

THE NORDFROST PROJECT REPORT

Farm Animal Gene Banks in the Nordic Region

Added Value Through Nordic Cooperation

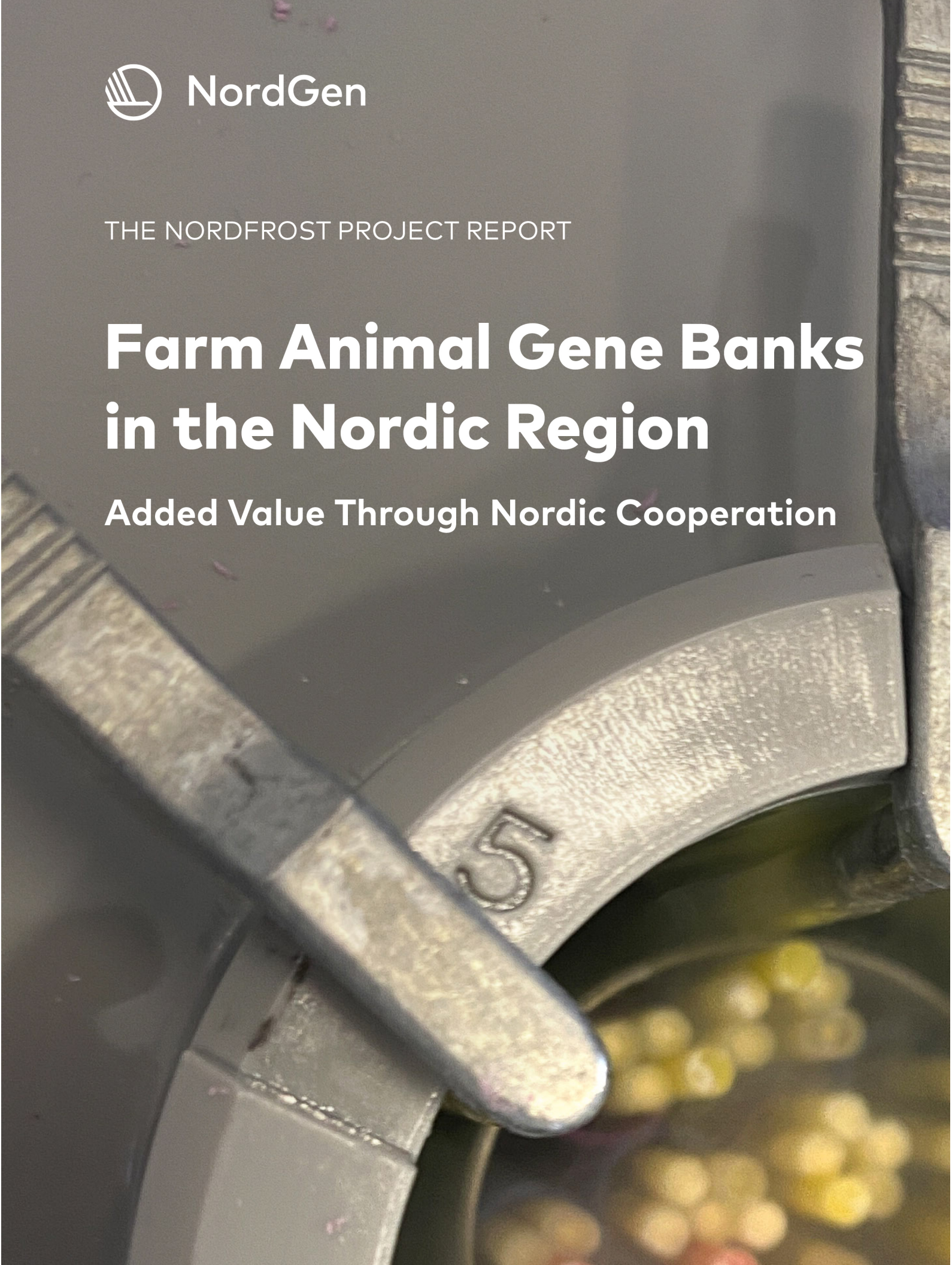


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Top photo: Practical workshop at NMBU, Norway, 20.4.2023.

1. Background

The network project titled "Nordic animal gene banks – added value through Nordic cooperation" (NordFrost), has aimed to strengthen the collaboration and competence for *ex-situ* conservation of animal genetic resources (AnGR) in the Nordic region. This project was launched as a case study following the Horizon2020 funded IMAGE project (2016-2020) where it was concluded that there is a broad variation in the current state of practices and the distribution of responsibilities related to cryoconservation activities between the Nordic countries. The national strategies on conserving AnGR emphasise *ex-situ* conservation in varying degrees. However, collection of samples, metadata, back-up storage of material or common strategies and action plans for *ex-situ* conservation on a regional level does not exist. This makes conservation of AnGR an exposed area that threatens the resilience of Nordic food security. By developing new collaborative models, strengthening Nordic infrastructure, and enhancing the development of Nordic strategies for *ex-situ* conservation in the region, this network will contribute to increased sustainability for populations and future Nordic food security.

Funding: The Nordic Joint Committee for Agricultural and Food Research (NKJ).

Initiating organisations and steering group members:

- Nordic Genetic Resource Center (NordGen) / Farm Animals (coordinator)
- Aarhus University / Morten Kargo, Center for Quantitative Genetics and Genomics
- Norwegian University of Life Sciences (NMBU) / Ian Mayer, The Faculty of Veterinary Medicine
- Natural Resources Institute Finland (Luke) / Annika Tienhaara, Bioeconomy and Environment



Top photo: Some of the participants during the workshop in Norway, april 2023.

2. Activities, topics for discussions and conclusions

The NordFrost network has organised two webinars, one physical workshop and two hands-on workshops for the Nordic stakeholders. In addition, together with the Finnish authorities, the NordFrost network initiated legislative amendments and guidelines related to new sample collection practices for gene banks. Subsequently, these updates can serve as an example in other Nordic countries. The NordFrost steering group also made a study trip to UK to become familiar with the outlook of well-managed charities and organisations related to gene banking of AnGR.

The two webinars were organised to discuss about the necessity of cryoconservation of AnGR and its current challenges. Following the webinars, a physical workshop and hands-on workshop were hosted at the Norwegian University for Life Sciences (NMBU) in Ås, Norway. The physical workshop focused on the status of cryoconservation of the AnGR among the Nordic countries and the suggestion of a possible back-up plan to secure the Nordic AnGR for the future. The participants in the hands-on workshop learned how to collect and cryopreserve epididymal sperm to broaden both knowledge and skills surrounding *ex-situ* conservation methods. The second practical workshop held at Natural Resources Institute Finland (Luke) aimed to further broaden the knowledge of the stakeholders about variety of tissue samples (testicular, ovarian and skin tissue) suitable for gene banking.

2.1 The webinars

The two webinars were organised during the COVID-19 pandemic in 2021.

Webinar 1: "Why gene banking?"

The first webinar (23.6.2021) had six invited speakers:

Mervi Honkatukia: The current status of Nordic gene banking. A case report in IMAGE EU Horizon 2020.

Annika Tienhaara: Benefits of conserving agricultural genetic resources in Finland: Summary of recent Finnish research and setting it in the international context.

Sipke Joost Hiemstra: Introduction on gene bank activities in Europe.

Mike Bruford: The Frozen Ark: Saving the DNA and viable cells of the world's endangered species.

Sigbjørn Gregusson: Introduction of Biobank AS.

Per Johan: How to secure/develop the original Nordic red breeds?

There were 39 registered online participants from six countries (Figure 1 and Table 1). Following the presentations the participants discussed in groups about contemporary topics, including:

1. Outreach activities – informing and educating the public (and students to engage the next generation of experts?) of the importance of genetic resource banking,
2. Current technological limitations (bottlenecks) in the cryopreservation of animal germplasm - future research priorities, and
3. Practical solutions to strengthen conservation.

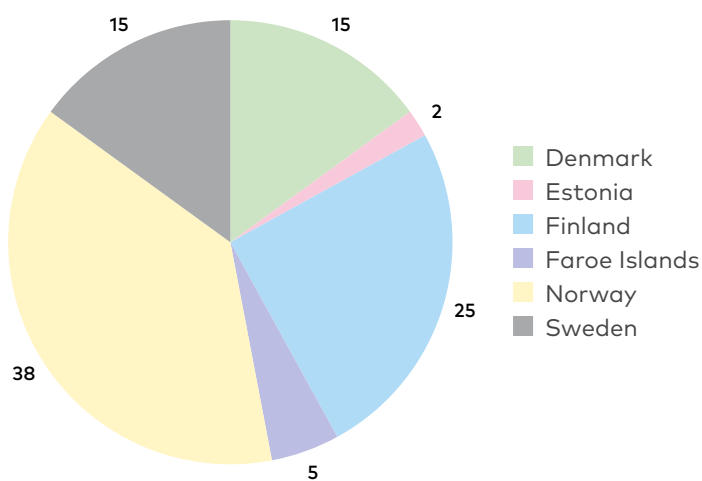


Figure 1: The country wise distribution of the participants for webinar 1. Date: 23.6.2021. Number of registered participants: 39.

Participating organisations and universities:

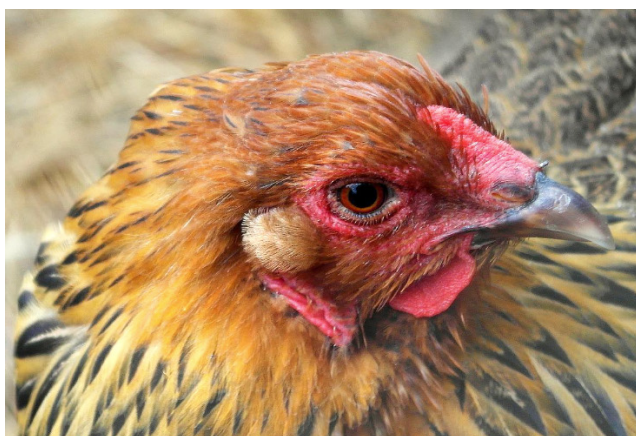
Häme University of Applied Sciences (HAMK)
Norwegian Institute of Bioeconomy Research (NIBIO)
Norwegian Genetic Resource Centre
Nordic Genetic Resource Center (NordGen)
Natural Resources Institute Finland (Luke)
SEGES Innovation
Norwegian University of Life Sciences (NMBU)
Norwegian Association of Sheep and Goat Breeders (NSG)
Norsk Rikstoto
Swedish University of Agriculture (SLU)
Norwegian Horse Association (NHS)
NORSVIN
Viking Genetics
The Department of Animal and Veterinary Sciences – ANIS health, Aarhus University
Landbrugsbestyrelsen
Finnish Animal Breeding Association (FABA)
Lammasmaailma
The Faculty of Health Sciences, University of Copenhagen
ProAgria
The Agricultural Agency of Faroe Islands
Norsk Fjordhestsenter (Norwegian association for fjord horse)
BioBank AS

Table 1: Participating organisations and universities in webinar 1. Date 23.6.2021. Number of registered participants: 39. Number of participating organisations and universities: 23.

Conclusions from the group discussion can be divided into the previously listed topics. The general census regarding the first topic comprised the necessity of education regarding genetic diversity and conservation, the importance of collaboration, and integrated multidisciplinary efforts towards ecosystem services and reinvention of local products. Education and open discussions surrounding genetic diversity, conservation and new technologies was encouraged for different audiences (*i.e.*, schools, farmers, consumers, scientists, administrators, funding agencies and the public) by appropriate channels for each of the target audiences (*e.g.*, social media, books, publications, seminars, exhibitions etc.).

For the second topic logistical and technical limitations associated with sampling of small and isolated populations were identified. Furthermore, it was noted that most of the *ex-situ* gene bank specimens are semen samples. For successful management of small populations and for the use of assisted reproductive technologies (ARTs) conservation of female germline is also crucial. However, species-specific differences of female germlines require further research for the optimized cryopreservation protocols free of animal-derived compounds and antibiotics. Participants highlighted that an evaluation of the already cryopreserved material in the Nordic countries would be valuable, as this would provide an overview of material that could be used as the basis for possible collaborative complementary cryoconservation in the region. The importance and feasibility of having geographically distributed back-up gene banks was discussed. The costs, legislation and regulations for transportation of samples that should be defined were considered. An educative workshop on FAO's cryoconservation protocols was suggested.

Lastly, the third topic had the following conclusions: There is a need to harmonize/standardize high-biosecurity protocols for the collection and storage of selected tissues. Species-specific differences in germlines require further research for the optimized cryopreservation protocols. Furthermore, the possibilities for financing gene banks were also discussed as an important factor for strengthening conservation efforts.



Four of the more than 160 Nordic native breeds: Finnish landrace chicken, Norwegian Telemark cattle, Swedish Klövsjöfår and the Faroese horse.

Webinar 2: "Arvokas geeniperimä pakkaseen – Eläin- ja kasvigeenivarojen pankittamisen nykytilanne ja haasteet"

(Cryoconservation of the valuable genetic resources – The current situation and challenges of gene banking animal and plant genetic resources)

The second webinar (8.12.2021) had five invited speakers:

Jaana Peippo: "NordFrost-verkoston esittely." (Eng: Introduction to the NordFrost network.)

Pekka Uimari: "Pienten populaatioiden jalostamisen ja säilyttämisen haasteet." (Eng: Challenges of management and conservation of small populations.)

Heli Lindeberg: "Eläingenipankkitoiminnan mahdollisuudet ja haasteet." (Eng: Possibilities and challenges of gene banking of animal genetic resources.)

Anna Nukari: "Kasvigeenipankkitoiminnan mahdollisuudet ja haasteet." (Eng: Possibilities and challenges of gene banking of plant genetic resources.)

Tuula Pehu: "Geenivarojen hallinta." (Eng: Ownership of genetic resources.)

There were 59 registered online participants from Finland (Figure 2, Table 2). Before the presentations the participants discussed in groups, about the following questions:

1. Onko Suomen kansallinen geenivaraohjelma sinulle tuttu, tunnetko sen sisällön? (Eng: Are you familiar with the Finnish National Genetic Resources Programme for Agriculture, Forestry and Fishery, do you know its content?)
2. Minullako arvokkaita geenivaroja? (Eng: Do I have valuable genetic resources?)
3. Miten mielestäni yhteydenpito tuottajien ja geenivarakoordinaattorin välillä pitäisi toteuttaa? (Eng: How do I think communication between producers and the national coordinator should be implemented?).
4. Kuka omistaa / kenen pitäisi omistaa geenivarat? (Eng: Who owns / who should own the genetic resources?).
5. Geenipankki ja eläintautien torjunta, miten lisäisit geenivarojen tunnettuutta – alkutuottajien tekemän geenivarasäilytyksen statuksen parantaminen? (Eng: The gene bank and the fight against animal diseases: How would you increase the awareness of genetic resources – improving the status of genetic resource preservation by primary producers?)
6. Geenivarojen säilytyksen taloudelliset näkökulmat, Miten näet geenivarojen tulevaisuuden? Terveiset geenipankille! (Eng: Economic aspects of conserving genetic resources: How do you see the future of genetic resources? Greetings to gene bank!)

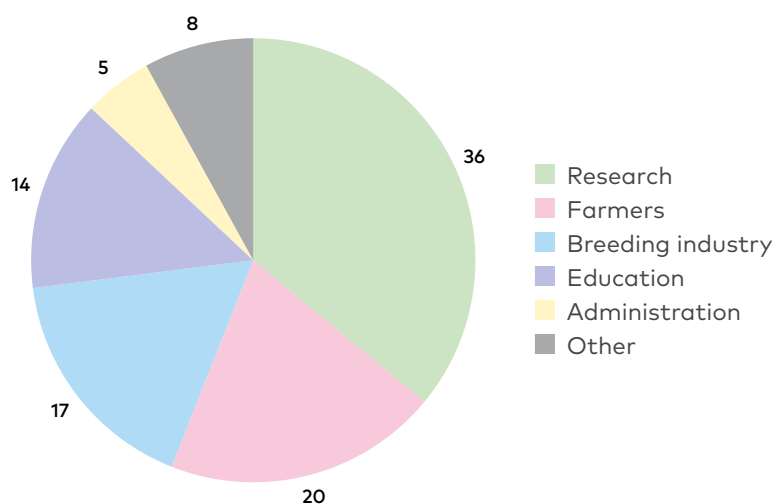


Figure 2: Background of participants in webinar 2. Date 8.12.2021. Number of registered participants: 59.

Participating organisations and universities:

Finnish Animal Breeding Association (FABA)
 Oulu University of Applied Sciences (OAMK)
 Häme University of Applied Sciences (HAMK)
 Savonia University of Applied Sciences (Savonia UAS)
 Natural Resources Institute Finland (Luke)
 Ministry of Agriculture and Forestry (MMM)
 Ministry of Education (OM)
 Viking Genetics
 Maaseudun tulevaisuus
 Suomen Hippos ry
 ProAgria
 Lammasmaailma
 Nordic Genetic Resource Center (NordGen)
 Suomen siemenperunakeskus Oy
 Kainuun ammattiopisto (KAO)
 Suomen Kennelliitto

Table 2: List of organisations and universities that the participants were representing. Date 8.12.2021.

For the group discussions participants were divided in five groups: cattle, horses, bees, plants and mixed. The groups used the given questions as a basis for their discussions, but with some modifications due to the limited time and interest of the participants. Conclusions from the discussions can be summarised as follows:

Cattle

1. The knowledge about the content of The Finnish National Genetic Resources Programme for Agriculture, Forestry and Fishery is superficial and depends on the farmers' own activity.
2. More science-based knowledge is needed for the different genetic lines within the native cattle breeds. Farmers consider that all production systems should be valued, e.g. both dairy and suckler cow production. Also, according to the participants, the concept of unique genetic resources should not be limited only to registered individuals. "It is time to focus on quality instead of quantity."
3. Up-to-date communication between the different stakeholders is considered very important. Farmers also hope for the establishment of a steering group for the management of the native cattle genetic resources. Farmers lack accurate science-based information about the conservation programme. It is not considered to be enough to have just pedigree and traditional knowledge-based information. Regular up-to-date reporting is also considered important. Farmers hope for an updated database to aid their decision making in breeding. At the same time farmers expressed concerns about bureaucratic involvement in a conservation programme.
4. Sample collection into a gene bank is based on mutual agreement between the animal owner and the gene bank.

Horse

1. The conservation programme of the Finnhorse is not well known. Horse owners hope for more publicly available information.
2. Public knowledge about the composition of the gene bank working group is missing, who are the members?
3. Public knowledge should also be available about the selection criteria of the Finnhorse stallions collected for the gene bank.
4. Using ARTs (cryopreservation of semen/ sperm and oocytes, ICSI) in horses is considered expensive.
5. Collaboration with the commercial equine sector is considered to benefit the conservation programme in the long run.
6. Somatic cell cloning may be used as tool to preserve native horse breeds.

Honeybee

1. Beekeeping of the Nordic native brown bee is not secure in Finland, because the population size of this subspecies is small, and only a small number of bee farmers are interested in keeping these bees.
2. Only semen cryopreservation is successful now. Successful cryopreservation of eggs would enable desired breeding goals.
3. Exchange of information is easy due to the small group of bee farmers but requires personal relationships and own activity. It requires constant activity to have enough publicity to succeed in the conservation of the Nordic brown bee.
4. Bee farmers own their own genetic resources.
5. Most viruses may be spread through inseminations and affect the breeding success of queens. It

would be beneficial to have a diagnostic tool to assess sperm quality/ sanitary status.

6. In the future, there will be costs for testing the purity of the Nordic brown bees from DNA to ensure conservation of the brown bee genetic resources.
7. Cryoconservation is not yet optimised in bees. It is therefore necessary to follow international research.

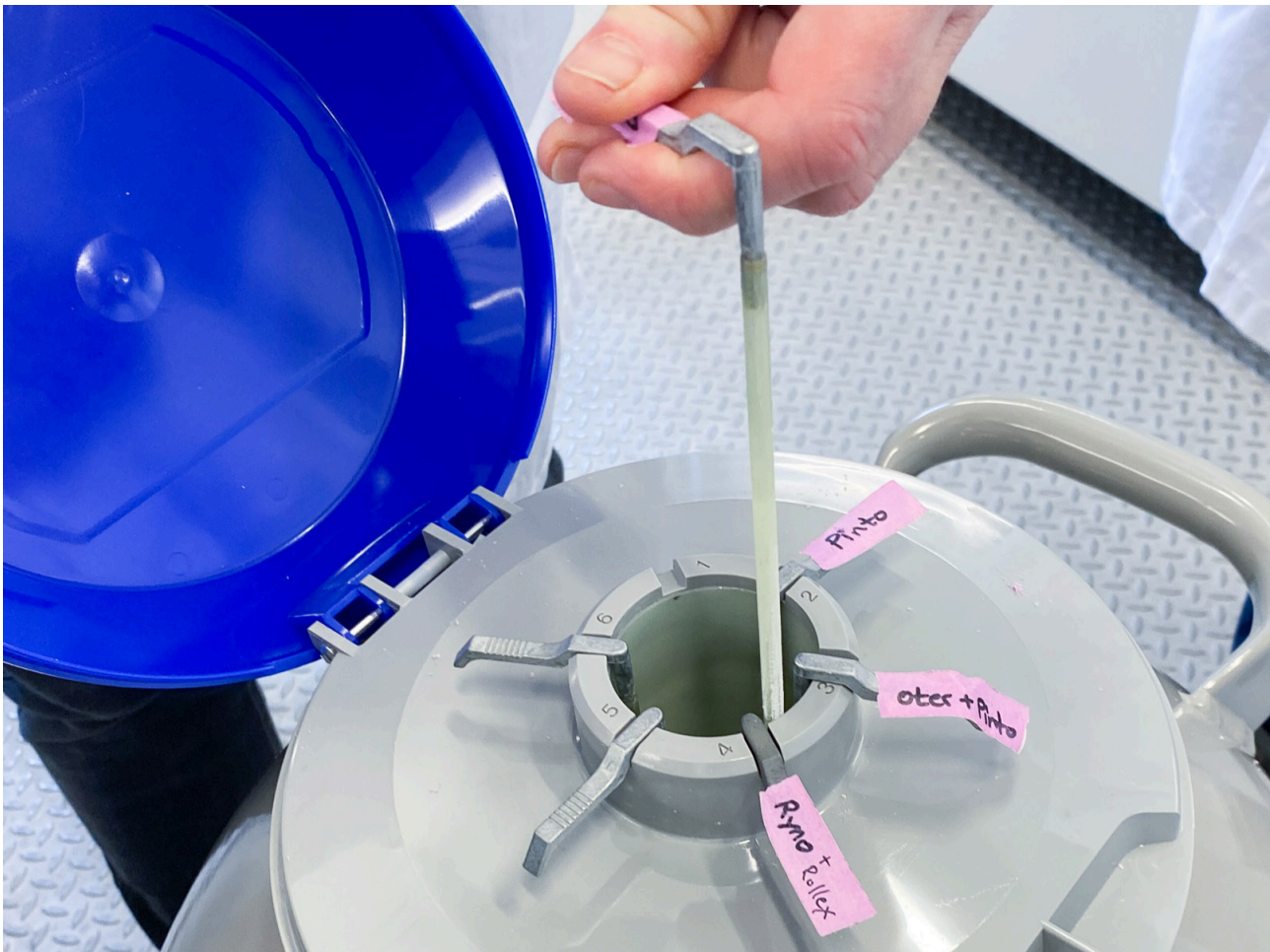
Mixed group

1. Different animal groups need to communicate/ be informed about their contemporary conservation status (future aims should be better known)
2. The public should be informed about the conservation programmes of our versatile animal genetic resources, including the content of the programmes and the parties involved.
3. The situation for many breeds/ subspecies is critical as circumstances change rapidly and genetic diversity is lost in every generation.
4. It would be beneficial for the conservation of the genetic resources of chicken if cryopreserved semen samples could be used successfully.
5. It was discussed what is reasonable compensation for the contribution in conservation of genetic diversity.
6. It is important to inform the public and/ or decision-makers that disease status changes rapidly, and that *ex-situ* gene banking is one solution that helps us to be prepared for the circumstances where a disease outbreak has caused extinction of an entire breed, or genetic diversity must be re-introduced into a population suffering from inbreeding depression.
7. The maedi-visna programme for sheep farms is needed. At the moment it is voluntary, and sheep farmers resign from it.

Plants

1. It is crucial to improve communication so that information is more easily available for the stakeholders.
2. It would be beneficial to supervise the public on how to recognize and classify valuable genetic resources.
3. It is also beneficial for the stakeholders to know what already exists in gene banks. NordGen maintains seeds for all the Nordic countries and its collections include around two thousand accessions of the Finnish origin. Around 1000 accessions of clonally propagated species varieties are conserved in the Finnish clonal gene banks in the field collections. The data that has been stored in of the national clonal collections will also be uploaded to the NordGen's database, where it will be publicly available, but it may be laborious to find. Most data are uploaded already.
4. GENBIS could serve as an important platform for this communication. It is worth informing the public where it can be found and how the plant data can be ordered.
5. There is a wish for more transparency and collaboration for the plant gene banks. The participants feel this will improve knowledge-sharing and important stakeholders to openly discuss which actions that are desired and needed from the genetic resources in the gene banks.
6. Luke maintains the gene bank of the clonally propagated plant species, and its accessions are safeguarded by cryopreservation (cryotanks in two locations) and by the safety maintainers network (outside Luke).
7. Genetic resources of cultivated plants should be available for plant breeding to ensure future food security. Through the gene banks they are available by SMTA (standard material transfer agreement) according to the International Treaty.

8. Cryoconservation offers a good approach to avoid plant diseases. Cryopreserved disease-free materials can be used to revitalize and renew gene bank field collections or commercial nurseries used for reproduction and marketing.
9. There could be interested customers for "cryoservice" since the establishment of cryoconservation is expensive. It is worth exploring whether Luke could sell such a service.
10. Because cryoconservation is rather expensive, it is crucial to communicate the value and importance of genetic resources to the public.
11. It is difficult to give financial value to the genetic resources. A gene bank that acts as a backup storage, can be shown to outsiders only as an expense, but it is indeed priceless material.
12. In Finland, subsidies are available for the cultivation of the registered conservation varieties, as well as for the network that maintains the backup collections of clonally propagated plant genetic resources.
13. It is of high importance to secure genetic resources and especially species that are under severe threat of diseases to safely maintain them for future use.



Cryotank at NMBU.

2.2 The travels

On September 22nd, 2022, representatives from the NordFrost network negotiated with the Finnish Ministry of Agriculture and Forestry regarding the terms for collecting epididymal sperm to allow its subsequent use in artificial insemination (AI) and laboratory embryo production related to *ex-situ* gene banking.

The NordFrost steering group's study trip to charities/organisations related to gene banking activities in the United Kingdom (5.-9.12.2022) included visits to four sites: Cryoarks/Frozen ark in London and Cardiff, Rare Breeds Survival Trust (RBST)/UK National Livestock Biobank in Warwickshire, and Nature's SAFE/Stallion AI/ Gemini Genetics/UK National Livestock Biobank in Shropshire. These visits inspired new collaborations and improved knowledge surrounding gene bank infrastructure, sample collection methods and future possibilities for cryoconservation.



Map showing the different visits in the UK.

2.3 The workshops

Three workshops were organised during 2023 and 2024.

Workshop 1: "Conservation of animal genetic resources – Towards conserving Nordic livestock biodiversity"

The first physical workshop (18.-19.4.2023) was organized at NMBU in Ås, Norway. This workshop had 15 invited speakers from 10 countries (Table 3) and 37 registered participants from 12 countries (Figure 3, 4; Table 4,5).

During the workshop, the stakeholders expressed a need to enhance collaboration in common gene banking activities. A few of the main takeaways from the workshop was to further discuss the necessity and desire for gene banking efforts in the Nordics within the NordGen Council for Animal Genetic Resources, the need for characterisation of the Nordic breeds and improved knowledge surrounding the status and future possibilities for transboundary breeds and country collaboration. It was also suggested to develop a "traffic light" system to determine which populations should first be prioritised for *ex-situ* conservation. For this both characterisation of the breeds, collection of information surrounding currently gene banked breeds and cross-border collaboration was viewed as highly necessary. It was also emphasised that funding opportunities should be investigated.

Table 3. Programme of the physical NordFrost workshop at NMBU in 2023.

Time	Speaker	Title
Tuesday 18 April		
09.00–09.40	Sipke Joost Hiemstra Centre for Genetic Resources (CGN), Wageningen University & Research, the Netherlands	Opening lecture: "Livestock gene banks – key element in National and European conservation and research infrastructures"
09.40–10.20	Tullis Matson & Lucy Morgan Nature's Safe, UK GeminiGenetics, UK	"Saving animals from extinction: the future of AnGR gene banking"
10.20–10.40	Nina Svartedal Norwegian Genetic Resource, Centre Norwegian Institute for Bioeconomy Research (NIBIO), Norway	"How to establish up-to-date monitoring and reporting system for Animal Genetic Resources?"

10.40–11.00	<i>Coffee break</i>	
11.00–11.40	Tom Blunt Rare Breeds Survival Trust, UK	"Europe's native livestock breeds – need to conserve genetic resources"
11.40–12.20	Mafalda Costa & Kirsty Lloyd The Frozen Ark, UK	"CryoArks: challenges and successes of setting up the UK's first national zoological biobank network"
<i>Lunch</i>		
13.30–14.10	Tim Rittinghaus Institute of Multiphase Processes, Leibniz University Hannover, Germany	"Cryotechnology: advances and pitfalls!"
14.10–14.40	Vivi Hunnicke Nielsen Aarhus University, Denmark	"Challenges in efficient use of gene bank material – an example from Danish Landrace-1970 (pigs)"
14.40–15.10	<i>Coffee break</i>	
15.10–15.50	Thor Blichfeldt Norwegian Association of Sheep and Goat Breeders (NSG), Norway	"Conservation status of Norwegian sheep and goat breeds"
<i>Wednesday 19 April</i>		
09.00–09.40	Maxime Reverchon French Poultry and Aquaculture Breeders Technical Centre, France	"Use of cryopreserved PGCs for the restoration of the complete genetic heritage of poultry breeds"
09.40–10.10	Anna Maria Johansson Swedish University of Agricultural Sciences, Sweden	"Current conservation status of native farm animal breeds in Sweden"

10.10–10.30	Jens Ivan í Gerðinum Faroe Islands Agricultural Agency, Faroe Islands	"Conservation of Faroe horse AnGRs and the future action plans"
10.30–10.50	Juha Kantanen Natural Resource Institute Finland, Finland	"State-of-art ARTs in conservation of Finnish native animal breeds"
10.50–11.20	<i>Coffee break</i>	
11.20–12.00	Martin Pšenička University of South Bohemia, Czech Republic	"Conservation of fish genetic resources: application of germ cells"
12.00–12.20	Ian Mayer Norwegian University of Life Sciences, Norway	"Conservation status of wild Atlantic salmon – need for a centralized gene bank"
12.20–13.10	<i>Lunch</i>	
13.10 – 15.10	"Round table discussion – need for a Nordic Gene Bank"	

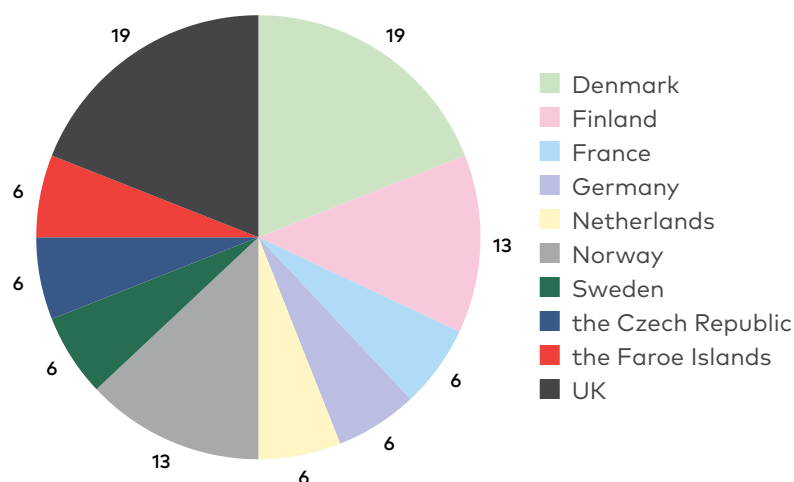


Figure 3: Country wise distribution of the speakers participating at workshop 1. Date 18.4.2023. Number of speakers: 15. Number of countries represented: 10.

Organisations that the speakers were representing

Aarhus University (AU)

Centre for Genetic Resources (CGN), Wageningen University

French Poultry and Aquaculture Breeders Technical Centre

Institute of Multiphase Processes, Leibniz University Hannover

Natural Resource Institute Finland (Luke)

Nature's Safe, UK

Norwegian Association of Sheep and Goat Breeders (NSG)

Norwegian Genetic Resource Centre, Norwegian Institute for Bioeconomy Research (NIBIO)

Norwegian University of Life Sciences (NMBU)

Rare Breeds Survival Trust, UK

Swedish University of Agricultural Sciences (SLU)

The Frozen Ark, UK

The Agricultural Agency (Faroe Islands)

University of South Bohemia, Czech Republic

Table 4: List of organisations and universities that the speakers were representing. Number of speakers: 15. Number of organisations and universities represented: 14.

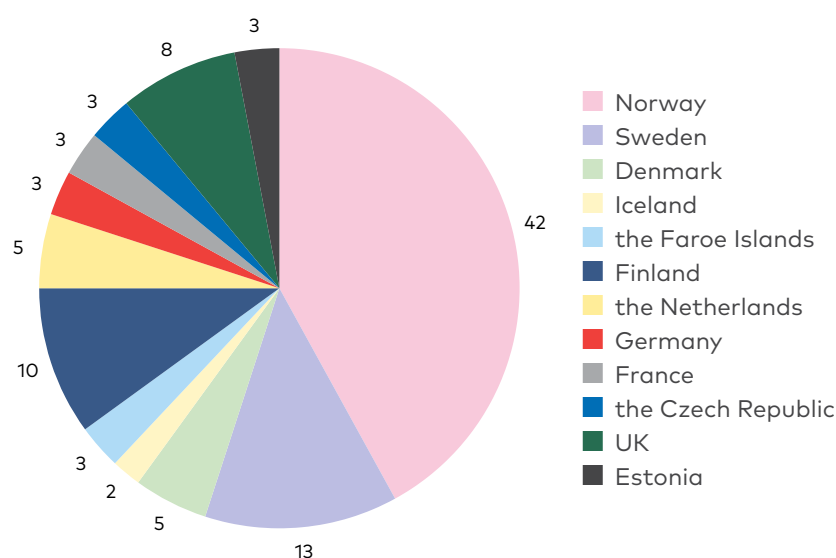


Figure 4: The country wise distribution of participants in workshop 1. Date: 18.4.2023. Number of registered participants: 37. Number of countries represented: 12.

Participating organisations and universities

Aarhus University (AU)

Cardiff University – CryoArks

Leibniz University

Natural Resources Institute Finland (Luke)

Norwegian Association of Sheep and Goat Breeders (NSG)

Norwegian Institute of Bioeconomy Research (NIBIO)

Norwegian University of Life Sciences (NMBU)

Nordic Genetic Resource Center (NordGen)

Rare Breeds Survival Trust

Research Associate at the Natural History Museum

SAVE Denmark

SpermVital AS

Swedish University of Agricultural Sciences (SLU)

SYSAAF

The Agricultural Agency (Faroe Islands)

The Estonian University of Life Sciences

The Genetic Resource Center/ Agricultural University of Iceland

Wageningen University and Research

Table 5: Participating organisations and universities in workshop 1. Number of registered participants: 37. Number of organisations and universities represented: 19.



Ian Mayer during his presentation at the first physical workshop.

Hands-on workshop 1: "Practical workshop on collection and cryopreservation of epididymal sperm"

After the first physical workshop, the first practical workshop was organised the next day (20.4.2023) at NMBU. Under supervision of NordGen this workshop focused on the collection and cryopreservation of epididymal sperm using a bull as a model. Because the participants attained hands-on experience, the number of participants was limited (maximum 2 representatives from each of the Nordic countries). This first workshop had six participants from four different Nordic countries altogether.

The learning outcomes of the workshop were:

1. Collection of testes after castration and slaughter.
2. Transportation of testes to laboratory.
3. Dissection of epididymides
4. Collection of sperm from epididymides.
5. Processing of sperm for cryopreservation.
6. Freezing and thawing of sperm.
7. Evaluation of post-thaw sperm motility and viability using Computer-assisted semen analyser (CASA) and Flow cytometry.

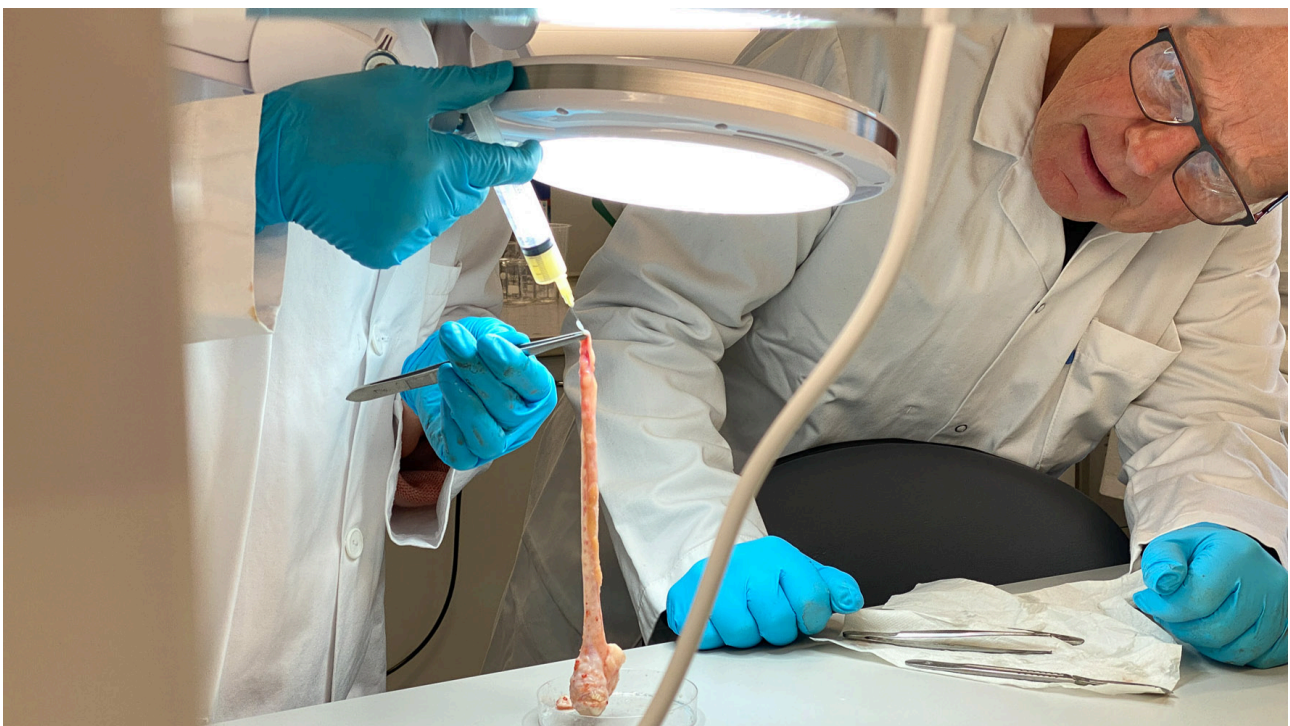


Photo from the first hands-on workshop at NMBU.

Hands-on workshop 2: "Practical workshop on collection and cryopreservation of somatic cell tissue samples for gene banks"

The second practical workshop was organized 3.-4.4.2024 at Luke, Jokioinen, Finland, where the focus was on collection of the somatic cell samples for gene banks. This workshop was organized in collaboration with Tullis Matson (Nature's SAFE) and Lucy Morgan (UK National Livestock Biobanking). On April 3rd, 2024, following introductory lectures the country representatives were offered hands-on experience in the collection and cryopreservation of porcine tissues post-mortem. There was a total of 21 participants from eight countries present (Figure 5). The participants represented nine different organisations/universities (Table 6).

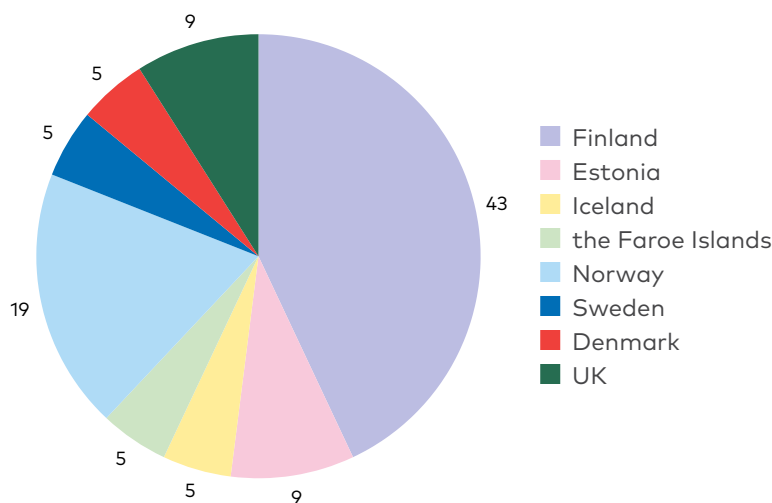


Figure 5: The country wise distribution of participants in workshop 2. Dates: 3-4.4.2024. Number of participants: 21. Number of countries represented: 8.

Participating organisations and universities
Natural Resources Institute Finland (Luke)
Nordic Genetic Resource Center (NordGen)
Lammasmaailma
The Estonian University of Life Sciences
The Genetic Resource Center/ Agricultural University of Iceland
Faroese Horse Association
Norwegian University of Life Sciences (NMBU)
Swedish University of Agricultural Sciences (SLU)
The Danish Agricultural Agency

Table 6: List of organisations and universities that were represented at the two-day workshop. Number of participants: 21. Number of organisations and universities represented: 9.

The practical workshop was accompanied by presentations from five invited speakers on April 4th, 2024. The goal of the hands-on workshop was to learn new techniques that can be useful for future cryoconservation and to spread this knowledge to interested stakeholders.

The learning outcomes from the workshop were:

1. To understand the equipment and infrastructure needed in tissue processing for gene banking.
2. To gain practical experience in tissue collection, processing and freezing for long-term gene banking
3. Observers acquired theoretical knowledge of the equipment and facilities needed for cryopreservation of tissues.



Photos from the second hands-on workshop arranged at Luke, Finland. From the left: workshop participants and Tullis Matson in the lab.



Top photo: Detail of cryotank photographed during a NordFrost workshop in Norway.

3. The major outcomes of the NordFrost activities

The Nordic model for conservation of AnGR

The discussions from the webinars, workshops and through studying other gene bank infrastructures led to the design of a Nordic model for conservation of AnGR (Figure 6). This model includes both *in-situ* and *ex-situ* measures for conservation as recommended by FAO. The model focuses on collaboration between short-term national gene banks, breeders and a larger long-term regional emergency back-up gene bank. The national coordinators are responsible for the coordination of conservation work on AnGR in their country, but the NordFrost network suggests that the responsibility for maintaining the long-term gene bank would be shared through collaboration.

Modification of gene banking regulations in Finland

The NordFrost network proposed implementation of new updated cryopreservation techniques for gene banking. The meeting led to concrete legislative amendments in Finland related to the collection and use of epididymal sperm, thus facilitating safe and more efficient gene banking practices.

Consensus paper surrounding the status and possibilities for conservation of Nordic breeds

The preparation of a consensus paper was a direct result from the webinars and the following physical workshops at NMBU. The paper presents and discusses the current status of the Nordic breeds in conservation in terms of both *in-situ* and *ex-situ* conservation.

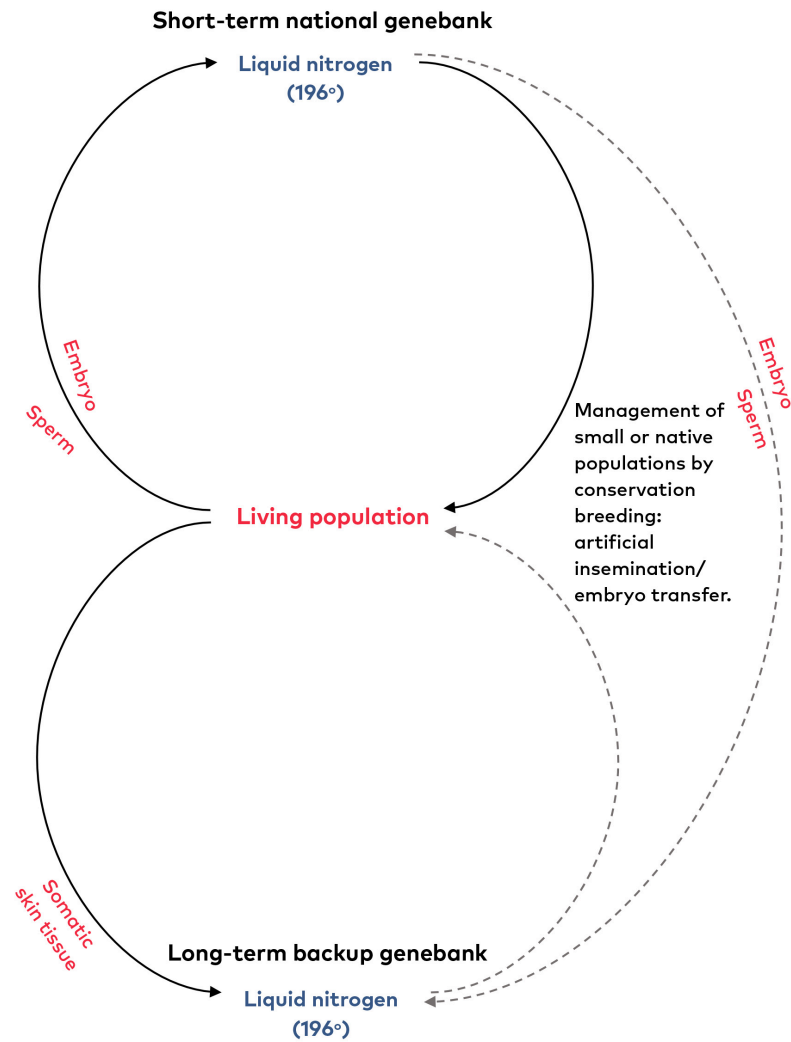


Figure 6: The Nordic model for conservation.



Sortbroget landracesvin, one of more than 160 native Nordic farm animal breeds.

About this publication

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NordGen

The Nordic Genetic Resource Centre (NordGen) is the Nordic countries' gene bank and knowledge center for genetic resources. NordGen is an organisation under the Nordic Council of Ministers 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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