one of NordGen's flagship projects, coordination of the project and our tasks in it took up many working hours in 2021. Due to the pandemic, many planned events and meetings had to be postponed or reverted to online arrangements instead. But despite these difficulties, the project has reached many relevant conclusions and managed to disseminate information about the cattle breeds to the different target groups. The project, which is financed by Interreg Nord, Lapin liitto and Region Norrbotten, is carried out in Nordic co-operation between universities, companies and breeding organisations in Finland, Sweden, Denmark and Norway.

EUCLEG

The project EUCLEG, *Breeding forage and grain legumes to increase EU's and China's protein self-sufficiency*, was initiated in 2017 with the aim to "improve diversification of crops, crop productivity, yield stability and protein quality of both forage (alfalfa and red clover) and grain (pea, faba bean and soybean) legumes" (www.eucleg.eu).

The project include development of molecular- and phenotypic tools, phenotyping and genotyping of genetic resources, development genomic selection strategies, improvement of access to data and facilitating of data exchange. NordGen's material is evaluated both genetically and phenotypically within the project.

NordGen's main contribution to the project has been work with improving public access to data on the focus species. During 2021, NordGen coordinated the public deliverable "Improved EURISCO database for alfalfa, red clover, pea, faba bean and soybean", which contains an inventory and gap analysis of information on the focus species in European PGR databases, a report on progress on inclusion of data on these crops in EURISCO during the project lifetime and a report on a pipeline for upload of data from the program Progeno to EURISCO.





PLANTBASED PROTEIN

The impact of climate change is becoming increasingly clear for every year. As a result of the debate, the demand for plant based protein food is on the rise, not least when it comes to domestic production.

The Nordic countries have a long cultivation tradition of legumes such as fava beans and peas. Given the increased interest, the future of Nordic cultivation of legumes should be bright. An increased domestic production would also be positive for Nordic food security and a climate-smart alternative to imported soybeans. Legumes such as peas also have the capacity of fixing nitrogen in the fields, a property with many benefits.

NordGen's collection includes lentils, beans and more than 2.000 accessions of peas – an asset that can be of importance for the future Nordic plant breeding. Below you can read more about some of our work with legumes.



Key Activities 2021

Photo Documentation

In 2021, a large part of NordGens seed samples of beans and peas were photographed. In total 2.227 accessions were photographed, 1.908 of these were peas. Thereby valuable information about the visual characteristics of the original seed samples are available.



Peas for Northern Cultivation

As described in the previous chapter [Projects](#), the results of the project Arctic Pea was published in 2021. During the years 2018 and 2019, the selection of 50 accessions selected from NordGen's pea collection was tested in four different locations in the Nordic region: Tromsø (Norway), Umeå (Sweden), Jokioinen (Finland) and Taastrup (Denmark).



For example, the results showed that landraces (i.e. populations of cultivated plants adapted locally where they were grown but not developed by commercial plant breeding) did well. Among the accessions that had high seed yield (about 13 dry grams of seeds per plant) were one cultivar and three landraces. Also when it came to the protein concentration of the peas, a number of landraces ended up at the top. Two landraces and two cultivars showed a protein concentration above 27 percent.

Many of the accessions that performed best at the northernmost cultivation sites in Tromsø and Umeå were sugar pea landraces gathered from northern locations.



SVALBARD GLOBAL SEED VAULT

Svalbard Global Seed Vault is a backup facility for the world’s crop diversity. By putting seed duplicates for long-term and safe storage in Svalbard, genebanks reduce the risk of losing invaluable genetic material if anything should happen to their original collections. NordGen is responsible for operating the Svalbard Global Seed Vault in cooperation with the Norwegian Ministry of Agriculture and Food and the international organization Global Crop Diversity Trust. NordGen’s role in the Seed Vault partnership is to communicate with genebanks, handle seed deposits and update the Seed Portal – a publicly accessible database gathering information about the seeds stored in the Seed Vault.

<p>Seed Vault Openings: 3, February, June and October</p>	<p>Depositing Institutions: 22, 2 first time</p>	<p>Number of seed samples in the Vault (31/12 2021): 1.125.419</p>
<p>New seed samples duplicates: 50.926</p>	<p>New institutions signing the deposit agreement: 1, Serbia</p>	<p>Number of depositing institutions (31/12 2021): 89</p>



Key Activities 2021

New Depositors

Two genebanks deposited seeds for the first time in 2021; the national genebanks in Serbia and in Latvia. Delegations from the two countries were present in Svalbard and accompanied their seed deposits at the Seed Vault Opening in October.



More Than 50,000 Safety Duplicates

In total 50.926 safety duplicates from 22 depositors were added to the Seed Vault collection in 2021. By the end of the year the total holding of seed accessions in the Seed Vault was 1.125.419 samples deposited by 89 genebanks/institutes.

100-year Seed Experiment

The second set of seeds belonging to the 100-year seed germination experiment in the Seed Vault produced by IPK, Germany and INIAV, Portugal was prepared and packed at NordGen in Alnarp and put in place in the Seed Vault in 2021.



Nanofilm Securing Information

Nanofilm labels displaying data on seed samples stored in the seed boxes in the Seed Vault were produced in 2021. The film labels will be fixed to all seed boxes in the Seed Vault in 2022.

The Seed Vault was established in 2008 and is owned by Norway. NordGen is responsible for managing the Seed Vault in partnership with the Norwegian Ministry of Agriculture and Food and the international organization Crop Trust. The iconic building, on the top of the world, safeguards security copies of seeds stored in genebanks and thereby contributes to securing the world's food supply.

The location of the Seed Vault was chosen due to Svalbard being a remote, cold and safe place, yet easily accessible for shipping and handling. In addition, the Nordic Genebank (now NordGen) stored a backup of the Nordic seed collection here already from 1984, something that inspired to the establishment of the Svalbard Global Seed Vault. The seed chambers of the Seed Vault are carved out from the solid rock of the Plateau mountain. They offer a frozen environment where artificial cooling keeps the temperature at a constant -18°C and according to FAO's genebank standards. The ownership of the seeds stored in the Seed Vault remains with the depositing genebank, and only the institution that deposited the seeds are allowed to withdraw them.



PUBLIC-PRIVATE PARTNERSHIP FOR PRE-BREEDING

Together we are stronger. That's the very essence of the Nordic Public-Private Partnership (PPP) for pre-breeding. Through the partnership, plant breeding companies in the Nordic region can cooperate in a non-competitive way on pre-breeding projects and cooperate on research with the Nordic public institutions. The Nordic Public-Private Partnership for pre-breeding is a collaboration aiming to strengthen plant pre-breeding in the Nordic countries and through its work promoting sustainable use of genetic resources in the Nordic region with its unique climate, temperature, and daylight. The Nordic Public-Private Partnership (PPP) for pre-breeding is funded by the Nordic countries and plant breeding entities, and the secretariat is placed at NordGen.

Top photo: Aakash Chawade

Key Activities 2021

2021 was a busy year within the Nordic Public-Private Partnership for pre-breeding, as it marks the first year for the current program period 2021-2023 and several projects started their activities. Read more about the current projects below.

NORDFRUIT Apple

NORDFRUIT Apple is one year project with the purpose to complete earlier PPP apple projects and aim to facilitate implementation of new technologies into the Nordic apple breeding programs. Considerable efforts have been made in tree and fruit storage diseases. However, results need to be confirmed to capitalize the investments, and that is the main tasks of the one-year project. Supplementary phenotyping will be conducted for validation of genetic markers, as phenotyping failed in previous years due to flower frost in spring.



Phenotyping Project Phase 3 (6P3)

6P3 will focus on operationalization of technologies and methods developed during the previous two project phases. Phenotypic data will be combined with a plant-soil-climate model to understand interactions between genotypes, local environments, climate and management. The aim is to provide Nordic plant breeders with the latest drone and imaging technologies, efficient data management tools, and a climate and stress response model to predict and breed genotypes resilient to climate change and environmental stresses.



SustainPotato

SustainPotato will bring the potato breeding programs in Sweden, Denmark and Norway together with scientists from the Nordic universities to develop and implement new genetic resources and molecular tools for effective disease resistance breeding. This new initiative is expected to provide Nordic potato breeders, growers and retailers with new competitive potato cultivars and improve research into new high-throughput phenotyping and genotype methods that will be needed for future genomic-led potato breeding.



CResWheat

Spring wheat is currently cultivated at the northernmost limit for the crop where it faces several challenges linked to climate change. The project aims to increase the spring wheat yield potential and self-sufficiency in the Nordic region. This requires extensive pre-breeding activities and collaboration between breeders and researchers across borders. The project focuses on the identification of germplasm, genes, and genetic markers associated with disease resistance pre-harvest sprouting, and early maturity. Special attention will be paid to drought tolerance and diseases expected to be of future relevance to spring wheat in northern Europe.



The Nordic Public-Private Partnership (PPP) for pre-breeding is a cooperation intended to strengthen plant breeding in the Nordic countries and through its work promote sustainable exploitation of genetic resources in the Nordic region with its unique climate, temperature, and daylight. The PPP is funded by the Nordic countries and plant breeding entities. The PPP Secretariat at NordGen is responsible for the administration of the Nordic PPP. The PPP Secretariat facilitates project management in cooperation with the PPP Steering Committee.

FINANCIAL STATEMENT

The Financial Statement for the year ending 31 December 2021 was prepared in accordance with Swedish National Financial Reporting Standards and audited by the Swedish National Audit Office.

(TSEK)	Budget 2021	Result 2021
Income		
Nordic Council of Ministers ordinary budget	32.162	31.870
National contributions	3.765	3.682
Other income	0	118
Financial income	0	159
Project funds, Nordic Council of Ministers	0	3.804
Other external project funding	9.489	9.158
Total income	45.416	48.791
Costs		
Staff costs	26.828	25.849
Goods and services	9.868	8.760
Contribution to external projects	106	106
Financial costs	250	1 043
Other costs	12.218	9.776
Total costs	49.270	45.534
Result year	-3.854	3.257

BOARD

The Board of NordGen meets three times a year to address issues of substantial importance to NordGen.

The members and their alternates are appointed by the Nordic Council of Ministers and the executive committee for Fisheries and Aquaculture, Agriculture, Food and Forestry.

BOARD MEMBERS	ALTERNATES
Finland	
Tove Jern, Chair Ministry of Agriculture and Forestry	Eero Pehkonen Ministry of Agriculture and Forestry
Sweden	
Carina Knorpp, Vice-Chair Ministry for Rural Affairs	Åsa Widebäck Ministry of Enterprise and Innovation
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Iceland	
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Staff Representative	The Environmental Sector
Karolina Aloisi NordGen	Birthe Ivars Ministry of Climate and Environment, NO

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NordGen

The Nordic Genetic Resource Centre (NordGen) is the Nordic countries' gene bank and knowledge center for genetic resources. NordGen is an organisation under the Nordic Council of Minister and works with the mission of conserving and facilitating the sustainable use of genetic resources linked to food, agriculture and forestry.

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