

NordGen Annual Review

2019



NordGen

NordGen Annual Review 2019

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

Layout: Christina Kjellstrand

Cover photo: Sara Landqvist/NordGen. Finncattle is a farm animal breed native to Finland. They are divided into Northern, Eastern and Western Finncattle. In 2019, NordGen established a project for gathering and distributing knowledge about the Northern Finncattle and its corresponding breeds in the northern parts of Norway and Sweden. The name of the project is "3MC – Traditional transboundary mountain cattle breeds in Nordic. Their cultural inheritance and genetic resources".

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NordGen

The Nordic Genetic Resource Centre (NordGen) is the Nordic countries' genebank 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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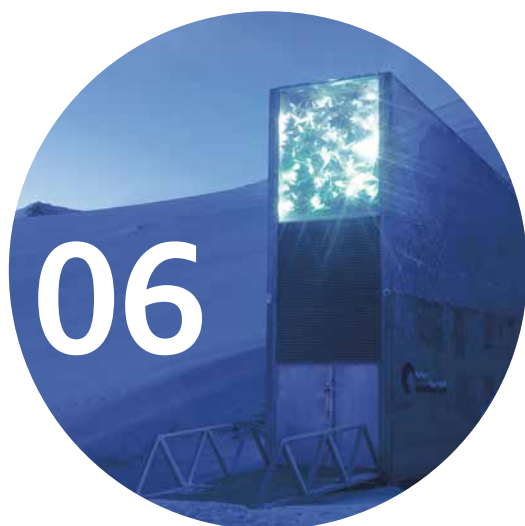
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01

Foreword

A SEED FROM a Norwegian forage crop, a forest conference in Iceland, curious and friendly Northern Finncattle, Danish disease resistant ashes and a protein packed Swedish pea thriving in the midnight sun. The work NordGen does as the Nordic countries' genebank and knowledge centre for genetic resources is truly a testament of which benefits the Nordic cooperation lead to. By working as a regional institution, serving all the five Nordic countries, we are not only more efficient compared to if each country would do the job nationally. We also weld a Nordic network of people working with genetic resources, environment, agriculture, and forestry. In our working groups, councils, conferences and seminars, people from all the Nordic countries meet and discuss urgent matters which lead to future innovations and a better and more sustainable society. That is Nordic benefit in its most distilled form!

Once again, we have had a very productive year behind us. When reading the annual review of 2019, I am very pleased of this year's results and achievements. The work of NordGen truly matters and creates improved prerequisites for a Nordic sustainable development and important contributions to fulfill the UN Sustainability Development Goals. NordGen is a key institution when it comes to innovative genetic solutions to adapt and mitigate to climate change and to strengthen the resilience in the Nordic agriculture and food production.

A workshop held with relevant stakeholders in the beginning of the year concluded that one important part of adapting to climate change is to step up the research, the plant breeding and make sure that the plant genetic diversity needed is well taken care of and in good order. The desired efforts outlined in the report following the workshop form the basis for an ongoing work which will lead to a more sustainable and more competitive Nordic agriculture.

That word – sustainable – is the very heart of NordGen. We find it in our mission, in our statutes and in the

"That word – sustainable – is the very heart of NordGen"

international agreements that are the very basis for our work. We shall conserve and promote the sustainable use of the Nordic genetic resources important for food and agriculture. We shall safeguard the resources we are so dependent on – for future generations, but also for today. Genetic resources are invaluable, and they are carrying possibilities for a more sustainable society. In our everyday work, we help beekeepers save the threatened Nordic brown bee. We identify and provide tools for protection of the precious wild relatives to our crops, which are crucial for adapting plants to future challenges. We provide a meeting place for Nordic foresters, where new ideas and contacts are born. We test, sow, harvest, dry, pack and distribute seeds to provide important genetic infrastructure for the Nordic research and development environments. We gather knowledge about the mountain cattle breeds to raise awareness about their vulnerable status. That is just a few examples of what we do.



Lise Lykke Steffensen,
Executive Director, NordGen

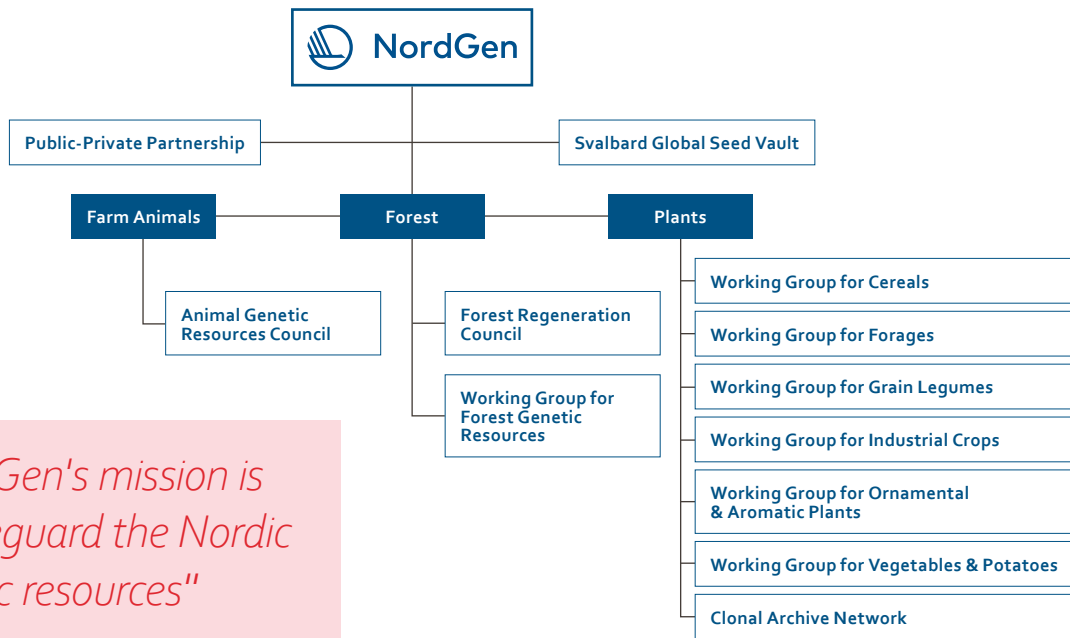
But those who work hard also need to enjoy some festivities from time to time. In the end of the year, we gathered partners and other stakeholders for the 40-years anniversary of NordGen Plants. In 1979, the Nordic Genebank was established as a unique agreement between the Nordic countries to have one common genebank. The benefits with Nordic cooperation was evident already then. Now, 40 years later, we continue along the same path as our predecessors envisioned. Nordic collaboration for greater benefits is crucial in the important task of conserving and promoting the sustainable use of genetic resources.

Lise Lykke Steffensen
Executive Director
NordGen



02

About
NordGen



"NordGen's mission is to safeguard the Nordic genetic resources"

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's mandate is laid down in the statutes adopted by the Nordic Council of Ministers (MR-FJLS) on 10 September 2014, which came into force on 1 January 2015.

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 as well as provide knowledge and genetic material to facilitate sustainable food and feed production and other biobased solutions in the Nordic region's changing climate.

NordGen is active in the development of cooperation with various user groups in the Nordic region and contributes to develop knowledge about and prerequisites for sustainable use of genetic resources.

As a knowledge center, NordGen also promotes collaboration between farm animals, plants, forest and the environmental area as well as disseminate knowledge and raise 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, sustainable plant choices in the forests, 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.



03

Knowledge
Centre

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 tool for exchanging knowledge within the Nordic countries

is our working groups and councils. The different working groups of NordGen Plants, the working group and 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.

Information is disseminated through our website nordgen.org, social media, project reports, press releases, arranged events, network meetings and targeted e-mails.

Facts & Figures

>350 event participants

4 press releases

35 website news articles

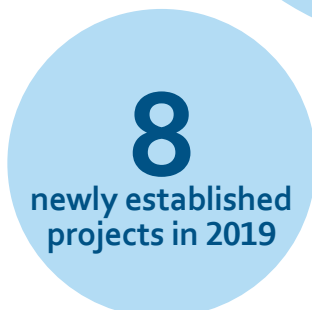
5 publications in NordPub


1 690 downloads of publications

11 forest scholarships

Followers on social media:
(31/12 2019):

2 631 on Facebook
1 118 on Instagram
639 on Twitter
338 on LinkedIn



A photograph of two Icelandic goats in a grassy field. The larger goat in the foreground has long, shaggy fur, with white on its back and legs, and dark brown on its neck and face. It has large, curved horns. A smaller, darker goat stands behind it. The background shows a rolling landscape with hills and a few buildings under a cloudy sky.

The Icelandic goat was brought to Iceland around year 1000. Today it's a threatened breed in Iceland.

NordGen Farm Animals

The genetic diversity that our farm animals carry is invaluable.

The landrace breeds originally used in Nordic agriculture are part of our history and culture and have adapted to our climate and conditions for thousands of years. They have developed desirable qualities that make them durable. Landrace breeds often also have a broader genetic base than commercial breeds, giving them a better ability to adapt to change. The animals also usually have good maternal characteristics and are kind and easy to handle.

Today, we're dependent on modern agriculture and commercial breeds to produce the amount of food we

eat. But the landraces should not be forgotten. They are ideal for smaller farms with more traditional farming methods. They can survive on poorer feed and might provide opportunities for tourism and rural development. However, many of our landraces are at risk of extinction.

One of NordGen Farm Animals' missions is to reverse this trend. We need a wide variety of animal genetic resources, not least to be able to adapt to the needs of the market and new production systems. At a time when climate change is becoming increasingly urgent, it is crucial to ensure that we can produce food sustainably in the future. The Finnish mountain cattle, the Norwegian coastal goat and the Scanian flower chicken can carry solutions to problems that we have not yet discovered.

"The landrace breeds are part of our history and culture."

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. We contribute 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, we 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 promote good collaboration between them. We actively distribute information about animal genetic resources and partake in international networks. We also work to promote sustainable breeding practices and good principles for fair trade in animal genetic material.

Key Activities in 2019

CONSERVATION ACTIONS OF THE NORDIC BROWN BEE.

A workshop for artificial insemination of Nordic brown bees was arranged in NMBU campus July 5th to 7th 2019. The workshop consisted of lectures, and hands-on exercises were instructed by a Swedish bee expert; Bert Thrybom. The participants came from Norway, Sweden and Denmark. The Nordic brown bees have been targeted by NordGen for a number of years. Read more about them under the projects section.

On the 19th of November, **THE NORDIC-BALTIC NETWORK FOR NATIVE HORSE BREEDS** met for the first time in a workshop arranged by NordGen in Oslo. Despite differences in the use of the horses and different size of the horse breeds in the Nordic countries, the breeding organizations experience the same challenges regarding controlling inbreeding and marketing of the horses. Thus, an international network will be helpful in targeting work efforts. The idea is that the NordGen native horse breed network will lead to knowledge exchange, common projects, and other matters which the par-

ticipants find useful. The network will also support the efforts done for safeguarding the native horse breeds in the different countries and promote a sustainable use of them. One outcome of the meeting was plans of producing educational material about the breeds targeting both members of the breeding organizations and the general public.

A WORKSHOP IN EVA ON THE 26–29TH OF NOVEMBER IN OSLO.

We are getting regularly enquires to arrange education in breeding of small populations with EVA software, a program package for monitoring the rate of inbreeding and optimizing breeding recommendations. Last November, 13 participants from Faroe Island, Finland, Germany, Italy, Lithuania and Norway gathered in Oslo to learn how to use EVA in their breeding populations. The EVA-course aimed to give an introduction to both theory and implementation of optimal contribution selection in management of breeding and conservation programs. The final goal was to promote independent use of EVA software with hands-on exercises. The previous EVA-course was held in 2016.



The Finnhorse is a native horse breed from Finland.



Klövsjöfår is a native sheep breed from Sweden.

In 2019, the annual forest conference was arranged in Iceland.

NordGen Forest



In the Nordic countries, forests have always played an important role.

Forests provide wood and bioenergy, protection against wind and erosion, biodiversity and is a carbon dioxide sink. When it comes to climate change, the forest is especially important because it binds carbon dioxide throughout its lifetime. In addition, timber can replace other materials that give large emissions when produced.

Climate change can hit our forests hard because the trees we plant today will grow for decades to come. During the



One of NordGen Forest's focus areas is seed and plant production.

life of a tree, the climate will change, and we must deal with the emergence of new pests and diseases that have not existed in the Nordic region before. Therefore, it is important that we have trees that are adapted to the place where they will grow, both now and for many years to come. This is needed to secure the forest's role in the future.

The forest industry within the Nordic countries agrees that there is a need for a strong, resilient forest in the future. An important key to this resilience is genetic diversity. Because different trees carry different genes, chances are that some of them can resist the new threats.

Key Activities in 2019

THE SPRING THEMATIC DAY this year was held in March at Skogplanter Midt-Norge's premises in Kvatninga in Trøndelag/Norway. NordGen Forest and partners arranged a successful thematic day on the supply of seed and forest plants in a future perspective. About 50 participants from forest research, forest management, nurseries and forest owner associations were present at the meeting in Norway. In addition, a live stream via Facebook was arranged for the meeting, which allowed more people to follow the presentations online.

THE AUTUMN THEMATIC DAY was held on 9 September in Jyväskylä in Finland. The theme was "Forest regeneration and early tending in the 2020's". The NordGen Forest thematic days are normally held in the language of the host country. The thematic in Jyväskylä was held in Finnish, whereas the thematic day in Norway was held mainly in Norwegian.

The main event in 2019, **THE NORDGEN FOREST CONFERENCE**, focused on threats posed to Nordic forestry and forest plant production by invasive pest species. Forest pests are a significant threat to boreal forests and forestry. The conference was held in Hveragerði, South Iceland on 17–18 September. The title was "Future Forest Health – Early detection and mitigation of invasive pests and diseases in Nordic forests". An excursion was held on the last day of the conference and included among other issues visits to geothermal heat forests in Reykir and breeding for resistance in Black cottonwood.

The annual NordGen Forest conferences are each year held in different Nordic countries. They are held in English for a broad participation from the Nordic and Baltic regions.



Hybrid of European and Siberian larch developed in Iceland.

Further, **THE WORKING GROUP HELD ITS MEETING** in Åland in 2019, back-to-back with a seminar of relevance to forests in Åland and fragmented species and populations. The seminar was held in Mariehamn and was followed by a forest field trip to e.g. Stornäset field test area. The seminar was regarded successful, both by the representatives from Åland and by the working group.

Scholarships

A total of 31 applications (15 male and 16 female) were received by the deadline on 15 February 2019. We have never had so many applicants. 11 of them were granted. The grants were given to travels, field and laboratory work, supporting activities in all the Nordic countries and Lithuania.

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

NORDGEN FOREST'S focus areas are forest genetics and conservation of forest genetic resources, seed and plant production and rejuvenation of forests. By disseminating knowledge and experience between the various actors and to the public, we help to develop better plant production and better rejuvenation

methods of forest. We also keep up to date and initiate research and development in the area and conduct various types of projects and information activities.

NORDGEN FOREST consists of two bodies: The Forest Regeneration Council which meets twice a year and the Genetic Resources Working Group 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 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.

We need to breed plants that are adapted to the new climate conditions, can withstand new pests and resist diseases. 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.

NordGen Plants' research is done in a close relationship with public institutions, plant breeding companies and other organizations in order to identify green solutions for a more sustainable society. Whether it's finding new plant protein sources, innovations for a more environmentally

friendly agriculture or educating children about the origin of our food, NordGen Plants strive to promote a sustainable use of plant genetic resources. By doing so, we contribute to the Nordic agriculture being more competitive and thereby enabling the Nordic countries to increase self-sufficiency.

"In those seed samples lie possibilities some yet to be discovered."

NordGen Plants is closely interconnected with the NordGen's genebank collection. Characterizing, mapping and evaluating the 33 000 seed samples stored in the genebank is an immense and constantly ongoing task but nonetheless crucial. In those seed samples lie possibilities, some yet to be discovered. May it be vegetables with health benefits, cereals with resistance against unknown diseases or fodder plants which grow well in drought. Through the daily work in the genebank, through projects, in collaborations with our partners and within Nordic, European and International networks, NordGen Plants is striving to preserve a wide biodiversity of crops and promote the use of this biodiversity, for present and future generations.

NORDGEN PLANTS is our largest department.

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. One important part of this work is maintaining the Nordic seed collection in the genebank.

NORDGEN PLANTS also cooperates with companies, universities, and other stakeholders to ensure the conservation and sustainable use of plant genetic resources. A central part of NordGen Plant is the working groups on plant genetic resources that together with the national programs constitute the very core of our network of Nordic experts. 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 as well as initiating projects on NordGen's plant material. They also contribute with important continuity in the work done.

Key Activities in 2019

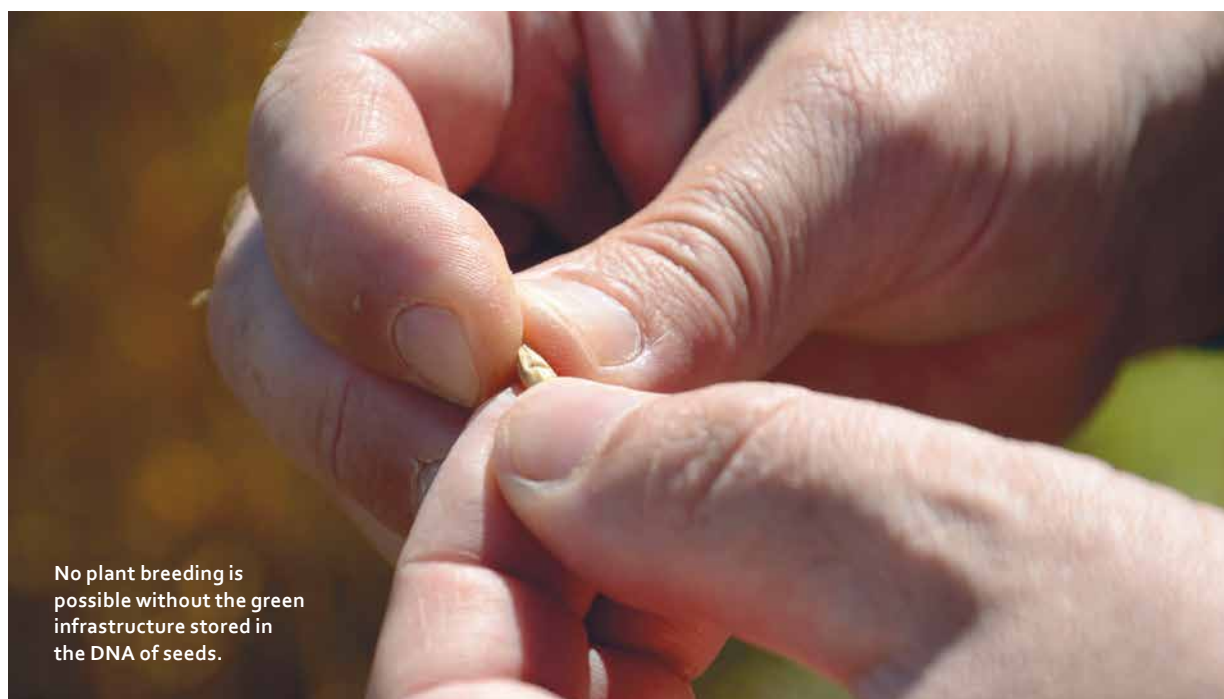
WORKSHOP ON "NORDIC AGRICULTURE AND CLIMATE CHANGE: MITIGATION AND ADAPTATION"

Climate change has already resulted in challenges for Nordic agriculture and the difficulties will continue to increase in the future. It is therefore important to act now to adapt our agriculture to future conditions, especially since the development of new crop varieties takes a long time (8–15 years). In the small business area, which the Nordic countries constitutes, collaboration within research and development of new varieties is crucial and beneficial, not least since we share the same climate and daylight conditions.

In the beginning of 2019, the workshop "Nordic Agriculture and Climate Change: Mitigation and Adaptation" was

organised by NordGen and NordForsk in Oslo. The aim was to discuss how future research can facilitate climate change adaptation and mitigation in the Nordic agriculture. The participants included representatives from the Nordic plant breeding sector, farmer organisations, research organisations as well as policy makers. Apart from several highly relevant presentations in the topic of climate change adaptation and mitigation, the participants had fruitful discussions and developed a set of recommendations.

The output of the workshop was summarized in the report "Nordic Agriculture and Climate Change – Mitigation and Adaptation: Recommendations from leading researchers and private companies within the Nordic plant breeding". Read more about it in the Publications section.



No plant breeding is possible without the green infrastructure stored in the DNA of seeds.

INTERNATIONAL COLLABORATION

Preserving 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 and the Convention on Biological Diversity, ratified by all the Nordic governments. To NordGen, as part of the global genebank community, international collaboration is crucial. Examples of forums for this work are the Governing Body to the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), the Commission on Genetic Resources for Food and Agriculture (CGRFA) and The European Cooperative Programme for Plant Genetic Resources (ECPGR).

In 2019, NordGen accepted trainees from Thailand's genebanks and [signed a memorandum of understanding with](#)

[Baekdudaegan National Arboretum in South Korea](#), who also visited us in Alnarp. In the fall of 2019, NordGen also [visited Poland's genebank](#) and gained valuable insights in their operations and signed a cooperation agreement.

REORGANIZATION OF WORKING GROUPS

The plant working groups are detrimental to secure that NordGen's work is relevant and of high quality. Through the participants' gathered expertise, NordGen is granted invaluable advice regarding which activities to engage in and how to use the Nordic cooperation in the best possible way.

NordGen Plants have seven working groups. Each is composed by one or two experts from each Nordic country as well as two representatives from NordGen. The groups are divided by the different plant species. The groups meet

at least once a year and has at least one more conference call.

In 2019 a re-organization of the working groups for plant genetic resources came into force following work to update the mandates and structure for the NordGen Working Groups to secure that NordGen's work continues to be relevant and of high quality in order to facilitate Nordic cooperation in the best possible way.

VISITS

An important part of NordGen's mission is to raise awareness of genetic resources and the sustainable use of them. One example of how this is done is that we every year accept numerous visitors to our headquarters in Alnarp, where we show them our labs, greenhouse and gardens. 2019 was no exception. We were for example

honored to receive the [Swedish Minister of Rural Affairs](#) and [representatives from the Dutch Embassy](#) in Denmark and Germany as well as students, NGO-representatives and other state officials.

CELEBRATION OF THE 40-YEARS ANNIVERSARY OF THE NORDIC GENE BANK/NORDGEN

The discussions concerning the need of safeguarding genetic resources in a genebank started already in the 1960's, at a café table in Rome, according to Stig Blixt. But it was in 1979 that the Nordic Genebank was first established as an institution under the Nordic Council of Ministers. In 2008, the Nordic Genebank merged with its forest- and farm animals' equivalents and was given its current name NordGen. [In December 2019, the 40-years anniversary was marked with a seminar and a small reception.](#) Some 80 attendants participated in the event arranged in Alnarp.

"Preserving genetic resources requires international collaboration."

A close-up photograph of a hand holding a thin, yellowish plant stem. The stem is being held between the thumb and index finger. The background is a plain, light-colored surface. The text '04' is overlaid in the upper right corner, and 'The Genebank' is overlaid below it, separated by a horizontal line. In the foreground, several other similar plant stems are lying on the white surface, some showing small green buds at their tips.

04

The Genebank

NordGen's genebank is a joint 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 is a global public good under [the International Treaty on Plant Genetic Resources for Food and Agriculture \(ITPGRFA\)](#). The plant genetic resources stored in our genebank are available for research, education, and breeding purposes.

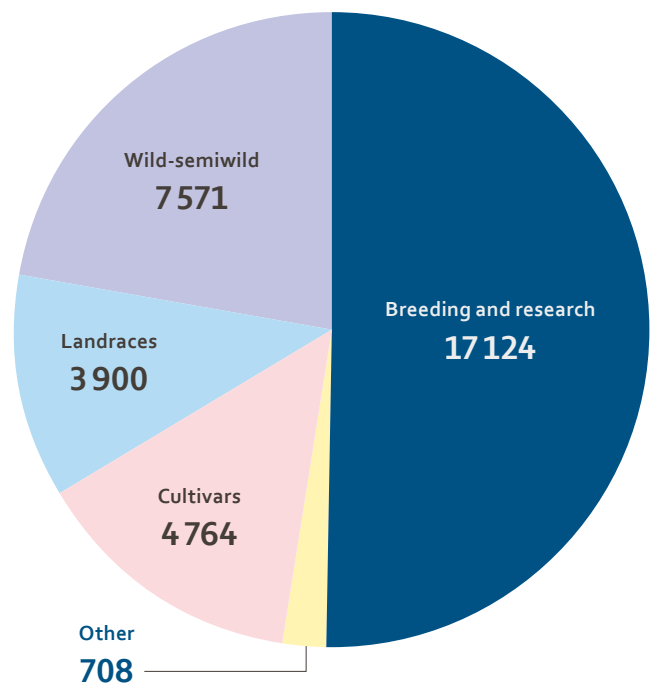
The genebank contains about 33 000 seed samples from 536 different plant species. These species carry a wide palette of different genetic traits that constitutes the green infrastructure for research and development of a sustainable agriculture and green growth.

Facts & Figures

Plant groups represented in the Nordic seed collection:

Cereals	20 000
Vegetables	6 500
Forages	4 800
Oil, fibre and root crops	1 500
Medicinal species	350
Ornamentals	230
Potatos	80
Fruits and berries	15

Origin of the seed samples:



"The services of the genebank is a global public good."

Genebank Activities in 2019

IMPLEMENTATION OF A NEW NORDIC-BALTIC

DATA MANAGEMENT SYSTEM

The very core of NordGen's genebank is the database that contains all the data gathered over the years about the seeds and the plants in NordGen's genebank collections. 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.

The current database system, SESTO, database is used by both external users and by the staff at NordGen and the national genebanks in all the Nordic and Baltic countries to manage their seed and clonal collections and provide documentation. However, SESTO, established in 2002, has reached the end of its life span and no longer meets the required needs.

Instead, NordGen has decided to transfer to the internationally well-known genebank data management software Grin-Global. The establishing and updating of the new data management system is a critical step in strengthening the documentation processes in genebanks.

During 2019, NordGen started implementing the data migration from the existing database SESTO to Grin-Global. New technical developments to ensure full functionality have been prioritized. For example, triggers for tracking of changes and add-ons for label printing and barcode scanning, which are critical functions for genebanks. The new database, which will serve NordGen as well as all Nordic and Baltic national genebanks, will enable each genebank to handle its own information. The new database will be more dynamic than SESTO, contain more information, include topnotch features such as

genotyping fields and rely on a better technological platform.

As part of the transfer, [two successful workshops hosted by NordGen](#) gathered data managers and national coordinators from nine Nordic and Baltic genebanks in 2019. They focused on introducing the participants to the new data management system and addressing issues related to the work with migration of data. They also provided a forum for best practice sharing.

The new database with the name "Nordic Baltic Genebanks" will be ready for launch in June 2020.

REDUCING THE REGENERATION BACKLOG

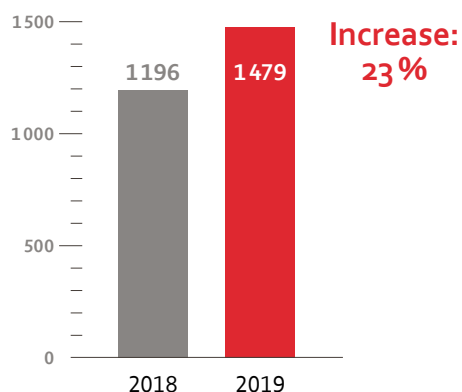
Project "No regeneration backlog by 2024".

Although NordGen carefully plans and carries out many regeneration activities each year, over time a backlog of accessions has been built up, which needs handling to secure long-term conservation. The collection at NordGen has grown considerably during the last decade or so and the obligations of NordGen are larger than the current capacity and have been for years.

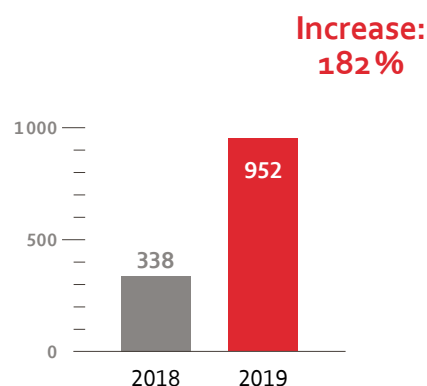
To further expand NordGen's regeneration activities to reduce these backlogs, the Board of NordGen has in late 2019 adopted a project plan to eliminate the backlogs in the genebank collection. This project is named "No regeneration backlog by 2024" and funded by extraordinary funds obtained from the Nordic Council of Ministers. The project activities will lead to a major reduction of the backlogs and activities include repacking of material, final decision of material with the status pending, regeneration of material in need for checking and cleaning and purification of material that is stored as uncleaned material.

Total number of seed samples in NordGen's collection: **33 000**

Total number of regenerated accessions



In-house regeneration





Greenhouse and Fields

Cereals propagated at Lönnstorp field site close to Alnarp. Here, more than 700 varieties are sown in square meter plots and harvested with a pair of scissors.

ALL SEEDS WILL regularly need to be regenerated or multiplied for securing that they are fresh and in a sufficient amount for storage and distribution. Internally at NordGen, thousands of plants, over 950 different seed accessions and more than 100 different species were grown in the greenhouses and fields in 2019. Each year, new accessions are sown. But for some biannual plants, such as for example *brassica* and asparagus, it takes several years of cultivation before we can harvest seeds.

In 2019, NordGen expanded the area for regeneration and got funding for regenerating additional accessions. The total number of accessions regenerated for harvest at NordGen was 952, of which 100 accessions were peas and 737 were cereals. In addition, NordGen has agreements with many external partners to have accessions regenerated at other locations in the Nordic region. Regeneration at external partners in 2019 included 100 pea accessions and 180 different cereals. In total 524 accessions were regenerated for harvest by external partners. This number is slightly lower than last year due to NordGen building up the capacity to regenerate more accessions in-house.

Below: Asparagus is one of the plants that are quite difficult to propagate. It can take three years from sowing to harvest of seeds.



Top: In 2019, NordGen propagated 100 different pea varieties. The pods were harvested by hand.

Bottom: Lönnstorp field site. Each cereal ear is precious. The harvesting is done manually and takes time.



Seed Laboratory



Each year, NordGen's seed lab performs about 5 000 seed germination tests.

NORDGEN FOLLOW THE FAO's international genebank standards on performing germination tests on the seeds to check their viability. Different species require different conditions for germination. Every year about 3 000 germination tests are done in NordGen's seed lab.

2019 was a busy year for the staff in the seed lab. There were many samples to thresh and clean due to the high number of regenerated accessions. Also, the staff took part in training in purity and germination tests as well as study tours to other seed testing laboratories.



Right: Some of the seeds need special treatment. Angelica is stored in a incubation cabin for six months before it will germinate.

Below, left: A video microscope is useful when cleaning samples of small seeds from capsules and other impurities.

Below, right: Results from a germination test of cucumber seeds.



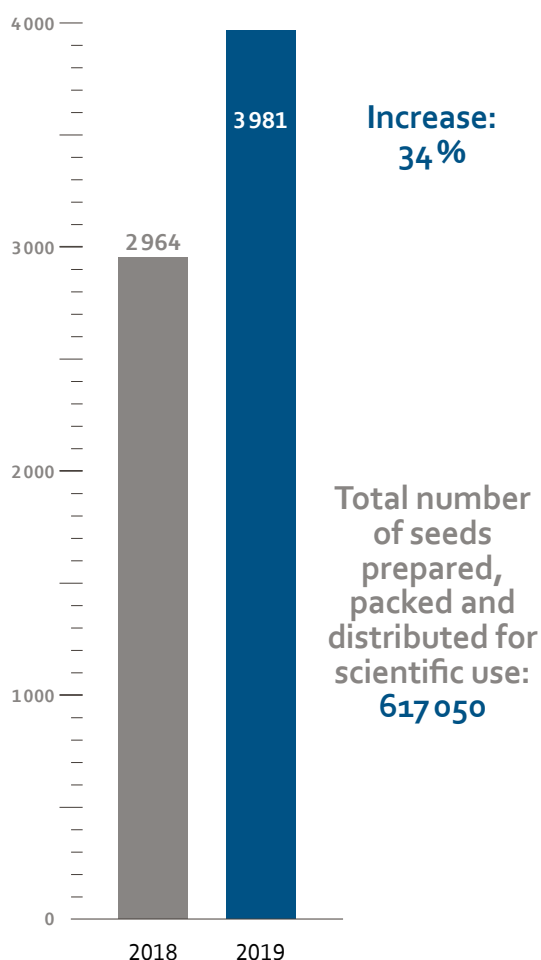
Promotion

of the sustainable use of genetic resources for agriculture, horticulture and forestry

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.

In 2019, the number of seed requests increased both for scientific use and from hobby growers. In total 862 orders have been handled and more than 7 000 seed samples sent. 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 more than 50% from 2018 to 2019.

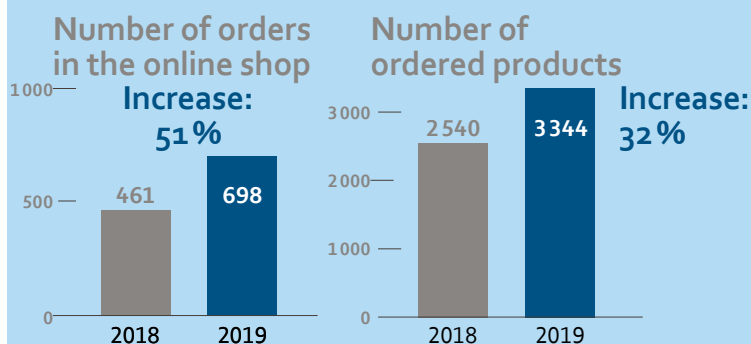
Number of seed samples ordered for scientific use



Online shop

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 2019, we also took the opportunity to offer gift boxes with seeds from Nordic cultivars in our webshop a few weeks before Christmas, which proved to be a big success.

The *brassica* Klint Karin was the most popular variety in the online shop during 2019.





05

Projects

Finncattle is one of the breeds studied in the project 3MC.

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 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.

On the following pages, you can find a summary of some of our more high-profiled projects.

3MC

Traditional Transboundary Mountain Cattle Breeds in Nordic. Their Cultural Inheritance and Genetic Resources.

NORTHERN FINNCATTLE, Norwegian Sidet Trønderfe and Nordlandsfe and Fjällko are three closely related cattle breeds that have played an essential role in the past for the Northern Scandinavia. To promote conservation for the Northern mountain cattle breeds, we need to scrutinize and distribute knowledge about their genetics, history and cultural heritage. Establishing a network by bringing together enthusiasts of local breeds, experts in the cultural history of the area and local entrepreneurs interested to utilize mountain cattle in the business will serve mountain cattle society also after the project has ended. Diverse information will be gathered by going through archives, performing interviews, writing competitions and exhibitions. Genetic studies will be done by pedigree, DNA and archaeological examinations to determine collective past and current relationships of the breeds. 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 project is financed by Interreg Nord, Lapin liitto and Region Norrbotten. The project is carried out in Nordic cooperation between Finland, Sweden, Denmark and Norway. 3MC project aims to lead a novel way for conserving local genetic resources.



In the project 3MC, knowledge about three mountain cattle breeds in Norway, Sweden and Finland is gathered and shared.

*"A novel way
for conserving
local genetic
resources."*

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 have 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. 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 A richer agricultural landscape is trying to identify and recommend the best heritage cereal varieties for baking and cultivation.



Arctic Pea

This pea variety is called Kärrboda and was characterized in the project Arctic pea.

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

2019 was the third year for the Nordic cooperation project Arctic Pea, funded by Nordregio's Arctic cooperation program. The trials performed in 2018, with the aim to identify pea accessions suitable for future cultivation in the Arctic regions, were repeated. The same 50 accessions from the NordGen pea collection were evaluated at the identical trial sites (Norway – Tromsø, Sweden – Umeå, Finland – Jokioinen and Denmark – Copenhagen).

The evaluated accessions represented sugar peas, shelling peas and dry seeded peas from Sweden, Finland and Norway. They were evaluated for traits of importance for cultivation in more northern regions such as flowering and maturation time. In addition, traits like yield and protein content were measured. The segregation found in the material when used under different Nordic conditions gives us good possibilities to find the most suitable accessions for the Arctic areas.

The results for the two years will be compiled during 2020 but so far it can be concluded that a number of accessions were found that reached green maturity at all trial sites. Among the most promising were a hand full landraces and local primitive accessions from Norrbotten, Sweden, together with a couple of Norwegian accessions.

Members of the project group in Tromsø, 2019.



Gästrikland from Umeå.

Naturum in Kristianstad, Sweden, is one of the hot-spots for crop wild relatives identified in the project.

Crop Wild Relatives

PHOTO: JENS WEIBULL



Cikory is one of the identified crop wild relatives that are important to preserve.

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.

"In many cases, wild species have traits that are not present in modern crops."

The Nordic network on Crop Wild Relatives (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 facilitate use of CWR. During 2019, the second phase of this network was finalized and a report was published summarizing the results so far. For more information, see the list of publications.

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 for a three-year period.

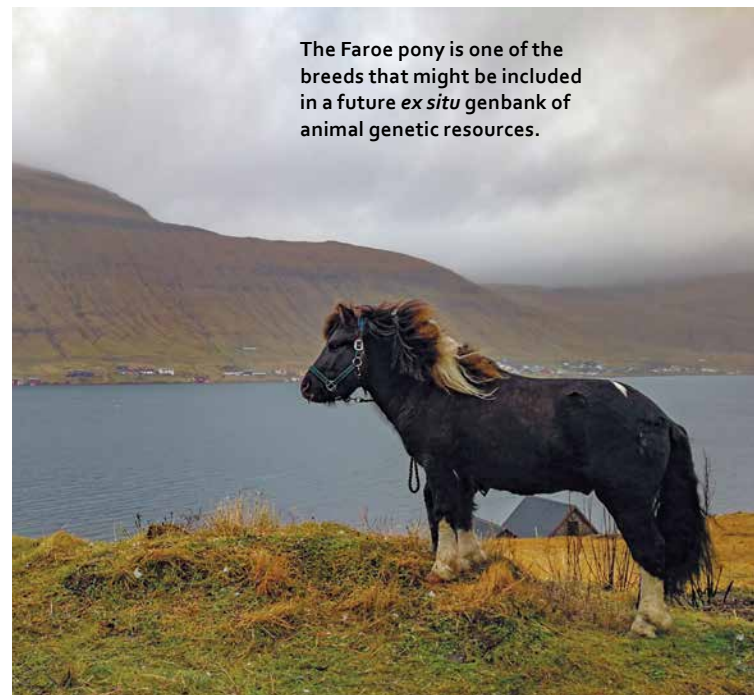
IMAGE

THE GLOBAL PLAN of Action for Animal Genetic Resources identifies conservation of animal genetic resources as a "Strategic Priority Area". Farm animal gene banks are important sources of genetic variation to ensure breeds' long-term survival and preservation of rare genotypes. Yet, their collections need to be better documented and progress in reproductive biotechnologies is needed to improve feasibility of gene banking.

The challenge for animal gene banks towards the future will be to raise global awareness of the value of their collections for research and breeding and to further strengthen, implement and optimize the *ex situ* conservation strategies.

The aim of IMAGE is to enhance the use of genetic collections and to upgrade animal genebank management. IMAGE partners are developing a renewed strategy for animal gene banks, taking advantage of genomic methodologies, biotechnologies, and bioinformatics for a better knowledge and exploitation of animal genetic resources.

"IMAGE – Innovative Management of Animal Genetic Resources" (acronym IMAGE) is a project funded by the Horizon 2020 Research and Innovation Programme of the European Union.



The Faroe pony is one of the breeds that might be included in a future *ex situ* genbank of animal genetic resources.

Nordic Brown Bee

THE BROWN BEE, *Apis mellifera mellifera*, is the bee originating from the Nordic region. In the 20th century, bee keepers introduced other subspecies of honey bees to the areas inhabited by the Nordic bees. This led to the Nordic brown bee being displaced and hybridised by the new subspecies. Today, the Nordic brown bee is considered a threatened breed.

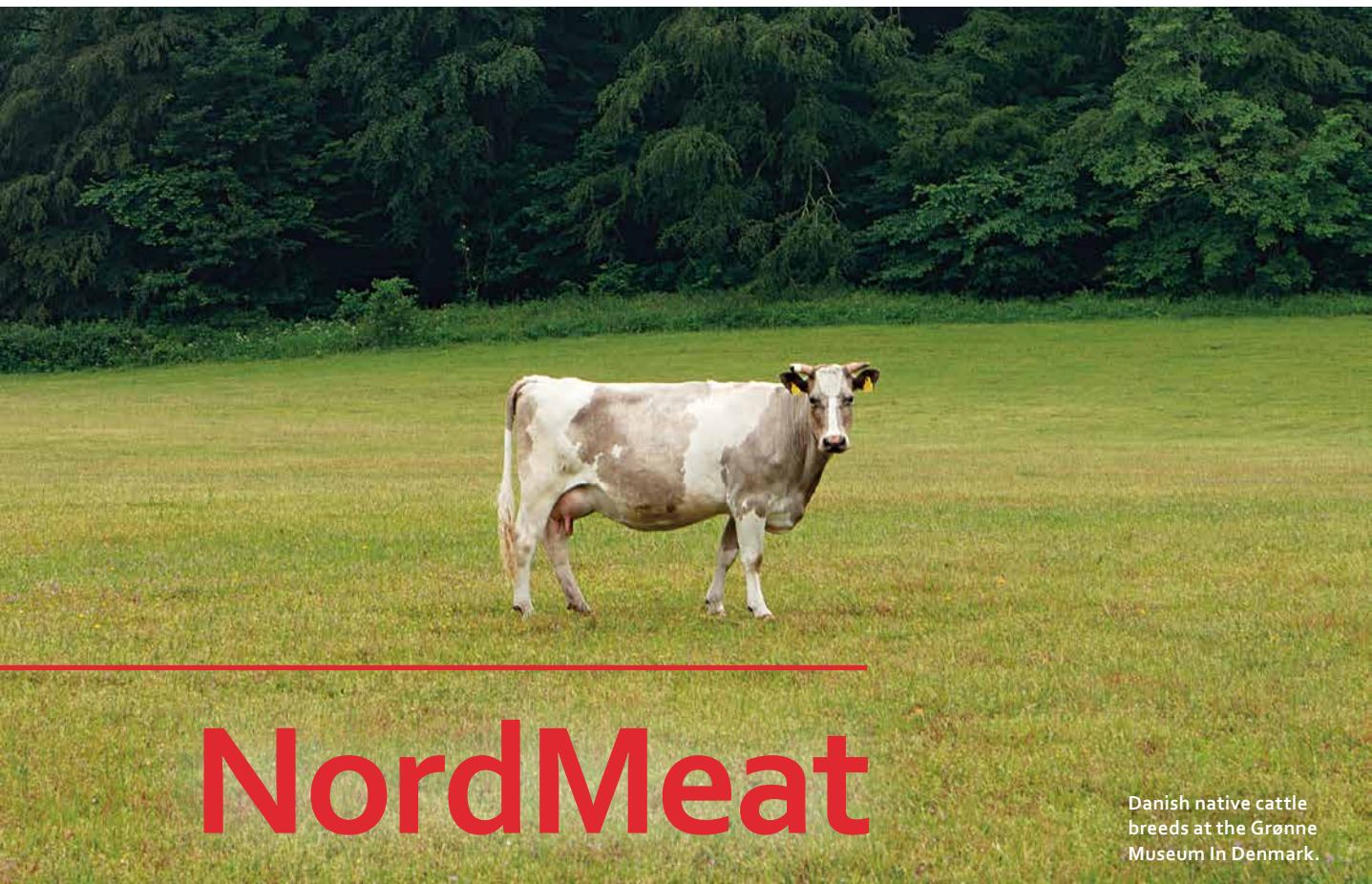
NordGen's work with the Nordic brown bee has been active for several years. In cooperation with experts from the Nordic Countries, the status for the bee has been summarised and a conservation plan published. The conservation plan has thereafter been released in a second version with recommendations. Further, a public platform (Brown Bee Wiki) has been established, gathering information about specific management practises for

the brown bee. The Nordic network of bee keepers and other relevant stakeholders has been promoted. The aim of the network has been to coordinate activities concerning conservation and the sustainable use of Nordic brown bees. A priority list of conservation actions for the Brown bees in the Nordic region was first time compiled in 2015 by the Nordic Brown bee network. In 2019, an updated version was launched. This second version contained 18 recommended activities for conserving the Nordic brown bee. The main points concerned on significance of networking; breeding and exchange of genetic material; education, research, characterization and marketing, to mention a few. Artificial insemination is one of the measures in the Second Plan of Actions. A workshop on artificial insemination was arranged during the summer of 2019.



PHOTO: PER KRYGER

The Nordic brown bee is native to the nordic countries. It flies at lower temperatures and is better adapted our climate.



NordMeat

Danish native cattle breeds at the Grønne Museum In Denmark.

HOW DOES MEAT from a native breed taste compared to meat from other breeds? Are there any differences in texture, does the meat have other traits? Today, we're lacking this kind of knowledge about the meat from our native breeds. Knowing more would be beneficial for developing niche products from native breeds and thereby promoting a sustainable use of them.

The project "NordMeat – characterisation of meat from native Nordic breeds" is aiming at stimulating and coordinating activities that characterises meat from native Nordic breeds. Functional differences in the meat quality are documented and the use of them are promoted. NordGen has established a research network from Nordic Countries. The expected outcome is a database with information and a scientific article.

"Knowing more would be beneficial for developing niche products."



06

Svalbard Global Seed Vault



NordGen is responsible for operating the Svalbard Global Seed Vault in co-operation with the Norwegian Ministry of Agriculture and Food and the international organization for crop diversity, Crop Trust.

NordGen's role in the Seed Vault partnership is to handle contacts with the genebanks, deposit seeds and update the Seed Portal – a publicly accessible database gathering information about the seeds stored in the Seed Vault.

Svalbard Global Seed Vault is a backup facility for the world's crop diversity. By putting seed duplicates for free, long-term and safe storage in Svalbard, genebanks reduce the risk of losing invaluable genetic material if anything should happen to their original collections. According to FAO's genebank standards, genebanks should backup

their germplasm collections in at least one, preferably two places.

Svalbard Global Seed Vault is acknowledged by the international community as a backup facility for the world's crop diversity. Close to one million seed samples are stored in the Seed Vault and the number of depositing institutions is constantly increasing. Anyone signing the deposit agreement is welcome to store a second backup of their seed collections here, free of charge and without any transfer of legal ownership.

Since its inauguration in 2008, the Seed Vault has gained massive media attention and a substantial part of NordGen's responsibility in the operations of the Seed Vault is also to answer enquiries from the public and media representatives. The attention for the Svalbard Global Seed Vault is re-directed to the important task of preserving crop diversity and the valuable work done by genebanks worldwide.

Facts & Figures

4 Seed Vault openings in 2019 (March, June, August and October).

992 032 seed samples in the Seed Vault .

7 depositing institutions 2019 (3 of these for the first time).

78 depositing institutions.

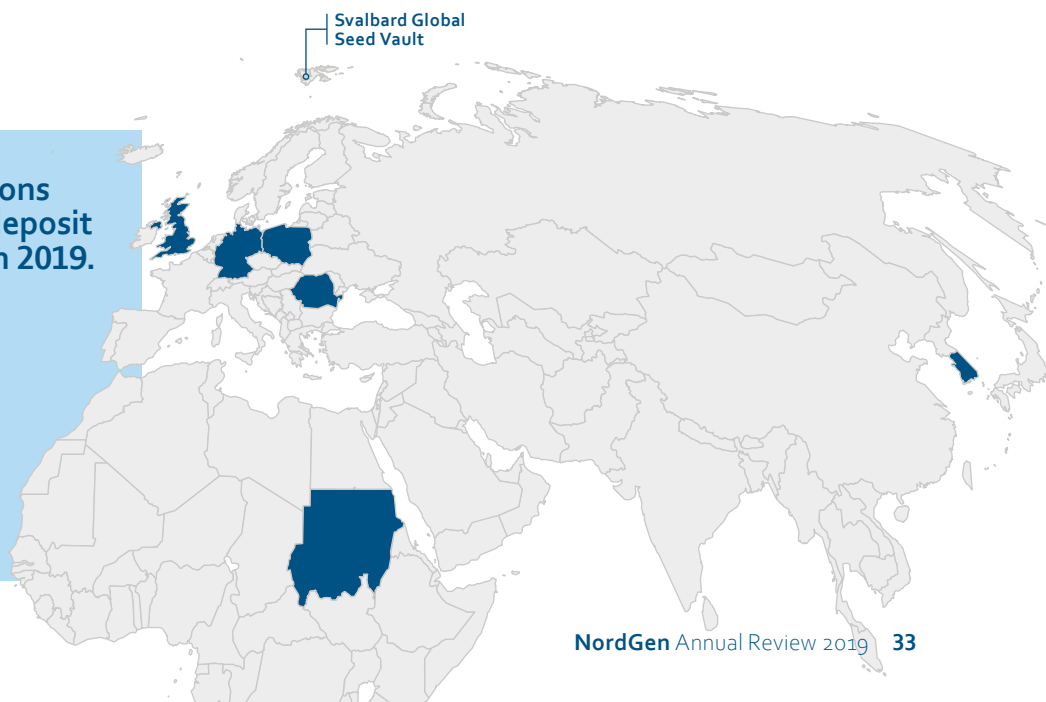
32 572 new seed sample duplicates.

20 lectures about the Seed Vault given by NordGen staff.

6 new institutions signing the deposit agreement in 2019.

Located in:

- Sudan
- Germany
- Poland
- Romania
- South-Korea
- the United Kingdom





Above: NordGen is an observer in the governing body for ITPGRFA which had its meeting in Rome in November 2019.

Left and below: NordGen is responsible for the seed handling at Svalbard Global Seed Vault.



In 2019, the technical upgrade of the Seed Vault was completed.



The seed deposit in October was attended by both the Slovakian Minister of Agriculture and Rural Development and the Norwegian Minister of Agriculture and Food.

Activities in 2019

THE COMPREHENSIVE UPGRADE of the Seed Vault facility, which was commenced in 2018, was completed during 2019. The completion was marked by a key handover ceremony hosted by the Norwegian Minister of Agriculture and Food in October. The ceremony was combined with a visit from the minister's Slovak colleague and the first seed deposit from Slovakia's national genebank.

2019 WAS OTHERWISE an unusually calm year seen to seed deposits as many institutions took the opportunity to deposit seeds during the marking of the Seed Vault's 10-year anniversary in February 2018. The seed deposits

and seed handling operations were also affected by the ongoing construction upgrade of the Seed Vault that was completed by the end of the year.

IN NOVEMBER 2019, the Governing Body of the International Treaty for Plant Genetic Resources for Food and Agriculture (ITPGRFA) met at FAO's headquarters in Rome. In connection with this, NordGen arranged a side-event about the Seed Vault together with the Norwegian Ministry of Agriculture and Food and Crop Trust. During the entire meeting week, a large model of the Seed Vault was also at display in the atrium of the FAO building.

Svalbard Global Seed Vault

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.

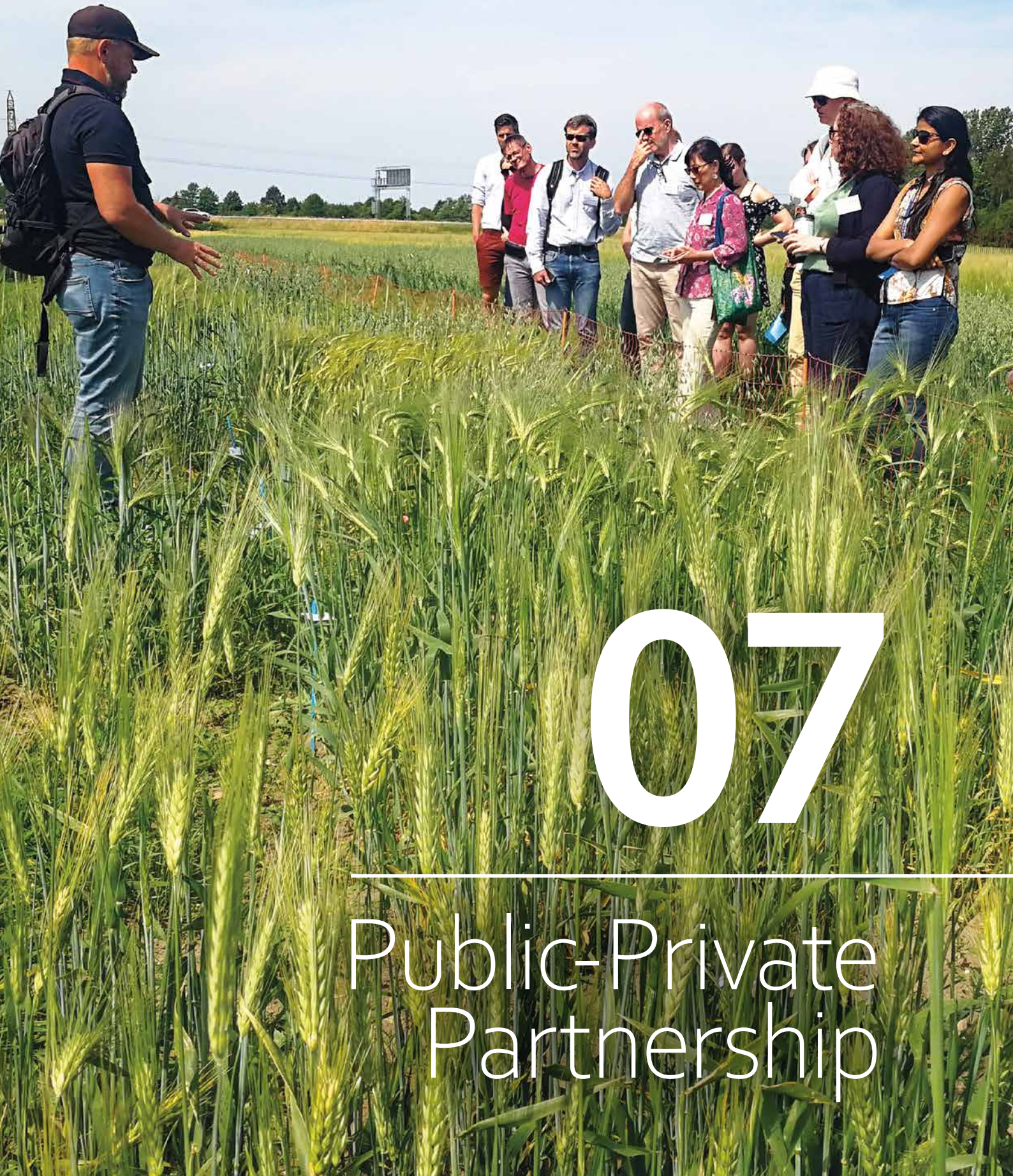
The iconic building, on the top of the world, safeguards security copies of seeds stored in genebanks and thereby contributes to securing the world's food supply.

The location of the Seed Vault was chosen due to

Svalbard being a remote and safe place, yet easily accessible for shipping and handling. 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. In the Seed Vault they are stored under so called black box conditions, meaning that only the institution that deposited the seeds are allowed to withdraw them.

One of the PPP-projects, 6P, is arranging annual field trips within their network.



07

Public-Private Partnership

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. The cooperation is of great value to all partners and the wish to continue this long-term cooperation reflects that plant breeding is long-term work and persistence is needed to reach the goals.

The Nordic Public-Private Partnership (PPP) 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.

Pre-breeding collaboration between practical plant breeding and plant breeding research is a powerful tool to secure the development of agriculture and horticulture. Such development will contribute to the sustainable growth of the bioeconomy and global food security by adapting our crops to climate change.

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.

The fodder plant perennial rye grass is important for the Nordic countries.

"The cooperation is of great value to all partners."

The PPP

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

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. In 2019 an effort has been made to improve the communication to the PPP Steering Committee and the project leaders.

Presentation of the Current Projects

Pre-Breeding for Future Challenges in Nordic Fruit and Berries

The focus in this project is to strengthen pre-breeding co-operation by validating available germplasm resources by genetic and phenotypic characterization in order to widen the parental pool aimed at genetic resources enhancement by increasing diversity for targeted traits in strawberries and apples.

Combining Knowledge from Field and from Laboratory for Pre-Breeding in Barley

The focus within the PPP barley project is to utilize a developed MAGIC populations and use the setup of genomics assisted pre-breeding using genome-wide association study and genomic selection in pre-breeding. A spring barley core set from genebank material will also be selected to be used for genomic assisted pre-breeding.

PPP for Pre-Breeding in Perennial Rye-Grass (*Lolium Perenne L.*)

The project aims at improving the winter hardiness, persistence and other important traits for perennial ryegrass in northern Europe. It will also make plant breeding in northern Europe more prepared to meet new demands due to climate change, political decisions

or consumer demand. Growth conditions in northern Europe differ from other parts of the world due to a unique combination of day length and other environmental variables like temperature. Only breeders in the Nordic and Baltic countries can be expected to breed for these special conditions. With this project, these breeders will get better tools and genetic variation to make adapted varieties. Agriculture in these countries will, despite its northern location, be more competitive compared to other countries.

6P Phenotyping Project

The main activities within 6P-phase 2 consist of two categories – Research & Innovation (R&I) and Networking. R&I activities will involve a continued focus on the use of unmanned aerial systems derived images and the integration of high-throughput phenotyping technology. The specifically targeted crops are barley, oats, wheat, ryegrass and potatoes. The networking activities will effectively be a social platform to integrate ongoing research, strengthen cooperation and facilitate knowledge sharing between research institutions, technology providers, and plant breeders. The benefit to the plant breeding industry arises from either making the current visual phenotype observations faster, more reliable and cost-efficient, or the introduction of new phenotyping traits not possible to score visually with the human eye.

PHOTO: PIXABAY



PPP Fruit and Berries is focusing on apples and strawberries.

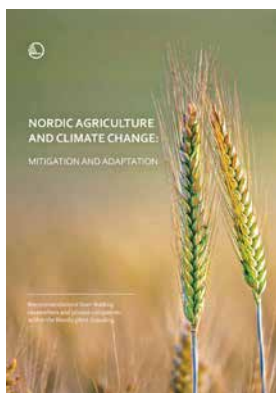


The PPP Barley project is focusing on pre-breeding using MAGIC populations.

A close-up photograph of a honeybee on a purple chive flower. The bee is positioned in the lower-left quadrant, facing left, with its wings partially spread. The flower it is on is in sharp focus, showing its intricate, pointed petals. The background is a dense field of similar purple flowers, which are softly blurred, creating a sense of depth. The overall color palette is dominated by various shades of purple and pink, with some green foliage visible in the background.

08

Publications

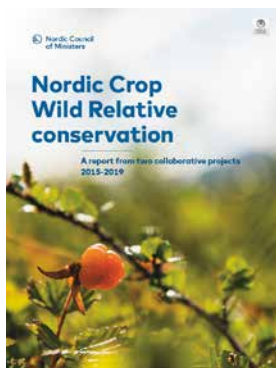


Nordic Agriculture and Climate Change

2019. NordGen (ed.). *Nordic Agriculture and Climate Change – Mitigation and Adaptation: Recommendations from leading researchers and private companies within the Nordic plant breeding.* NordGen publication series 2019:01. NordGen.

CLIMATE CHANGE HAS already resulted in challenges for Nordic agriculture and the difficulties will continue to increase in the future. It is therefore important to act now to adapt our agriculture to future conditions, especially since the development of new crop varieties takes a long time (8–15 years).

In this report, based on a workshop with the leading researchers and plant breeders in the Nordic region, nine specific recommendations are listed. The recommendations have the main goal to support future food security in the Nordic countries by facilitating the development of new crop varieties adapted to our future needs. Special attention is given to the challenge of adaptation to climate change and high-quality food and feed production.



Nordic Crop Wild Relative conservation

2019. Palmé, A., Fitzgerald, H., Weibull, J., Bjureke, K., Eisto K., Endresen, D., Hagenblad, J., Hyvärinen, M., Kiviharju E., Lund B., Rasmussen M., Porbjörnsson H. *Nordic Crop Wild Relative conservation: A report from*

two collaborative projects 2015–2019. TemaNord.

ISBN: 978-92-893-6186-6, DOI: 10.6027/TN2019-533

THE REPORT SUMMARIZES results from a cooperation among all the Nordic countries during the period 2015 – 2019 (two projects). The work has focused on the conservation of Crop Wild Relatives (CWR), i.e. wild plant species closely related to crops. They are of special importance to humanity since traits of potential value for food security and climate change adaptation can be transferred from CWR into crops. The projects represent the first joint action on the Nordic level regarding *in situ* conservation of CWR. Substantial progress has been made regarding CWR conservation planning, including development of a Nordic CWR checklist and identification of suitable sites for CWR conservation. A set of recommended future actions was developed, with the most important one being initiation of active *in situ* conservation of CWR in all Nordic countries. The outputs of the project includes [a check list of CWR in all the Nordic countries](#), [a CWR priority list](#), [identification of protected areas suitable for conservation of CWR](#) and [a Nordic webpage dedicated to CWR](#).



Conservation of the Nordic Brown Bee

2019. NordGen (ed.). *Second Plan of Action for the Conservation of the Nordic Brown Bee.* NordGen publication series 2019:02. NordGen.

THE BROWN BEE, *Apis mellifera mellifera*, is the honey bee subspecies that occurs natively in the Nordic region. In the 20th century, other honey bee subspecies were introduced to this region by beekeepers. Today, the native brown bee is endangered due to displacement and introgression by these other subspecies. The conservation of genetic diversity is imperative for maintaining future adaptive potential. Bees are not only important farm animals due to their honey production, but also due to their pollination services.

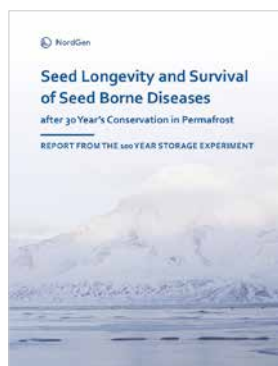


The brown bee,
Apis mellifera mellifera.

PHOTO: PER KRUGER

Roughly a third of the world's crop production is based on insect-pollinated plant species and honey bees represent an important pollinator.

In 2014, the Nordic Genetic Resource Center published a report on the current status and conservation of the Nordic brown bee. This final report of an international *ad-hoc* working group, consisting of beekeepers, researchers and members of national beekeeping organizations came to the conclusion that cooperation amongst actors and coordination at the national and international level in the conservation of the brown bee is of utmost importance. More specifically, consistent characterization of bee populations in the Nordic region to facilitate exchange of breeding material where necessary and development and promotion of brown bee specific management techniques were identified as important conservation measures. The ultimate goal is to have viable populations of brown bees, with characteristics that beekeepers value, in each of the Nordic countries. A priority list of recommended actions for the conservation of the brown bee in the Nordic region was compiled for the first time in 2015 and updated in this second version in 2019.

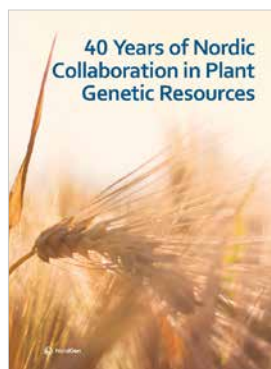


Seed Longevity and Survival of Seed Borne Diseases

2019. Asdal, Å., Brodal G., Solberg S., Yndgaard, F., von Bothmer, R., Meen E. *Seed Longevity and Survival of Seed Borne Diseases after 30 Years Conservation in Permafrost: Report from the 100 Year Storage experiment.*

NordGen publication series 2019:04.

THE NORDIC GENE BANK established the 100 year seed storage experiment in Coal mine no. 3 outside Longyearbyen in 1986. Security duplicate samples of the Nordic seed collection had been deposited in permafrost in the coal mine since 1984. The experiment was established with the aim to monitor the longevity of seeds in this Nordic back-up seed collection and to gain general knowledge about the longevity of seed stored under permafrost conditions, as well as studying the survival of seed borne plant pathogens. The experimental set up included in total 41 seed lots of 17 agricultural and horticultural crop species commonly grown in the Nordic countries. The seed germination experiment included two or three varieties of each crop. The experimental part dedicated to studies of pathogen survival included seeds from 11 crops naturally contaminated by pathogens. The test program comprises germination and pathogen survival tests every 2.5 years during the first 20 years and then every 5 years for the last 80 years. In total 25 identical sets of test seeds placed in sealed glass tubes were packed in wooden boxes, one box for each planned test year. The tests have been carried out according to schedule and this report sums up the results from the first 30 years of the experiment. All tests have been carried out in accordance with the same ISTA-protocols.



40 years of Nordic cooperation

2019. Asdal Å., von Bothmer, R., Brodal G., Carlson-Nilsson, U., Diederichsen, A., Endresen D., Engels J., Hägnefelt A., El-Khalifeh, M., Knüpffer, H., Loskutov, I. G., Lundqvist, U., Meen, E., Nilsson, A., Palmé, A., Solberg S. Ø., Svensson, J.,

Tigerstedt, P., Weibull, J., Yndgaard F. *40 years of Nordic cooperation on Plant Genetic Resources.* NordGen.

ISBN: 978-91-981510-9-1.

THE CURRENT BOOK is a celebration of 40 years of Nordic collaboration on plant genetic resources. International perspectives are highlighted and the first chapter is written with input from Axel Diederichsen from Plant Gene Resources of Canada and Igor G. Loskutov from the N.I. Vavilov Institute of Plant Genetic Resources (VIR), and the chapter traces lines back to the pioneers and with a specific focus on Vavilov and how he had influenced scientists in the Nordic countries. Roland von Bothmer and Peter Tigerstedt give an overview of the Nordic plant breeding and genetic resources. Jens Weibull discusses the role of NGB (and NordGen) in the European

"A celebration of 40 years of Nordic collaboration."

genebank collaboration. A special section is given to a historical recap of how NGB worked with the Gatersleben gene bank in the early 1980s, at a time when computers were large and collaboration with GDR was not straight forward for western countries, and this section is written with inputs from Jan Engels (former Bioversity International) and Helmut Knüpffer (former IPK Gatersleben). The data management systems at NGB and NordGen are discussed by inputs from Dag Endresen (former IT leader at NGB, now at University of Oslo). We also have chapters on the collaboration with VIR and the Baltic States, the 100-years experiment on seed longevity in permafrost, and the Svalbard Global Seed Vault. Regarding the collections, Roland von Bothmer gives the story of the international *Hordeum* and *Triticeae* project and Udda Lundqvist of the Swedish Barley Mutant Collection. The celebration book is finished by chapters on the NordGen's Plant Genetic Resource Collection of today with perspectives on conservation and use, amongst others the ongoing Public-Private Partnership project, written by the current staff at the genebank and Anders Nilsson at the Swedish University of Agricultural Sciences, Alnarp. A special thanks to Helmut Knüpffer, Kit Lundborg, Roland von Bothmer and Sara Landqvist for their comments and proof-readings of this book.

GWAS-Assisted Genomic Prediction

2019. Firuz, O., Rita, A., Koc, A., Svensson, J. and Chadwade, A. (2019). *GWAS-Assisted Genomic Prediction to Predict Resistance to Septoria Tritici Blotch in Nordic Winter Wheat at Seedling Stage*. *Front. Genet.* 10:1224. DOI=10.3389/fgene.2019.01224.

SEPTORIA TRITICI BLOTCH (STB) disease caused by *Zymoseptoria tritici* is one of the most damaging diseases of wheat causing significant yield losses worldwide. Identification and employment of resistant germplasm is the most cost-effective method to control STB. In this study, we characterized seedling stage resistance to STB in 175 winter wheat landraces and old cultivars of Nordic origin. The study revealed significant ($p < 0.05$) phenotypic differences in STB severity in the germplasm. Genome-wide association analysis (GWAS) using five different algorithms identified ten significant markers on five chromosomes. Six markers were localized within a region of 2 cM that contained seven candidate genes on chromosome 1B. Genomic prediction (GP) analysis resulted in a model with an accuracy of 0.47. To further improve the prediction efficiency, significant markers identified by GWAS were included as fixed effects in the GP model. Depending on the number of fixed effect markers, the prediction accuracy improved from 0.47 (without fixed effects) to 0.62 (all non-redundant GWAS markers as fixed effects), respectively. The resistant genotypes and single-nucleotide polymorphism (SNP) markers identified in the present study will serve as a valuable resource for future breeding for STB resistance in wheat. The results also highlight the benefits of integrating GWAS with GP to further improve the accuracy of GP.

A field of barley.



PHOTO: PIXABAY



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Financial
Statement

The Financial Statement for the year ending 31 December 2019 was prepared in accordance with Swedish National Financial Reporting Standards and audited by the Swedish National Audit Office.

(TSEK)	Budget 2019	Result 2019
Income		
Nordic Council of Ministers ordinary budget	27 777	28 293
National contributions	3 205	3 299
Other income	70	609
Financial income	0	350
Project funds, Nordic Council of Ministers	3 189	4 493
Other external project funding	4 950	6 075
Total income	39 191	43 119
Costs		
Staff costs	22 863	24 225
Goods and services	9 985	9 423
Contribution to external projects	100	100
Other costs	6 213	9 593
Total costs	39 161	43 341
Result year	30	-222



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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
Norway	
Geir Dalholt , Chairman Ministry of Agriculture and Food	Ivar Ekanger Ministry of Agriculture and Food
Sweden	
Carina Knorpp , Vice-Chair Ministry for Rural Affairs	Åsa Widebäck Ministry for Rural Affairs
Denmark	
Gitte Wolff , Member The Danish Agricultural Agency	Birgitte Lund The Danish Agricultural Agency
Finland	
Tove Jern , Member Ministry of Agriculture and Forestry	Eero Pehkonen Ministry of Agriculture and Forestry
Iceland	
Emma Eyþórsdóttir , Member Agricultural University of Iceland	Sæmundur Sveinsson Agricultural University of Iceland

Observers	
Birgitte Jacobsen Greenland	Birthe Ivars The Environmental Sector
Rólvur Djurhuus The Faroe Islands	Jan Svensson Staff Representative

