

Annual Review 2022



NordGen



Table of Content

INTRODUCTION	3
ABOUT NORDGEN	5
KNOWLEDGE CENTER	7
Knowledge Centre – NordGen Plants	9
Knowledge Centre – NordGen Farm Animals	12
Knowledge Centre – NordGen Forest	15
GENEBANK	17
Genebank – Sustainable Use of Plant Genetic Resources	20
Genebank – Digitalization	22
PROJECTS	23
PLANTBASED PROTEIN	27
SVALBARD GLOBAL SEED VAULT	29
PUBLIC-PRIVATE PARTNERSHIP FOR PRE-BREEDING	31
FINANCIAL STATEMENT	33
BOARD	34

INTRODUCTION



Lise Lykke Steffensen, Executive Director, NordGen, sums up the year of 2022. See the video [here](#).

We are looking into a changing world. Society faces major challenges with war in Europe and accompanying energy prices and increased inflation. At the same time there are major challenges with climate change, biodiversity loss, an increased demand for new plant-based solutions and a desire for greater self-sufficiency in food in the Nordic countries.

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. Therefore, NordGen's operations and research has a great influence on the major societal challenges in a changing world.

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

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 research projects and networks related to genetic resources at both Nordic, European and international levels, and we bring together industry professionals in the Nordic countries.



Therefore, NordGen's operations has a great influence on the major societal challenges in a changing world.



New Main Office

2022 was the year that NordGen moved to a new main office and knowledge center in Alnarp, Sweden. The new building, which is generously financed by the Swedish Ministry of Climate and Enterprise, is built for the future and will be of great importance for the general operations with a positive impact on the work environment. The premises provide new opportunities to support NordGen as the Nordic joint knowledge center for genetic resources and as genebank for agricultural and horticultural plants.

This building has 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. Recycled building material has been used as much as possible and the house is classified as gold, the highest standard in the environmental certification system for buildings in Sweden.

Strategy

NordGen is in the strategic period 2020-2022, and in 2022, 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 safety back-up facility in Denmark.

The year 2022 also accelerated the work with utilization of the genetic resources within documentation, characterization and evaluation of the genetic resources.



The new main office was inaugurated on April 4 2022. Ministers from Sweden, Finland and Norway was present together with Secretary General of the Nordic Council of Ministers.





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, research institution 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



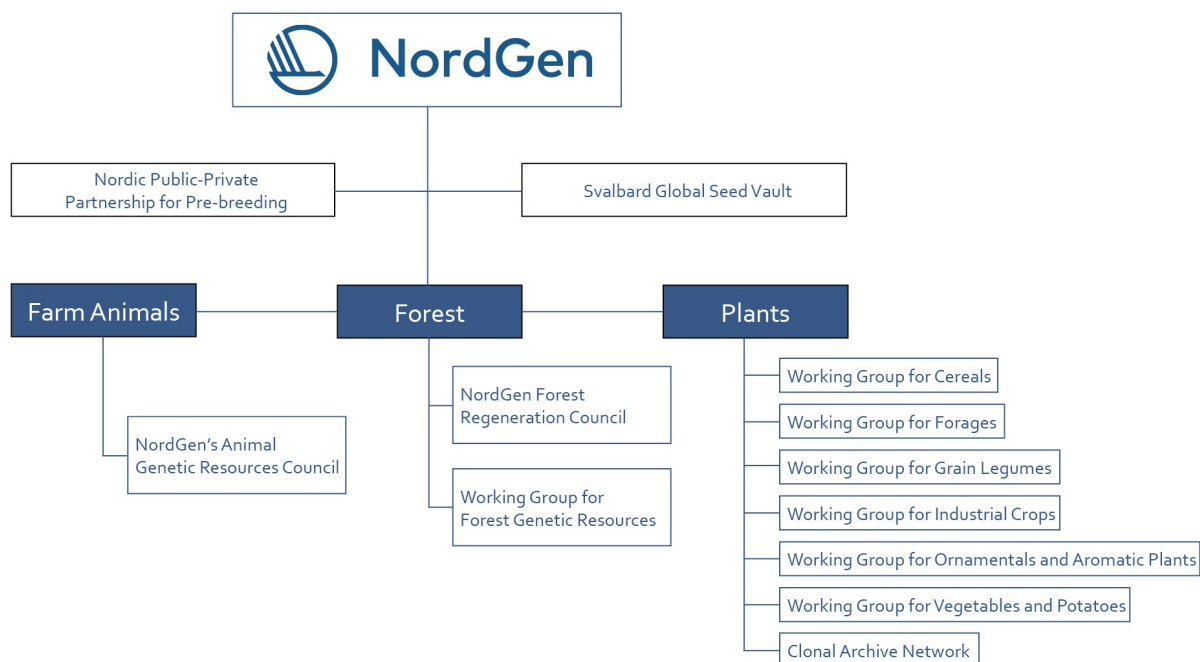
for collections held by NordGen for other genebanks, are under joint Nordic management and are a common good.

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.

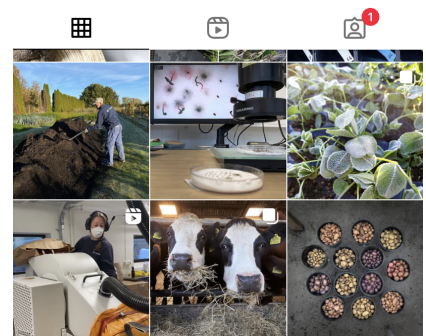




KNOWLEDGE CENTER

As the Nordic knowledge center for genetic resources, NordGen participates in and leads research 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	2021	2022
Instagram	2.156	2.470
Facebook	3.563	3.789
LinkedIn	1.175	1.994
Twitter	1.287	1.610

Table 1: Social media statistics.

In 2022, 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.

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.

New Main Building and Knowledge Centre

The fourth of April 2022, NordGen's new main building and knowledge center was inaugurated. 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.

In 2022, we have noticed a great interest in visiting NordGen and the relocation of the main office also offers new opportunities for receiving visitors. During the year, many delegations from the Nordic region as well as international (for example from Mongolia, Singapore, Mexico and many of the European countries) visited the new premises.

NordGen has high sustainability goals and for the building to have as small a climate footprint as possible. Therefore, the house is built of wood. The roof is 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 2022 will be introduced in more detail.



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.

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".

Potato Backup Inauguration in Finland

NordGen is responsible for the long-term conservation of the Nordic potato collection, which consists of 95 different varieties of potatoes from the Nordic countries, including the Faroe Islands. Potato varieties are not kept in genebanks as seed samples because that would change the genetic characteristics. Therefore, the potato collection is preserved as living plants, clones, in glass tubes. To avoid the plants being infected by virus diseases, the potato collection is handled and stored *in vitro*, ie in a sterile environment.



The potato collection is placed at NordGen's head office in Alnarp, Sweden. But just as with any genebank collection, it is important to have a backup. This safety duplicate is now stored at the Finnish Seed Potato Centre Ltd (SPK) in Tyrnävä, outside Oulu. On March 14th 2022, the facilities were inaugurated by the Finnish Minister of Agriculture and Forestry, Jari Leppä.

Nordic Collaboration

NordGen is part of and arranges several different meetings and seminars for the Nordic stakeholders concerning plant genetic resources. After several years of pandemic restrictions, 2022 was again a year filled with many interesting meetings on site where

the year's main event was the inauguration of the new house when many partners and stakeholders from the Nordic countries met in Alnarp.

However, during 2022 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.

One such example is an extensive collaboration on the Nordic oat collection between NordGen, Oatly, Lantmännen and ScanOats. This project aims to increase knowledge about the oat collection, data that will make the collection easier to use for researchers and plant breeders that are interested to develop new oat varieties. In the project, all partners share the cost and information gained from genotyping (genetic characteristics investigated through DNA analyses). Therefore, 764 accessions (seed samples) of oats were sown in field during 2022. Read more in the chapter [Projects](#).



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.

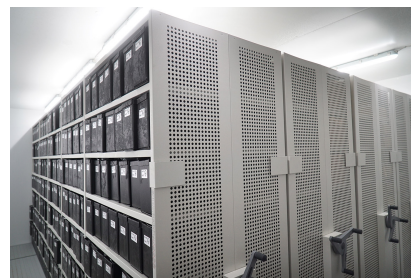


In april 2022, the 16th ECPGR Steering Committee Meeting was hosted by NordGen in Malmö and Alnarp.

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 2022 will lead to an increased value and a considerable improvement of the Nordic seed collection and its safety.



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 2022, 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 Webinars in Collaboration With FAO.

NordGen has organised together with FAO a series of global webinars based on the FAO guidelines “[Innovations in cryoconservation of animal genetic resources](#)”. The dozen of webinars were organized during 2022 in collaboration with FAO and the authors involved in the FAO guidelines. The recordings of the webinars [can be found here](#).



Initially, NordGen compiled the newest information on cryoconservation resulted from the EU HORIZON project ‘IMAGE Innovative management of Animal genetic resources’. Thereafter NordGen coordinated processing of the material as an FAO publication. These FAO guidelines included an overview of technical details, germplasm types, principles from a biological perspective, and from different species. It also had up-to-date information on health interventions, data management, legal issues, and capacity building. The webinars complemented the collaboration between FAO and NordGen in revising the FAO

cryoconservation guidelines.

Breed Stories

In 2022, 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 organizations 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 2022, NordGen published the story of the Nordic Brown bee, Finnish Native Chicken, Norwegian Nordland/Lyngen horse and Eastern Finncattle on their website.



Nordic brown bee, photo: Hege Vatland Hvidsten.

Nordic Mountain Cattle – Cultural heritage and Genetics (3MC).

The project utilized 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. The results can be used, for example, in achieving more attention, and making safeguarding decisions for the endangered breeds.



Photo: Suvi Tiainen.

The project was running 2019-2022 and 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. Read more in "Projects".

NordFrost Network, NaNo Horse and Northern European Horse Network

In 2022, 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".

NordGen arranged the first **Native Horse Network** meeting in November 2019 in Oslo, Norway, with participants from the Nordic countries and Lithuania. Since then, the network has had

meetings online due to covid-19. The network has been successful and one of the results from the network is the project for genomic characterization of the Nordic Native Horse breeds (Project NaNo Horse). Through an ERFP ad-hoc action (European Regional Focal Point for Animal Genetic Resources) - we expanded to a new and broader network in 2022 The Network for native horse breeds in the Baltic Sea region and Northern Europe. This network had a physical meeting in Alnarp, Sweden on November 18-19, 2022.

The goal of the network is focused on the improvement of the management of endangered native horse breeds and contributes to the:

- Conservation and sustainable use of Animal Genetic Resources (AnGR)
- Strengthen collaboration within the European Region searching new regional projects, research, workshops, and knowledge exchange of good practice on national programs.

In 2022 NordGen Farm animals in collaboration with SLU, NMBU and the Norwegian Horse Center started the project "Genomic Characterization as a Tool Towards Sustainable Breeding of the Nordic Native Horse Breeds" (**NaNo Horse**) to characterize the native Nordic horse breeds at a genomic level through whole-genome sequence DNA. The native Nordic horse breeds are an important genetic resource, not only due to their cultural heritage, but also due to their potential unique genetics that may prove to be valuable for the horse breeding sector, and more widely, to society. Read more in "Projects".



The ERFP meeting held in Alnarp included participants from Norway, Sweden, Denmark, Faroe Islands, Lithuania, Estonia, Latvia and Poland. In addition, there were 4 participants online from UK, Finland, Sweden and Norway.

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

For NordGen Forest, the year 2022 was again a year filled with fruitful meetings on site in the Nordic countries. For example, a successful forest conference was arranged in Swedish Lund, and the NordGen Forest Working Group on Genetic Resources met for a couple of inspiring days in Iceland, more information about these events will follow below.



Thematic Day, Anniversary and Seminar

The first NordGen Forest event in 2022 was a thematic day organized on 24 March in Danish Silkeborg. About 50 persons joined the day of presentations and excursions in the area. Four lecturers were invited to give presentations in connection with the theme climate change and how to choose the right plant material for the forest of the future. A second thematic day was organized on 1 December in Finnish Tampere where nine lecturers gave presentations.

The NordGen Forest 50 years anniversary conference (originally to be held on site in 2020 but postponed due to COVID-19) was arranged on 27-28 September 2022 in Lund, Sweden. About 70 persons participated in the conference that was titled "Scoping our forests for the future". During the first day, 14 lecturers gave presentations covering topics on forest's adaptability to climate change as well as opportunities and bottlenecks in forest seedling production and planting. Presentations by young researchers were also given special attention in poster session. The second day was devoted to forest excursions in the region. The conference participants were able to visit the estate Dragesholm and Skogforsk's research station Ekebo. Both the thematic days and

the conference had digital participants in additions to people on site.

All meetings in the NordGen Forest Regeneration Council and in the NordGen Forest Working Group on Genetic Resources were arranged as planned. In August, the Working Group gathered in Iceland for seminars and excursions organized by the Icelandic Forest Service (IFS).

NordGen Forest-SNS Scholarships

A total of 10 applications (6 male, 3 female and 1 NA) were received by the deadline on 15 February 2022. Seven of them were granted. The grants (in total NOK 118.000 due to unused assets from 2021) were given to travels and field work, supporting activities in several Nordic countries. In 2022, field work was also performed on Greenland with support from the scholarship.

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 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.

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.



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.

”

The plant genetic resources stored in our genebank are available for research, education, and breeding purposes.



The seed samples are conserved in bags made of laminated layers of plastic and aluminum.

Plant groups represented in the active collection	Number of seed samples
Cereals	21.290
Grain legumes	2.859
Vegetables	2.068
Forages	4.661
Oil, textile fibre and root crops	1.607
Medicinal plants and spices	421
Ornamentals	272
Potatoes	96

Table 2: Plant Groups and number of seed samples (accessions) in the Nordic seed collection.

The genebank contains about 34.000 seed samples (accessions) in the active collection 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.

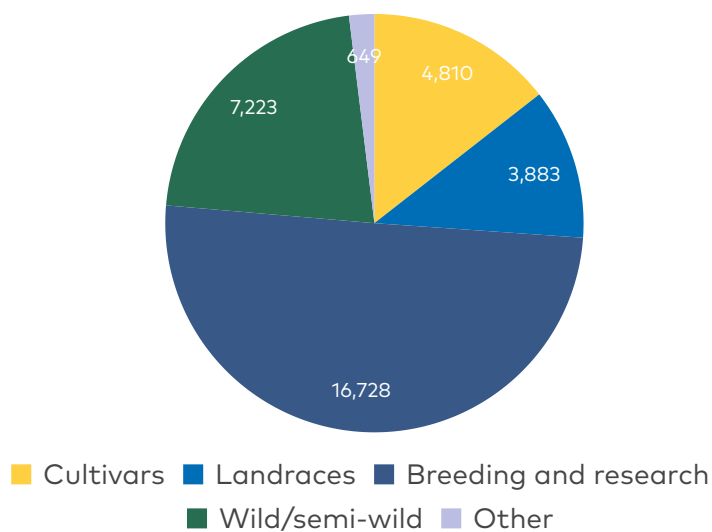


Figure 2: Plant groups represented in the Nordic seed collection.

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, both 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.



One part of NordGen's garden used for regeneration captured by drone in June, 2022.

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 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 2022 the project showed good progress and all expected goals were met.

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. Seeds are primarily requested by Nordic and European countries.



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.

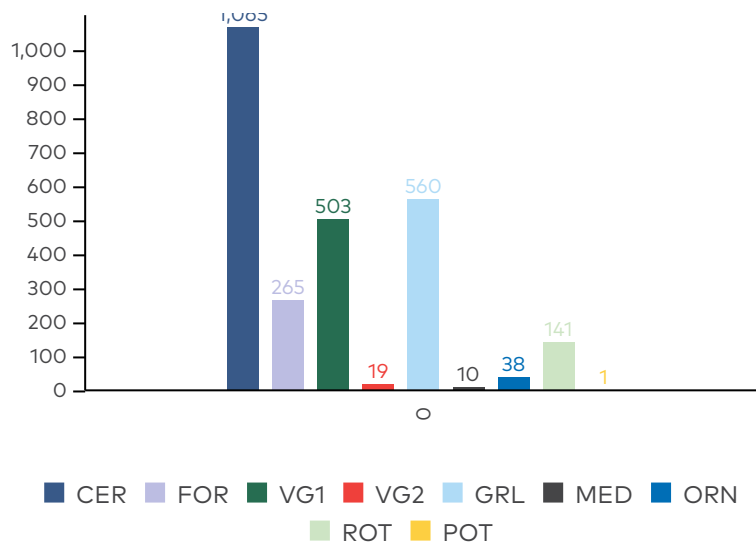


Figure 3: Crop of requested accessions in 2022 (number of bags).

CER: Cereals
 FOR: Forages
 VG1: Vegetables1
 VG2: Vegetables2
 GRL: Grain legumes
 MED: Medicinal plants
 ORN: Ornamentals
 ROT: Oil, textile fibre and root crops
 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 per year has reached over 1000 since 2020.

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 2022 the website work with the online shop continued, for example the product range was expanded with new products.

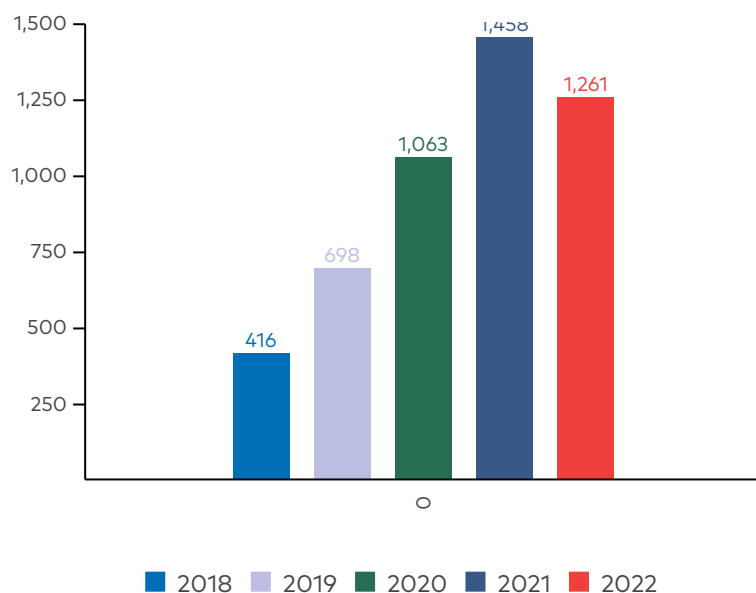


Figure 4: Number of orders in the online shop 2018-2022.



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 2022, the cooperation with the Baltic countries continued and in November, a workshop was organized by NordGen on site in Alnarp. 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 the work on developing a new interface to the website began.





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-profile projects that were active in 2022.

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



Seed collection of sea lyme grass in Hanko, southern Finland.

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.

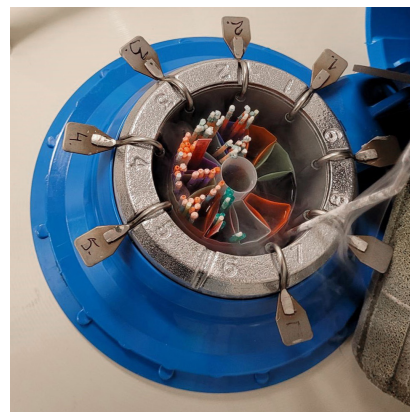
During 2022, several activities were carried out within the project with the goal to strengthen *in situ* and *ex situ* conservation of CWR and facilitate sustainable use. **Inventories of CWR** were conducted in Færder national park in Norway, Oulanka and Nuuksio national parks in Finland, and Abisko national park in Sweden and seeds of CWR were collected in several locations in Denmark, Iceland, Norway, Sweden, and Finland. To better understand the impact of climate change on Nordic CWR, climate modelling was used to evaluate future geographic distributions under different climate scenarios. The distribution of genetic diversity was studied in selected CWR across the Nordic region using molecular markers. In addition, the five **outdoor exhibitions** continued to be displayed in all the Nordic countries.

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.

According to the submitted proposal, "The main objective of the NordFrost network is to develop a regional action plan for the Nordic ex-situ in-vitro conservation programmes that will serve as a new tool to increase resilience of agriculture in the Nordic region". In these programmes cryoconservation of farm animal genetic resources is a crucial tool for the success in management and conservation of genetic diversity in small native farm animal populations. Subsequently, NordFrost project has created roadmap aiming at Pan-Nordic back-up ex situ gene banks for the native farm animal breeds. Related to that, in 2022 NordFrost project focused on the following topics:

- Optimizations of protocol for cost-effective epididymal semen collection for ex situ gene banks in cattle This allowed



Cryotank, photo: Tuula-Marjatta Hamama.

us to aid in rescuing the remaining Faroese cattle genetic resources in May.

- Initiation of the assessment and adjustment of legal regulations related to use of epididymal semen – This step of action is required to facilitate the use of epididymal semen in management of the small native cattle populations.
- Study trip to animal gene banks in the UK – This study trip enabled us to discuss about the pros and cons of the different gene banking strategies for animal genetic resources and showed us what the well-managed gene bank looks like.

Nordic Oat Collaboration

In 2022, 764 different accessions (seed samples) of oats from NordGen were sown in the field, among other things to study the plants' cultivation traits. During the year, a project was developed to genotype all the accessions (i.e. genetic characteristics of the plant individual investigated through DNA analyses). NordGen, Oatly, Lantmännen and ScanOats share equally the costs of the DNA analyzes which are being conducted by bioinformaticians at ScanOats.



NordGen and Oatly have also carried out characterization based on phenotype (physical characteristics such as straw height, grain color, panicle shape and tendency for shattering). The effort required many hours of work in the field, a job that demonstrated the genetic diversity among the 800 oat varieties.

The new data will result in much more knowledge about the collection and provide information on the genetic relationship between all the samples. Because of this, it will be easier for researchers and plant breeders to be able to choose exactly the varieties they have a use for in the future. A better described genebank collection thus becomes more useful for those actors who are interested in developing new oat varieties that are more nutritious, more profitable or better adapted to a changing climate.

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 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.

In the final year, the 3MC-team worked on intensively for the preparing a touring exhibition "Snöhvit, Punakorva, Fjellblom" in collaboration with Museum of Torneo Valley. The exhibition was an overview of the project - the past, present and future of three sister breeds. Instead of being displayed only in Torneo Valley, it went to Rovaniemi, Luleå and Gävle. At the museums, more than 23 000 visitors have seen the exhibition.



Photo: Suvi Tiainen.

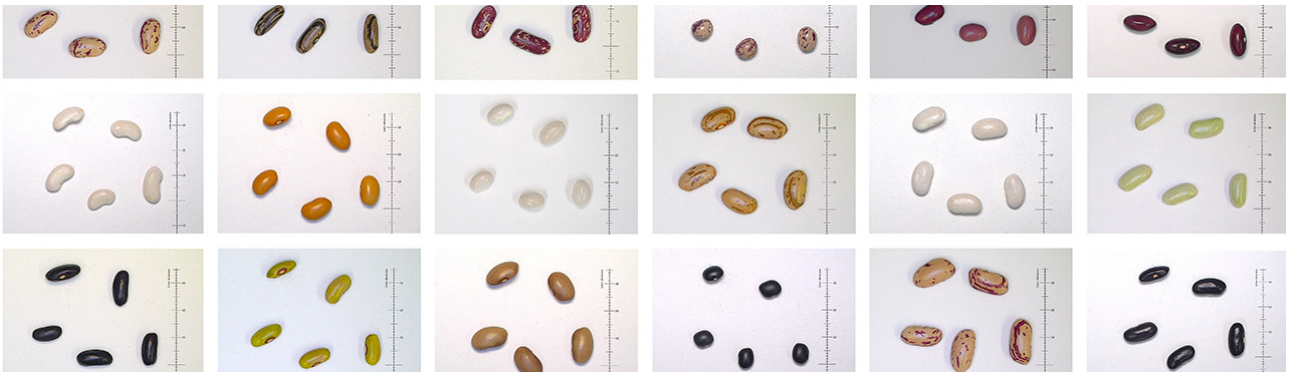
NaNo Horse

Genomic Characterization as a Tool Towards Sustainable Breeding of the native Nordic Horse Breeds (NaNo horse) aims to fill in knowledge gaps by characterizing the standing genetic diversity and relatedness within breeds, and unique variation between the breeds. This information can be utilized by breed associations to make well informed conservation and breeding plans.

The aim of the project is to characterize genomic diversity and inbreeding, within and between Nordic native horse breeds. There are broad knowledge gaps regarding our native breeds, and the true status of their genetic diversity and relatedness. This is an essential first step in describing standing genetic variation within breeds to be preserved, and unique variation between breeds. It can further provide knowledge about genomic regions with unique characteristics and diversity.

This information can be utilized by breed associations to make well informed conservation and breeding plans. During 2022 the project collected all the necessary DNA samples and will continue to process them in 2023. The project will be running from 2022-2024.





PLANTBASED PROTEIN

The impact of climate change is becoming increasingly clear for every year. As a result, the demand for plant-based protein food is on the rise, not least domestically produced.

The Nordic countries have a long cultivation tradition of grain legumes such as fava beans and peas. Given the increased interest, the future of Nordic cultivation of grain legumes should be bright. An enlarged domestic production would also contribute in a positive direction when it comes to Nordic food security being a climate-smart alternative to imported soybeans. In addition, grain legumes such as peas have the capacity of nitrogen fixation in the fields, a property with many benefits.

NordGen's collection includes fava beans, common beans, lentils 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 grain legumes.



Key Activities

Photo Documentation

In 2022, the photo documentation of NordGen's seed samples of grain legumes were completed. In total 2.227 accessions were photographed, 1.908 of these were peas. Thereby valuable information about the morphology of the original seed samples is now publicly available in the GENBIS database. In addition to being an asset for users of the genetic resources, the information is of greatest importance for internal quality assurance after regeneration of the accessions.



Nordic Bean Collection Characterized

During the year, NordGen joined the international EU research project INCREASE as a stakeholder. INCREASE aims at improving

the sustainable use of plant genetic resources by enhancing the status of the genetic resources of four important food legumes: chickpea, common bean, lentil, lupin. Within the framework of the project, NordGen's entire collection of beans (145 accessions) were cultivated in the greenhouse for characterization.

Cross-Fertilization in Beans

In the summer, NordGen's working group for grain legumes conducted a pilot project with the purpose to find out if there is a safe distance to avoid cross-fertilization in common beans, information that can be valuable to both genebanks and seed producers. Beans with red stems were planted in a square as pollen donors and beans with green stems were planted at different distances from 0,25 to 24 meters. Two trials were situated in Sweden and one in Norway. At the end of the summer, the beans were harvested and germination tests were carried out to observe the coloration of the lower part of the lower parts of the stems of the new seedlings. A red lower part of a stem would tell that a cross-pollination had occurred. However, all germinated seedlings, from all distances at all three sites, had green lower part of the stems which indicates that no cross-pollination had taken place.



New Book About Nordic Peas

In the previous project Arctic Pea (conducted during 2017-2021), 50 accessions selected from NordGen's pea collection were evaluated in field trials at four different locations in the Nordic region: Tromsø (Norway), Umeå (Sweden), Jokioinen (Finland) and Taastrup (Denmark). For example, the results showed that no accessions managed to produce mature peas at the northernmost location but many accessions, most of them sugar peas (mainly landraces) with a northern origin did well and managed to produce a green harvest (pod and unripe seeds) that could be consumed as a vegetable. In 2022, the histories of these 50 pea varieties were gathered in a popular scientific book together with evaluation results from the field trials. In addition, the history of pea cultivation and breeding in the Nordic region and information about the Arctic Pea project are included. The book "Nordiska ärter – 50 traditionella sorter" is now available in NordGen's webshop.





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:</p> <p>3, February, June and October</p>	<p>Depositing Institutions:</p> <p>31, four first time</p>	<p>Number of seed samples in the Vault (31/12 2021):</p> <p>1.195.244</p>
<p>New seed samples duplicates:</p> <p>69.825</p>	<p>New institutions signing the deposit agreement:</p> <p>5, located in Spain, Lithuania, Iraq, Albania and Uruguay</p>	<p>Number of depositing institutions (31/12 2021):</p> <p>93</p>



Key Activities

New Depositors

Four genebanks deposited seeds for the first time in 2022; the national genebanks in Spain, Lithuania, Iraq and Uruguay. Delegations from Spain and Lithuania were present in Svalbard and accompanied their seed deposits at the Seed Vault Opening in June.



Nearly 70,000 Safety Duplicates

In total 69,825 safety duplicates from 31 depositors were added to the Seed Vault collection in 2022. By the end of the year the total holding of seed accessions in the Seed Vault was 1.195.244 samples deposited by 93 genebanks/institutes.

100-year Seed Experiment

New sets of seed samples to the 100-year seed germination experiment in the Seed Vault have been deployed in the Seed Vault in 2022. During the year seeds of all 14 crops have, despite some delays, been produced and shipped to NordGen for drying and packing.

Nanofilm Securing Information

Nanofilm labels displaying data on seed samples stored in the seed boxes in the Seed Vault have been attached to around 350 seed boxes in 2022. Attaching already produced film labels to seed boxes will continue in 2023.

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: Graminor/Nikolai Ødegaard.

Key Activities

2022 was a busy year within the Nordic Public-Private Partnership for pre-breeding, as it marks the second year for the current program period 2021-2023 and several projects continued their activities. Read more about the current projects below.

During the year, the planning for the following year's "NordGen PPP Conference" began and the evaluation report for the previous program period (2019-2021) was also completed.

Phenotyping Project Phase 3 (6P3)

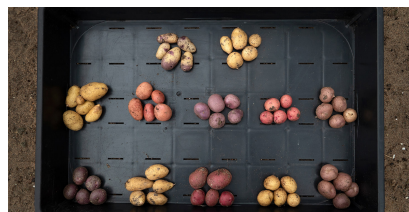
6P3 will focus on operationalization of technologies and methods developed during the previous two project phases. Phenotypic data will be combined with a plant-soil-climate model to understand interactions between genotypes, local environments, climate and management. The aim is to provide Nordic plant 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 2022 was prepared in accordance with Swedish National Financial Reporting Standards and audited by the Swedish National Audit Office.

(TSEK)	Budget 2022	Result 2022
Income		
Nordic Council of Ministers ordinary budget	32.317	32.317
National contributions	7.605	7.528
Other income	0	1.291
Financial income	0	194
Project funds, Nordic Council of Ministers	4.681	4.807
Other external project funding	9.576	10.271
Total income	54.179	56.408
Costs		
Staff costs	27.811	26.183
Goods and services	8.480	9.191
Contribution to external projects	108	108
Financial costs	250	125
Other costs	21.143	20.870
Total costs	57.792	56.477
Result year	-3.613	-69

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. The list below shows those who were active on the board during 2022.

BOARD MEMBERS	ALTERNATES
Finland	
Tove Jern, Chair Ministry of Agriculture and Forestry	Kati Lassi Ministry of Agriculture and Forestry
Sweden	
Carina Knorpp, Vice-Chair Ministry for Rural Affairs	Åsa Widebäck Ministry of Enterprise and Innovation
Denmark	
Mette Hyldebrandt-Larsen The Danish Agricultural Agency	Birgitte Lund The Danish Agricultural Agency
Iceland	
Emma Eyþórsdóttir Agricultural University of Iceland	Guðni Þorvaldsson Agricultural University of Iceland
Norway	
Geir Dalholt Ministry of Agriculture and Food	Ivar Ekanger Ministry of Agriculture and Food
OBSERVERS	
Greenland	
Birgitte Jacobsen Ministry of Fisheries, Hunting and Agriculture	The Faroe Islands
Staff Representative	Tróndur Gilli Leivsson The Agricultural Agency
Ulrika Carlson-Nilsson NordGen	The Environmental Sector
	Katileena Lohtander-Buckbee The Finnish Environment Institute (Syke), FI

NordGen Annual Review 2022

NordGen Publication Series: 2023:01

© NordGen 2022

The publication can be downloaded from NordGen's website or from www.norden.org/nordpub.

Cover photo: Jonatan Jacobson/NordGen.

Other photos: NordGen if not otherwise stated.

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 Ministers and works with the mission of conserving and facilitating the sustainable use of genetic resources linked to food, agriculture and forestry.

Address: Växthusvägen 12, 234 23 Alnarp, Sverige

Website: www.nordgen.org

E-mail: info@nordgen.org

Phone number: +46 40 53 66 40