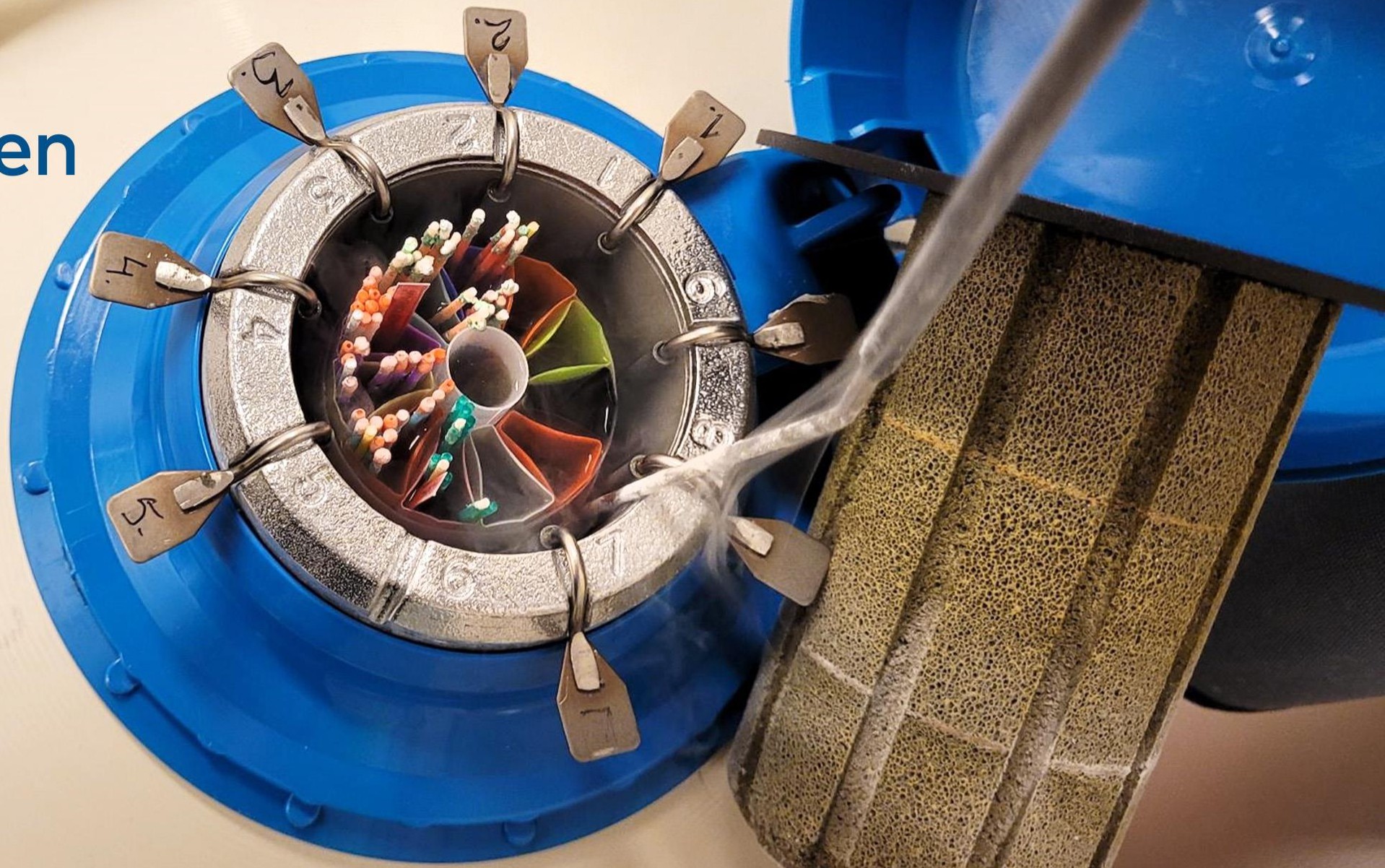
Jaana Peippo

NordGen



Towards Pan-Nordic *ex situ* gene banking

NordFrost (2021-2022)

- Nordic animal gene banks - added value through Nordic cooperation (NordFrost) funded by The Nordic Joint Committee for Agricultural and Food Research

- Steering committee
  - Ian Maier, NMBU, Norway
  - Morten Kargo, Aarhus University, Denmark
  - Annika Tienhaara, Luke, Finland
  - NordGen Farm Animals, Sweden & Norway

NordFrost ROADMAP for cryoconservation

Strengthen **Nordic cooperation** in the conservation of Nordic farm animal biodiversity

Stakeholders & AnGR

- To identify relevant stakeholders and AnGR

Activity survey

- By using national strategies, FAO reports, IMAGE project, interviews.

Recognition of best practices and knowledge gaps

- To support development of activities for *ex situ* conservation programmes; and educate new generation

Regional collaboration

- To increase infrastructure in the Nordic region for cryoconservation programmes through collaboration and education.

Pan-Nordic backup gene bank for AnGR

- Pros and cons for common gene bank as a backup storage

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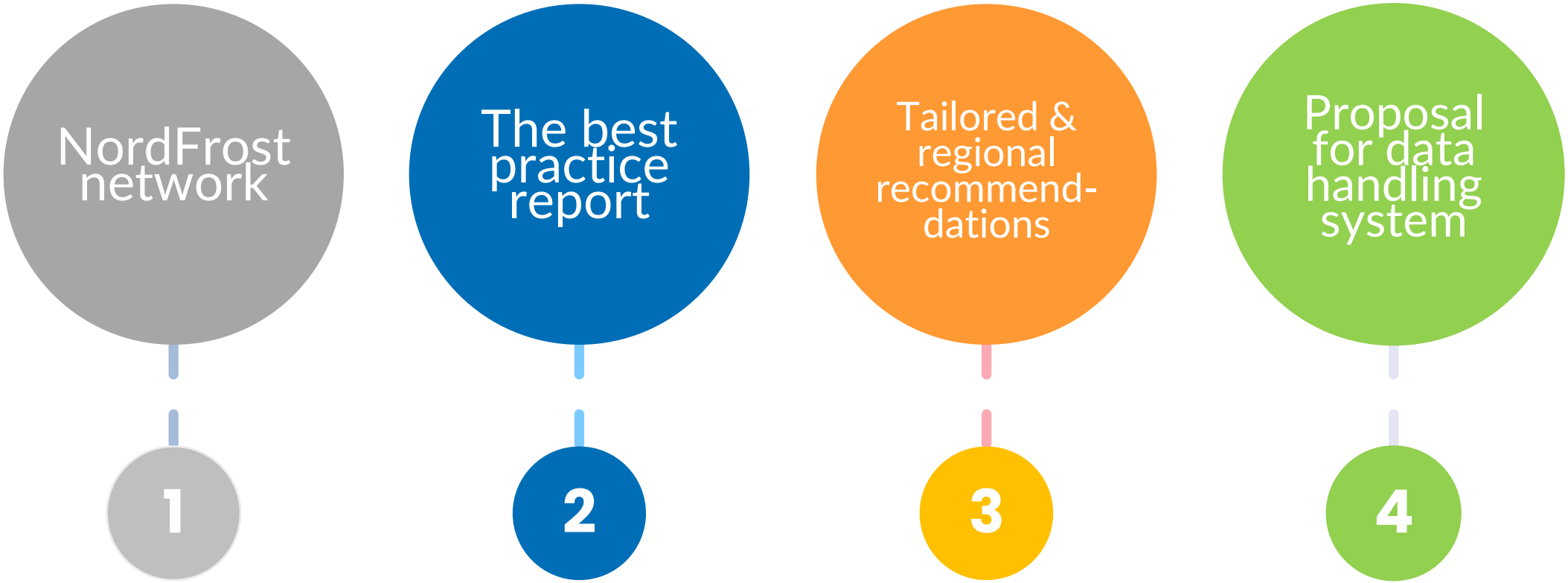
Expected outcome from NordFrost

Activities



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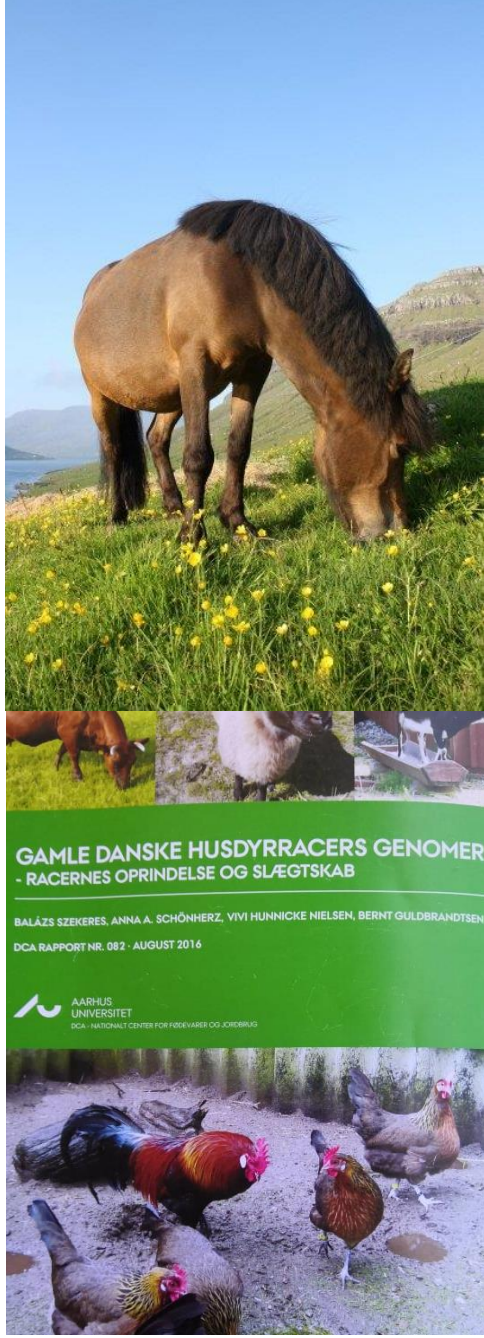
We already know…

- **Norway**: monitoring and reporting
- **Sweden**: wide variety of native breeds (69)
- **Finland**: utilization of the state-of-art methodologies
- **Denmark**: genomic characterization
- **Iceland**: sustainable use of AnGR
- **Faroe Islands**: successful rescue operation of the Faroese Horse



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Nordic farm animal gene banks – added value through Nordic cooperation?

NordGen Farm Animals

- A case study in H2020 IMAGE project "Innovative Management of Animal Genetic resources
- Aimed to fill the knowledge gaps and describe the situation of gene banks in the Nordic countries
- How the Nordic region is utilizing its close collaboration within *ex situ* conservation for mutual benefit

IMAGE
Innovative Management of Animal Genetic Resources

Materials

- Data collected from various sources
    - Data received through FAO questionnaires
    - IMAGE project:
        - Boettcher P. et al. 2019. Quality Management Gap Analysis and Framework for Certification of Individual Gene Banks
        - Passemard A-S et al. 2017. Inventory and Mapping of European Animal Genetic Collections
    - National strategies for animal genetic resources of Nordic countries
    - Personnel communication / national coordinators

Content of the report

"Nordic farm animal gene banks – added value through Nordic cooperation?"

- National goals
- Structural information
- Responsibilities
- Material and storage
- Quality management and risks
- Access
- Unexploited possibilities of collaboration

Examples of the national goals

Denmark: *in situ* conservation preferred over *ex situ* conservation. Will expand its gene bank collections for semen, oocytes and somatic cells.

Sweden: *in situ* conservation should primarily be aimed. Insurance against breed extinction, management of diversity of *in vivo* population and research.

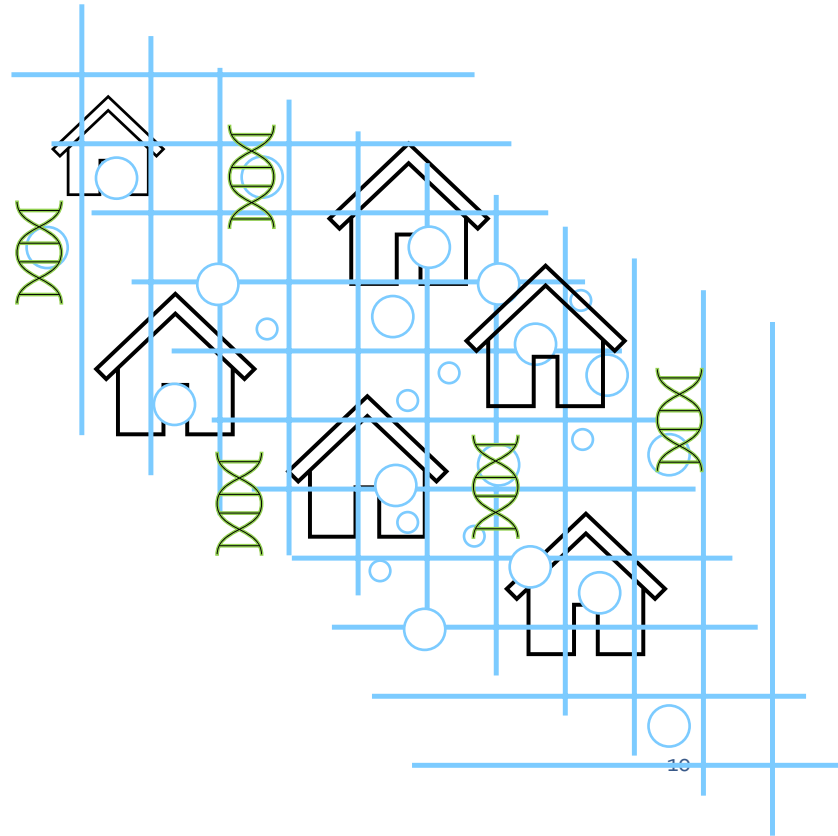
Finland: both *in vivo* and *in vitro* measures with focus on *in vivo* conservation. Insurance against breed extinction, management of diversity of *in vivo* population and research. International collaboration.

Norway: *ex situ* conservation as a complementary method. Gene bank collection must be expanded every year; long term storage.

Iceland: Informal goals like those mentioned by the other Nordic countries.

Common in structural information

- The national gene banks in most countries are not independent entities located at a single physical facility and/or managed as one unit
- Almost all gene banks in Nordic listed as 100% public



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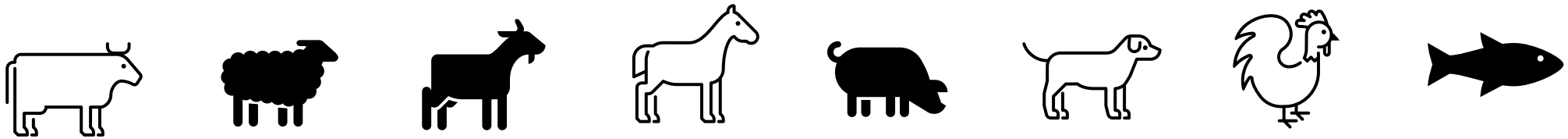
Responsibilities

Who will make decisions which material is stored

- **Norway**: Norwegian Genetic Resource Center & Norwegian Horse Center; breeding organizations
- **Sweden**: The Swedish Board of Agriculture for Frozen Gene Bank, conservation purposes
- **Finland**: Natural Resources Institute Finland (Luke) coordinates. All measures are carried out in cooperation with the respective breed organization.
- **Iceland**: Agricultural Genetic Resource Committee
- **Denmark**: The Advisory Conservation Committee for Danish animal genetic resources under the auspices of the Ministry of Environment and Food

Material and storage

- **Live animals** — Iceland & Finland
- Semen — All countries
- Oocytes — None
- Embryos & DNA — Denmark & Finland
- Somatic cells and various tissues — Finland, Norway, Sweden



	Cattle	Sheep	Goat	Horse	Pig	Dog	Chicken	Fish
Denmark	✓	✓	✓	✓	✓		✓	?
Sweden	✓	✓	✓	✓	✓	✓		?
Norway	✓	✓	✓				✓	?
Finland	✓	✓	✓	✓		✓	✓	?
Iceland	✓	✓	✓					?

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Major findings

- National gene banks are not "under one roof", but rather collections of samples stored in multiple locations.
    - Definition of gene bank unclear/missing
- Every country does have national gene bank activities; variation in strategic goals
- No metadata on a regional level available
- Level of **quality control** / **safeguarding** / **expertise** of the staff involved differs
    - no one is solely employed at a national gene bank
    - no back up stores
    - dependence on economic situations
- Ownership: national gene banks are listed as 100% public, however breeding companies are administering their own specimen

Rationalization of backup gene banking

- To secure decades of work
- A complementary to the *in vivo* conservation (accidents, natural disasters, catastrophes)

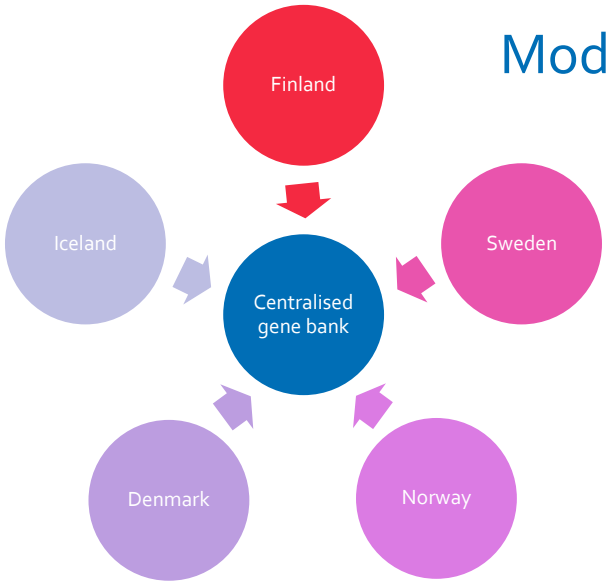
Rationalization of backup gene banking

- A cheap insurance
- A country has carried out cryopreservation for 30 years, with costs 10 000€ per year costs to date 300,000 €
- Another country has invested 25 000€ per year > costs to date 750 000€
- If all stages of genetic banking were considered, such as the efforts of livestock keepers, the price tag would be significantly higher
- However, even a million euros will not bring lost genetic resources back

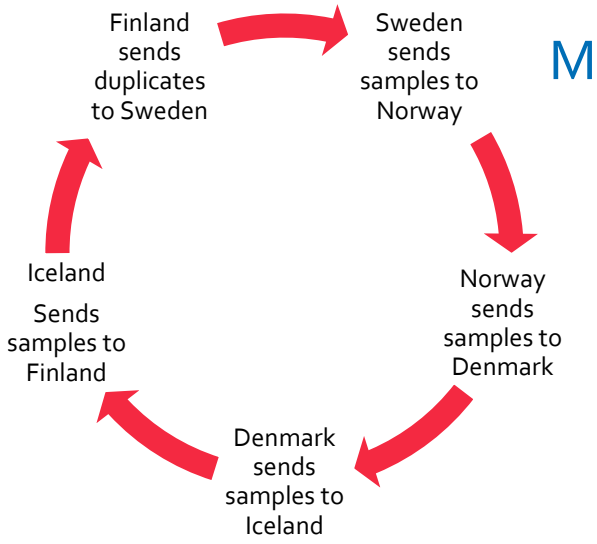
Risk management

- A backup plan for risk management needed
- There are several different scenarios
  - Model A: a common centralized Nordic gene bank
  - Model B: A chain model of bilateral agreements
  - Others ?

Model A



Model B



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Conclusions

- It is important to pay **special attention to ownership** of material and **distribution of responsibilities**
- It is recommended to establish a multi-stakeholder management group
- It would be valuable to establish a common Nordic point for back up of samples and/or storing data
- It is important to educate experts; regional networks targeted to increase capacity building and infrastructure in cryopreservation

Faroe Islands – a case study

Gene banking of Faroese Cattle genetics

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2019:

- NordGen was invited to come and rescue the remaining genetic resources of Faroese Cattle
- Semen doses from 4 bulls exported to Luke, Finland in liquid nitrogen
- Samples from 1 female collected:
  - Tissue (three types of adipose, blood)
  - Oocytes
- Oocytes transported to IVP laboratory in Finland during maturation step (within 24 h)
- Transferable embryos for cryopreservation

➢ Oocyte transportation as air cargo at +38.5°C challenging

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2022:

- Epididymal semen collection from one bull:
  - Semen doses frozen at Faroe Islands
- Samples from 2 females collected:
  - Blood
  - Oocytes
- Oocytes transported to IVP laboratory in Finland at ambient temperature
- Transferable embryos cryopreserved

➢ Epididymal semen collection and oocyte transportation at ambient temperature feasible

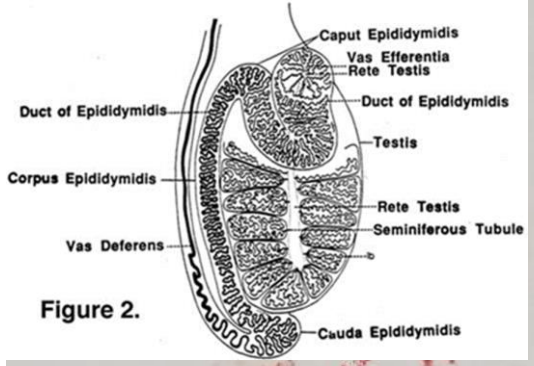

Figure 2.

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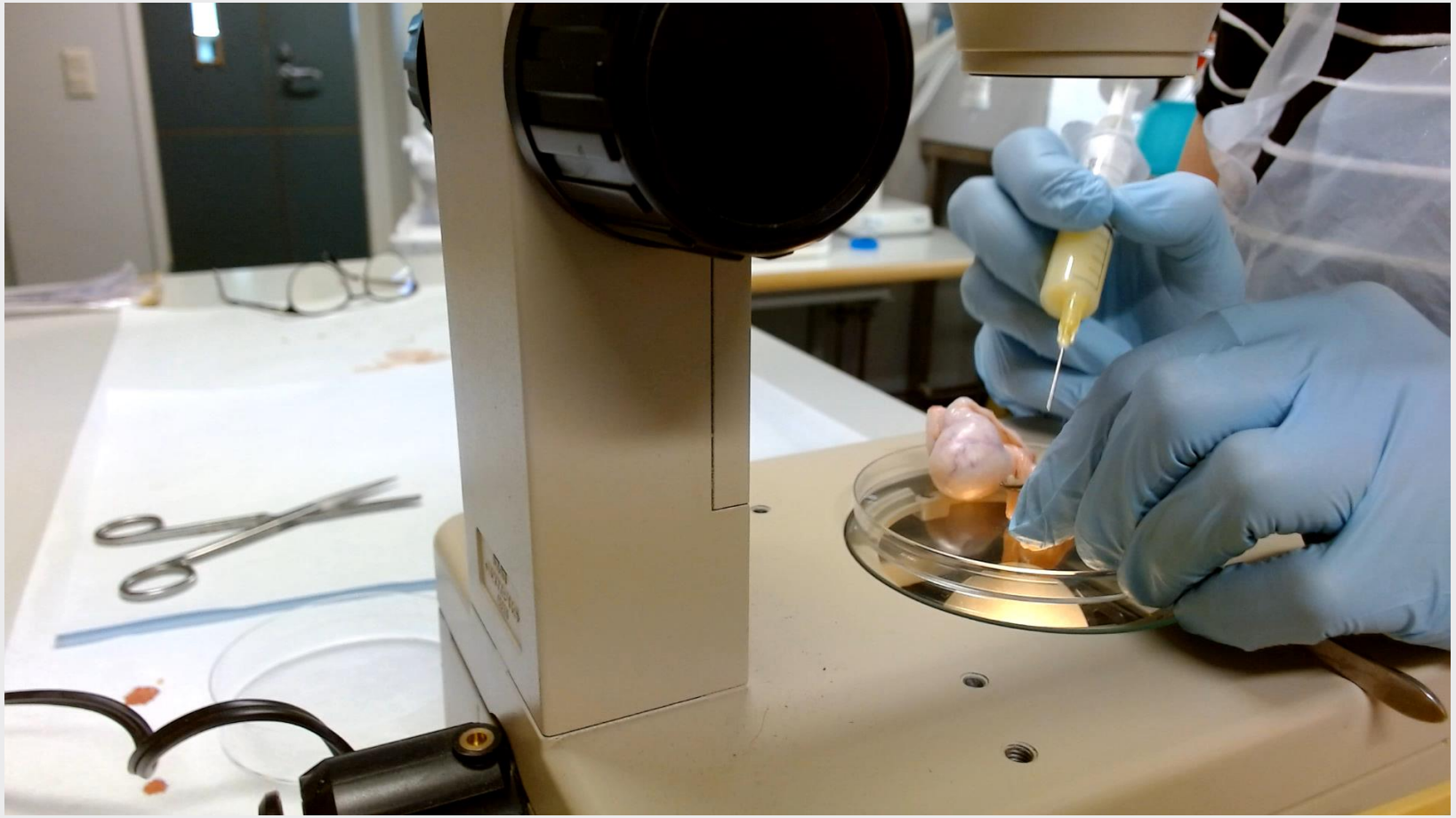
Collection of epididymal semen



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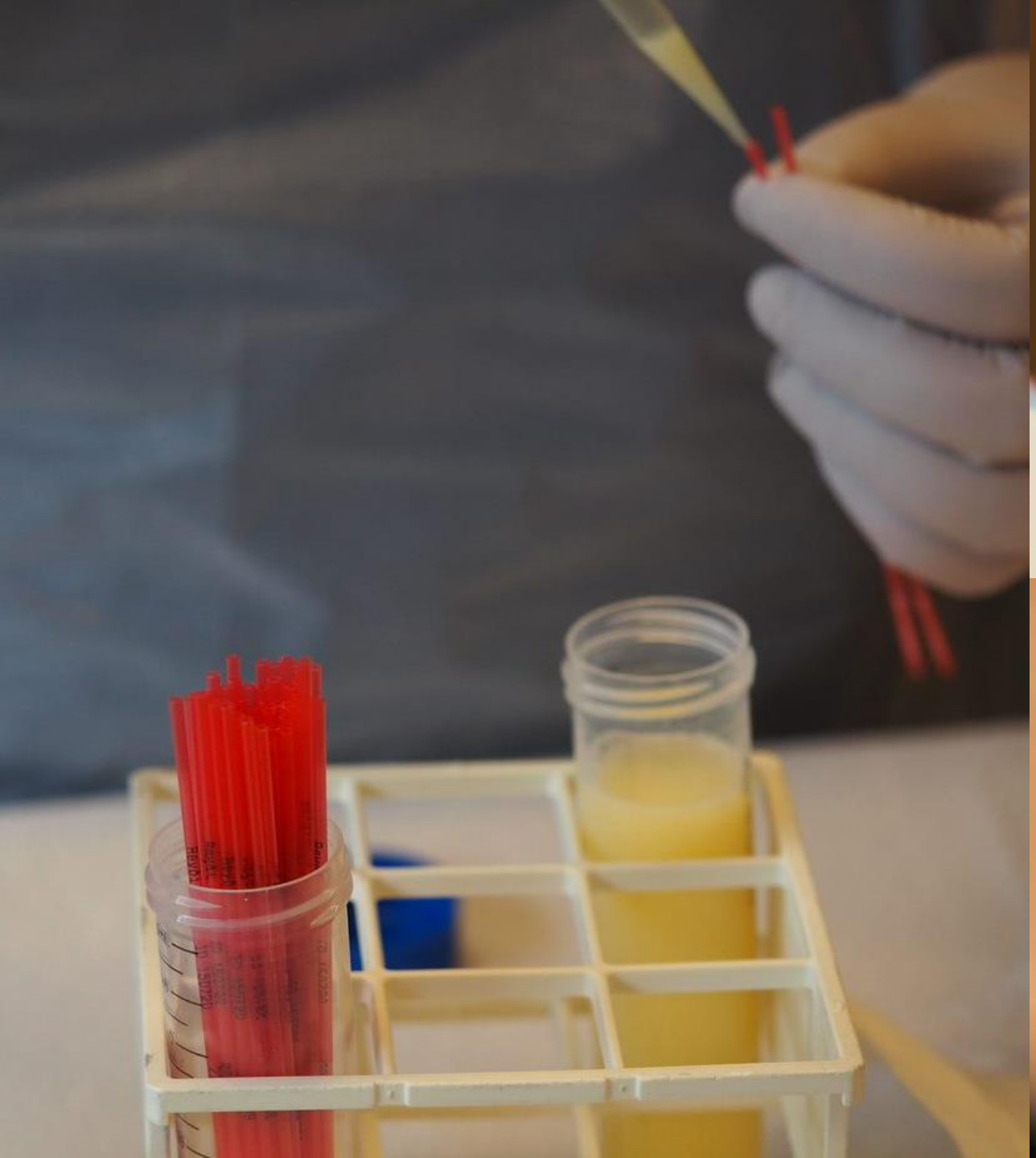
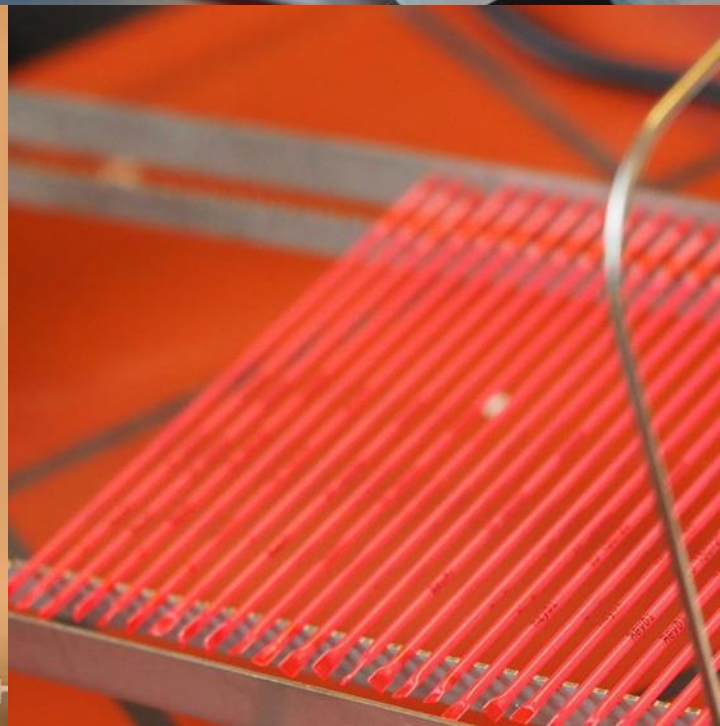




Ejaculated vs epididymal semen

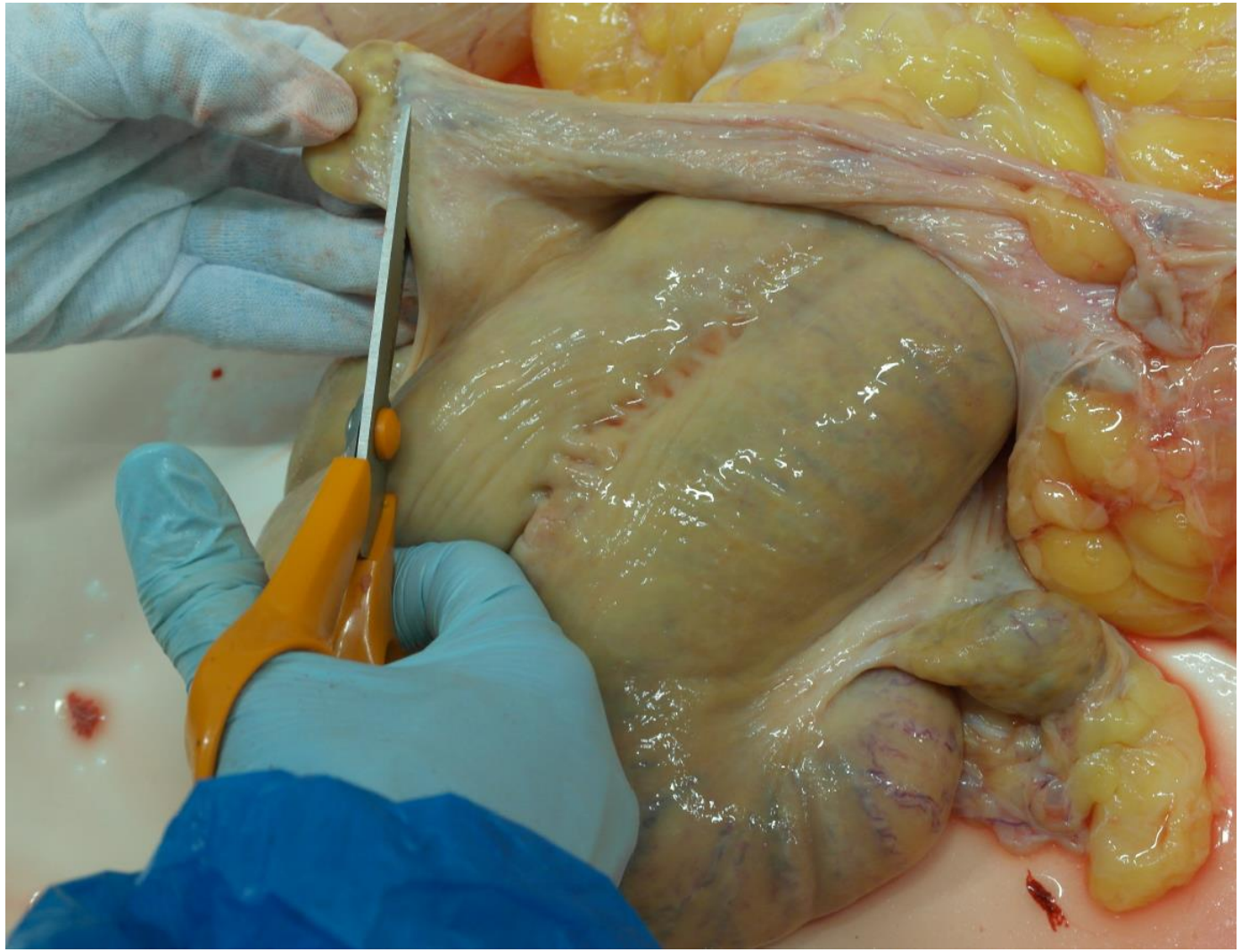
Ejaculated semen

- Expensive infrastructure
- Few bulls
  - Breeding schemes
  - Genetic diversity ↓
- Repeated collections
  - Large number of doses
  - X and Y sorted semen
- Sanitary status of bulls is already well defined

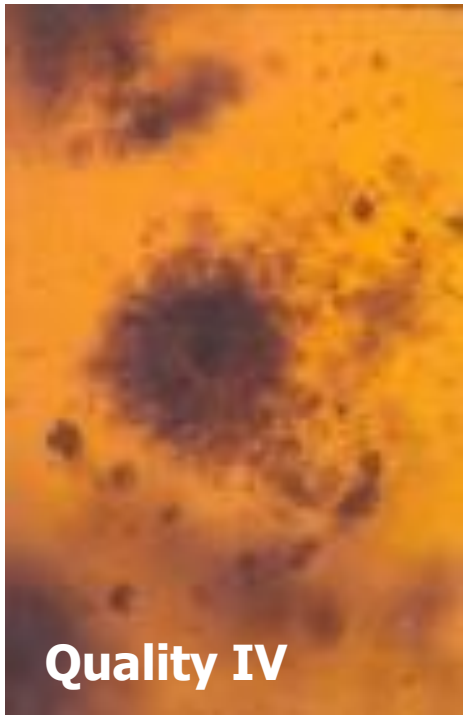
Epididymal semen

- Cheap infrastructure
- Many bulls
  - *In situ* conservation schemes
  - Genetic diversity↑
- Single collection
  - Limited number of doses
- Sanitary status of bulls needs to be defined

Ovary collection

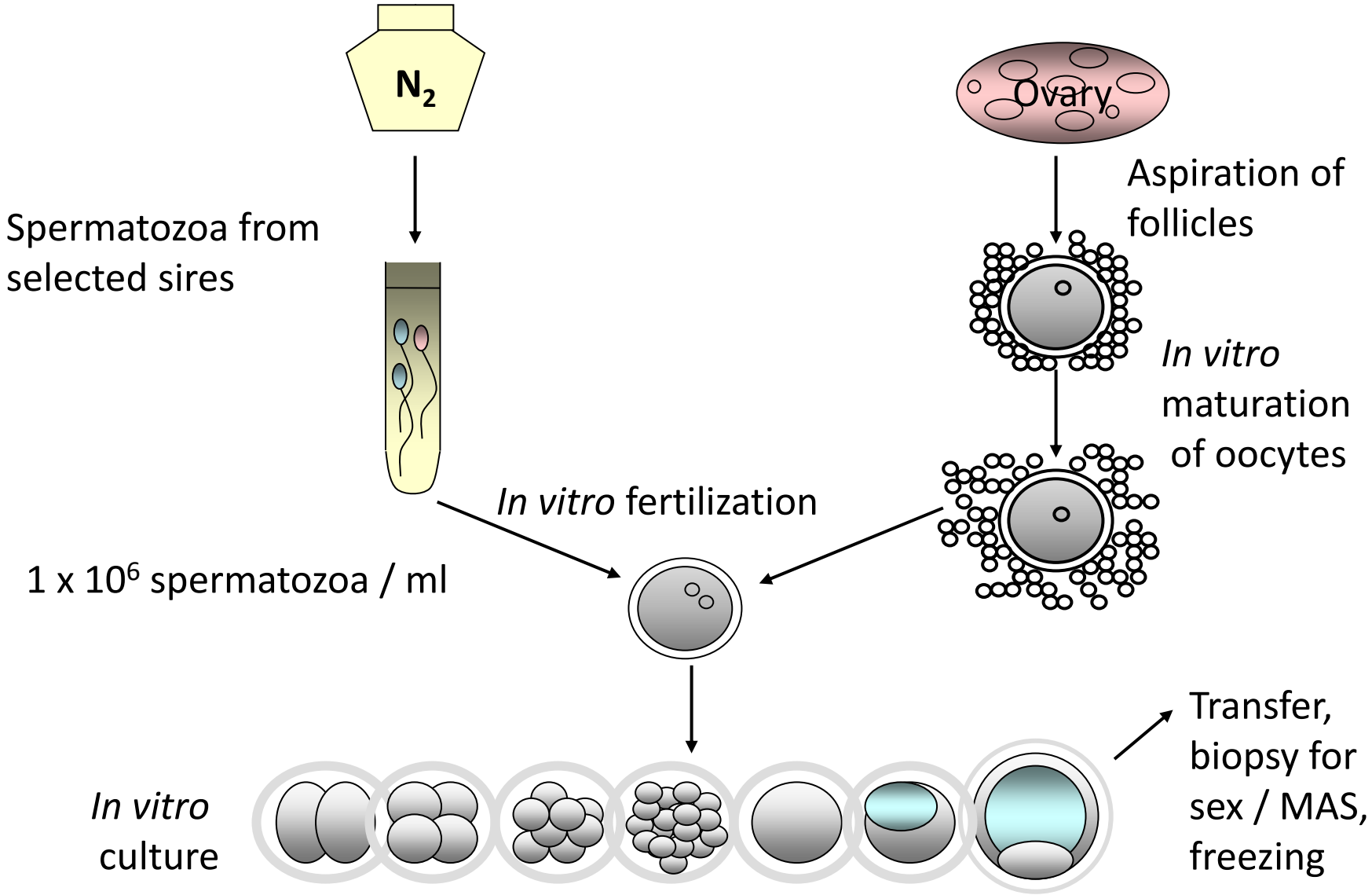


The amount and quality of immature oocytes is variable per pair of ovaries



Note! All variation not visible

In vitro embryo production



GENEBANKING ONLINE WORKSHIOP

March 26, 1-3 pm EST

We'll take you through each step to conserve your favorite heritage breed through gene or bio banking.

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FAO Guidelines: "Innovations in cryoconservation of animal genetic resources"

– Suggestions for lead authors and other contributors for webinar series 2022
Section Webinar Date and time IMAGE lead author 2nd Lead author Editor

1. **Building a gene bank strategy**
May 18th At 5 pm Michelle Boichard michele.boichard@inrae.fr Harvey Blackburn harvey.blackburn@usda.gov JB
French version on 18 May at 10 am CET? To be confirmed – Michele
2. **Implementation and organization**
Sipke Hiemstra sipkejoost.hiemstra@wur.nl Paul Boettcher JB
3. **Choice of biological material to be preserved**
May 24th At 5 pm Purdy Phil phil.purdy@usda.gov Elisabeth Blesbois elisabeth.blesbois@inrae.fr MH
4. **Economics of gene banking**
May 31st At 5 pm CET Dominic Moran Dominic.Moran@ed.ac.uk DE OLIVEIRA SILVA Rafael Rafael.Silva@ed.ac.uk Carl Lessard carl.lessard@canada.ca JB
5. **Developing and using gene bank collections**
June 28th at 16.00 CET Windig Jack jack.windig@wur.nl Reimer Christian christian.reimer@agr.uni-goettingen.de Danchin Coralie Coralie.Danchin@idele.fr MH
6. **Collection and cryopreservation of germ plasm and tissues**
Elisabeth Blesbois elisabeth.blesbois@inrae.fr Janice Bailey janice.Bailey@frq.gouv.qc.ca Purdy Phil phil.purdy@usda.gov MH
7. **Sanitary issues and recommendations**
July 5th At 5 pm CET Beate Berger Beate.Berger@raumberg-gumpenstein.at Tejerina Ampudia Fernando FTejerina@mapa.es JB
Spanish version on 6 or 7 July at 4:30 pm CET To be confirmed – Fernando
8. **Databases and documentation**
June 15th at 10 am Alessandra Stella alessandra.stella@ibba.cnr.it Samuel Rezende Paiva samuel.paiva@embrapa.br Zhivko Duchev zhivko.duchev@agriacad.bg MH
9. **Legal issues: acquisition, storage and transfer of gene bank material**
Elżbieta Martyniuk elzbieta_martyniuk@sggw.edu.pl Věra Mátlová kozulena@post.cz MH
10. **Capacity building and training**
Luis Gama ltgama1@yahoo.com ltgama@fmv.utl.pt Paul Boettcher JB

Editors: MH = Mervi Honkatukia, JB = Jaap Boes (NordGen)

Thank you for your attention!

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