Food and Agriculture Organization of the United Nations

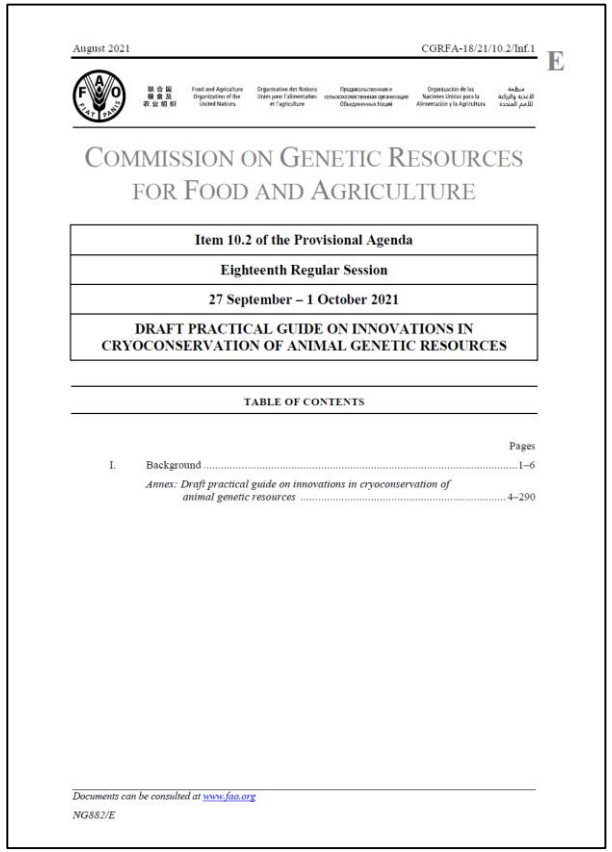
SUSTAINABLE DEVELOPMENT GOALS

Innovation in cryoconservation of animal genetic resources

Webinar series

Background

- In 2020 and 2021, FAO prepared *Draft Practical Guides on Innovation in Cryoconservation of Animal Genetic Resources*
  - International authors including from EU Horizon 2020 project IMAGE
  - In cooperation with Nordic Genetic Resources Center
- Guidelines were reviewed by ITWG-AnGR and CGRFA
  - Commission requested FAO to build capacity
- This is first in series of webinars from now until October
  - One per chapter, plus some versions in French in Spanish
  - Dedicated page on FAO Animal Genetics website fao.org/animal-genetics



August 2021 CGRFA-18/21/10.2/Inf.1 E

COMMISSION ON GENETIC RESOURCES FOR FOOD AND AGRICULTURE

Item 10.2 of the Provisional Agenda
Eighteenth Regular Session
27 September – 1 October 2021

DRAFT PRACTICAL GUIDE ON INNOVATIONS IN CRYOCONSERVATION OF ANIMAL GENETIC RESOURCES

TABLE OF CONTENTS

Pages

I. Background 1–6

Annex: Draft practical guide on innovations in cryoconservation of animal genetic resources 4–290

Documents can be consulted at www.fao.org

NG882/E

Section 1: Building a gene banking strategy

- Introduction (P Boettcher)
- Issues and challenges to be considered in a gene banking strategy (M Boichard)
- Governance (H Blackburn)
- Elements of the gene banking strategy (S Hiemstra)
- Strategic considerations for multi-country gene banking (P Boettcher)
  - case study – West Africa (I Houaga)
- Questions and answers (J Boes)
  - First priority are questions written in the “chat”, followed by live questions (raise your hand)
- One hour total length

Introduction

- Cryoconservation is a powerful tool for management of animal genetic resources and addresses various objectives:
  - insurance against breed loss
  - increasing genetic variation of populations *in situ*
  - development of new breeds and lines
  - research
- Setting up and operating a gene bank is an investment
  - Greater number of objectives helps justify costs

Complexity demands planning

- The many possible uses for gene banks suggests multiple stakeholders
  - farmers and breeders
  - breed associations
  - government
  - researchers
- Developing a strategy is critical to satisfying all the objectives and the needs of stakeholders in a cost-efficient manner

Food and Agriculture Organization of the United Nations

SUSTAINABLE DEVELOPMENT GOALS

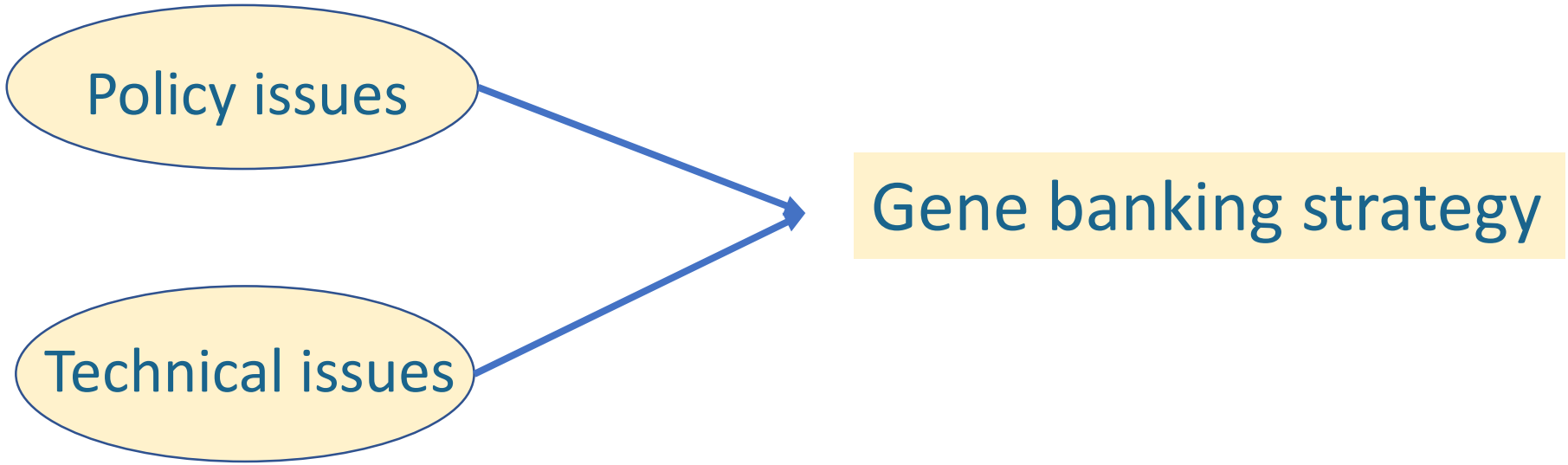
Thank you

Issues and challenges to be considered in a genebanking strategy

Michèle TIXIER-BOICHARD
University Paris-Saclay, INRAE, AgroParisTech, GABI, Jouy-en-Josas, France,

Coordinator or the CRB-Anim infrastructure for genetic resources https://crb-anim.fr
Coordinator of the IMAGE project
Chair of the governing board of the French National Gene Bank and of @BRIDGe BRC

Issues and challenges



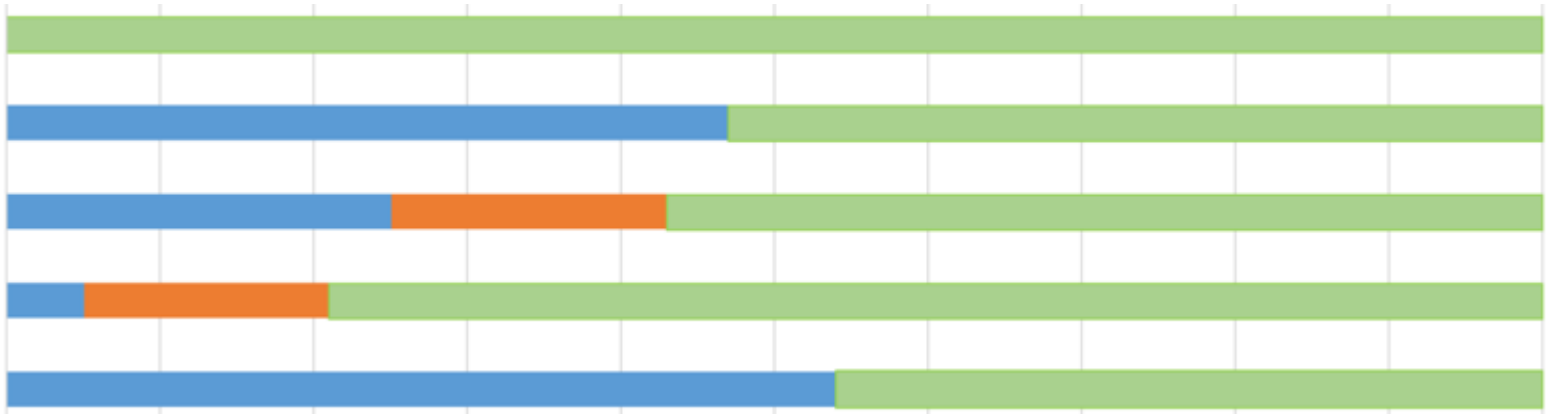
Policy : why cryoconservation ?

Risk of losing breeds

Maximise Genetic variation

Important phenotypes

One breed may contribute to more than one goal



Species Differences

Exemple : French National Gene bank

Ethical issues ?

Which breed to choose ?

Funding
Cultural values
→ Prioritisation is difficult

Which technologies to use ?

Biotechnologies : public perception
Invasive techniques
→ Justify the use, explain the constraints

Cost effectiveness

Gene banks are not-for-profit entities

Full cost analysis

All components :
staff, equipment, energy...

According to steps:
Collection, storage, management…

Which resources ?

Public subsidies ↔ national strategy

Fee policy : to cover some costs

More in Section 4…

Information management

A genetic resource =
biological material + associated data

New and powerful Computing & Communication technologies

Documentation of stored material:
As much as possible :
Pedigrees, phenotypes, molecular data

Access to data
Connection with related data sets

More in Section 8…

Genebanking objectives

Consider the whole range

Loss (disaster) → Reconstitution of an extinct breed

Significant quantities and costs
An option for research lines

Support to on-farm populations →
- *in vivo* conservation, increased number of sires, limit inbreeding
- Develop new lines or breeds by crossbreeding
- Back-up for not-at-risk populations: **ACT BEFORE it becomes at risk**
  Re-orient breeding goals

Research → **Store tissues, DNA in addition to germplasm**
For further characterisation, further use

Food and Agriculture Organization of the United Nations

SUSTAINABLE DEVELOPMENT GOALS

→ governance

Gene Bank Governance

Agricultural Research Service

Harvey Blackburn

National Animal Germplasm Program
ARS-USDA

United States

Background

- National Coordinator for National Animal Germplasm Program
  - Direct gene bank development
  - Manage Species Committees
- National Coordinator Animal Genetic Resources – FAO
- Our Gene Bank
  - 1.1 million samples from >60,000 animals representing 171 breeds and >300 special populations

Governance – Cornerstone of Gene Bank Development and Operation

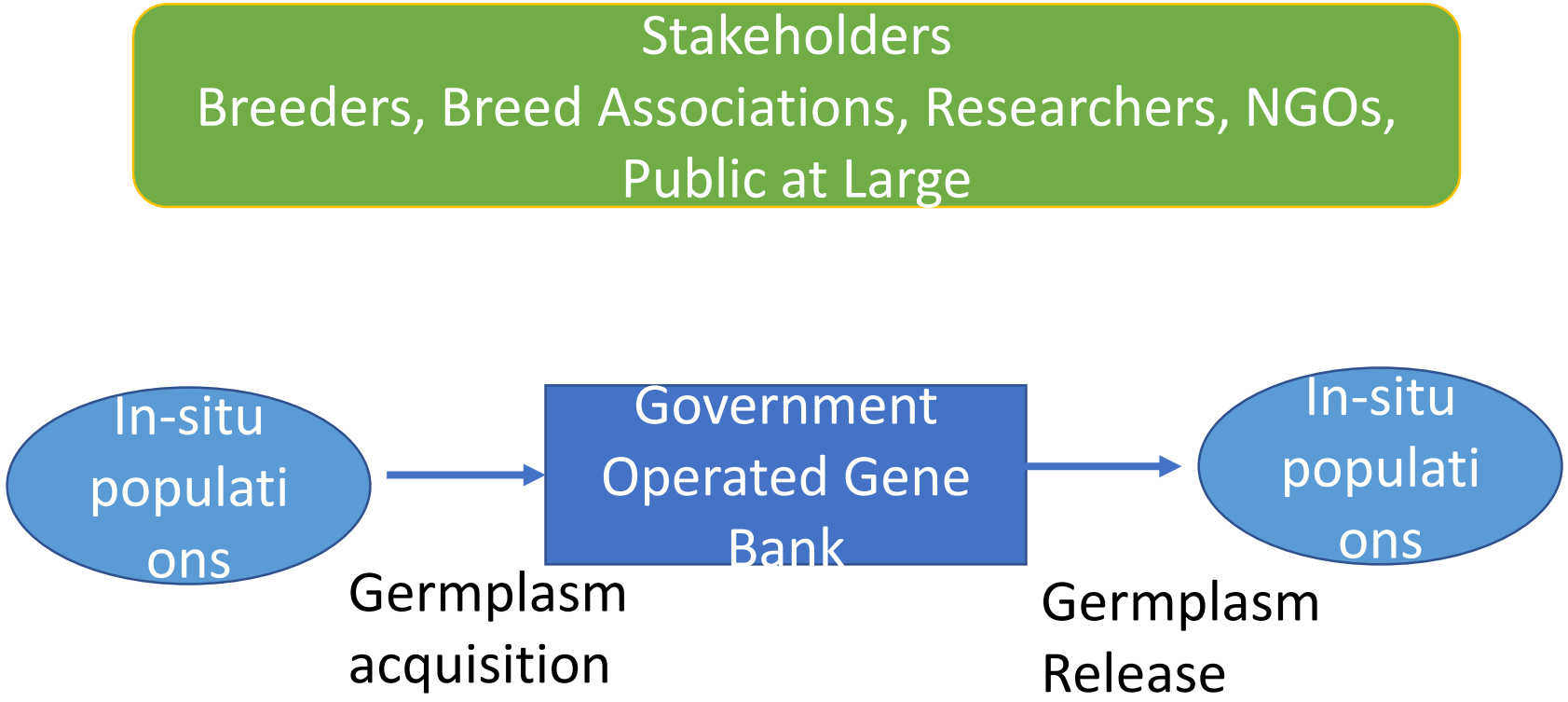
Why?

Transparency and consistency are key gene bank features

- Establish clear operating procedures
- Many stakeholders
- Many samples

Stakeholder Involvement

- Assess stakeholder needs & perceptions
- Equal weight per stakeholder not required
- All factored in with government regulation

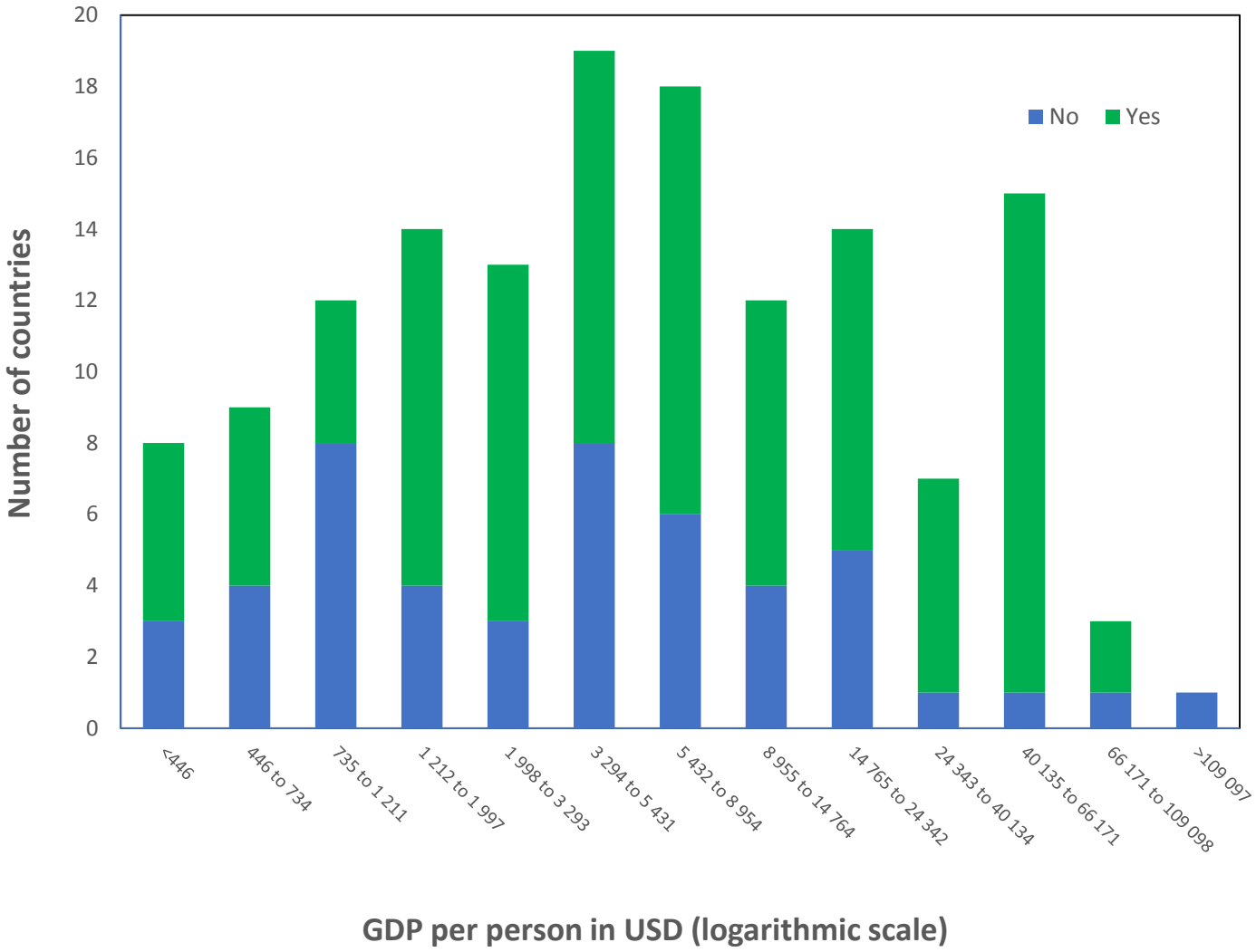


Institutional Commitment

For gene banks to succeed:

- Long term (>50 yrs) commitment to funding
- Scale variable based on country size & resources

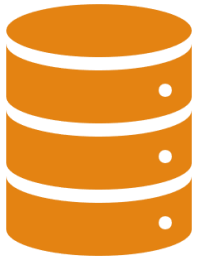
Number of countries with or without Gene banks based upon GDP/person



Governance Structure & Decision Making

- Gene bank management might consult with stakeholders across a broad range of subjects concerning the gene bank and genetic resources, including:
  1. Stakeholder groups formed to suggest approaches for acquisition and release of germplasm samples from the collection
  2. Stakeholders may provide support for seeking additional funds
  3. The National Advisory Committee may serve in a consultative role for the gene bank
- The formality of such interactions is dependent upon government regulations
- Therefore, gene bank managers will need autonym to manage the collection's development.

Data concerning samples in the gene bank can be as important as the samples themselves.



Therefore, policies are needed for:

types of data to be collected and managed;

system for organization of data, and standards for documentation and metadata;

protection of privacy, security, confidentiality, intellectual property or other rights;

access to and sharing of data: how and when to share data an*d* with whom; and

data storage: where to be maintained, and how to be secured.

Data Policy

Thank you

Gene Bank Governance

Agricultural Research Service

HARVEY BLACKBURN

NATIONAL ANIMAL GERMPLASM PROGRAM ARS-USDA

UNITED STATES

Background

National Coordinator for National Animal Germplasm Program

- Direct gene bank development
- Manage Species Committees

National Coordinator Animal Genetic Resources – FAO

Our Gene Bank

- 1.1 million samples from >60,000 animals representing 171 breeds and >300 special populations

Governance – Cornerstone of Gene Bank Development and Operation

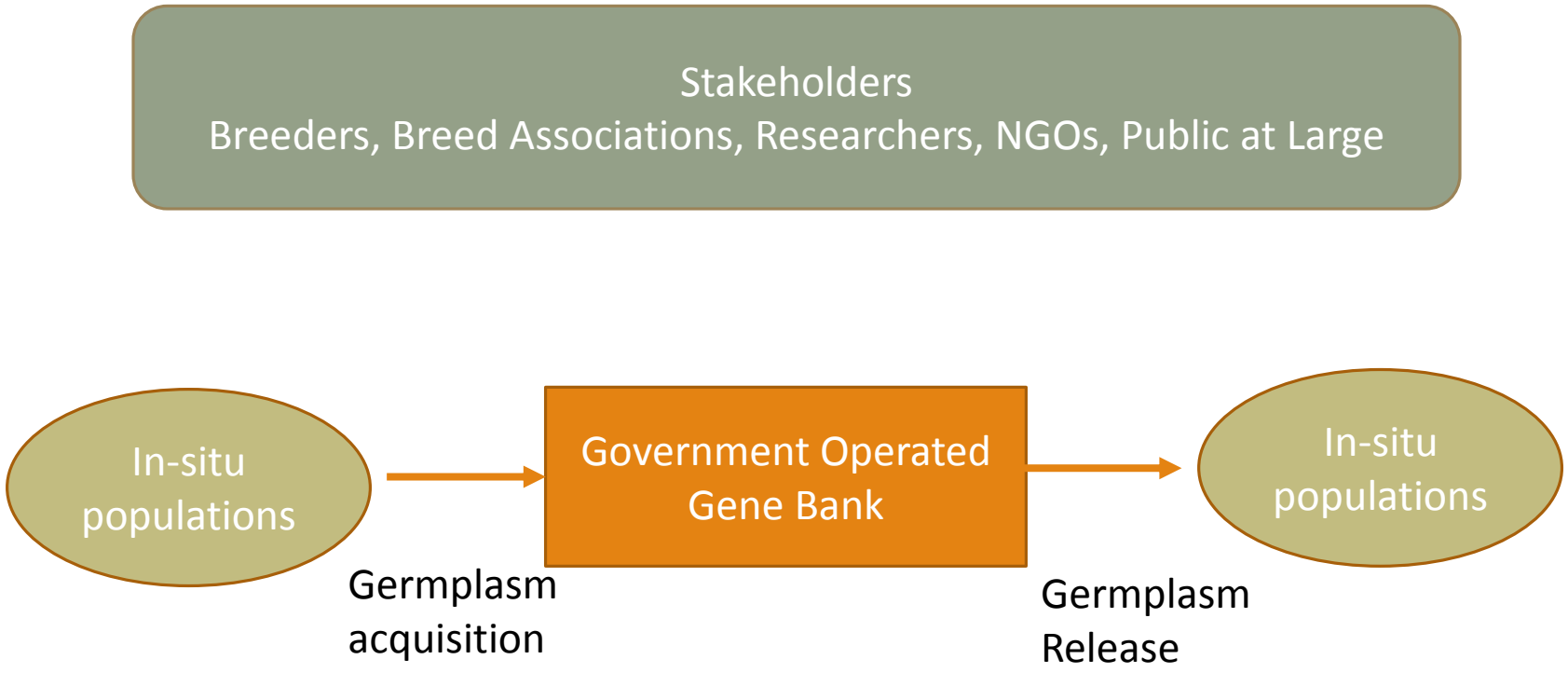
Why?

Transparency and consistency are key gene bank features

- Establish clear operating procedures
- Many stakeholders
- Many samples

Stakeholder Involvement

- Assess stakeholder needs & perceptions
- Equal weight per stakeholder not required
- All factored in with government regulation

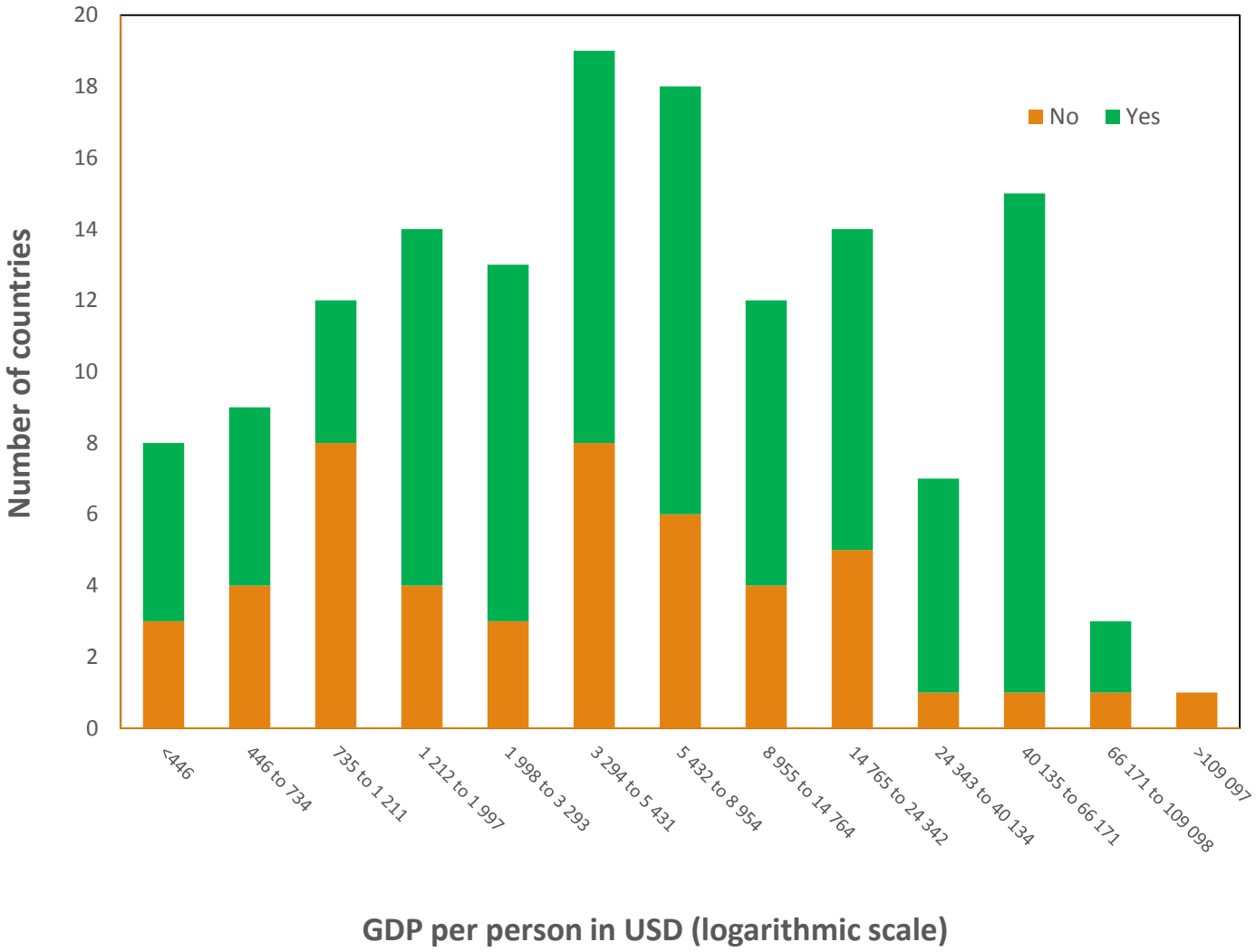


Institutional Commitment

For gene banks to succeed:

- Long term (>50 yrs) commitment to funding
- Scale variable based on country size & resources

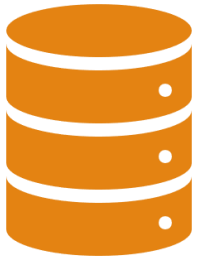
Number of countries with or without Gene banks based upon GDP/person



Governance Structure & Decision Making

- Gene bank management might consult with stakeholders across a broad range of subjects concerning the gene bank and genetic resources, including:
  1. Stakeholder groups formed to suggest approaches for acquisition and release of germplasm samples from the collection
  2. Stakeholders may provide support for seeking additional funds
  3. The National Advisory Committee may serve in a consultative role for the gene bank
- The formality of such interactions is dependent upon government regulations
- Therefore, gene bank managers will need autonym to manage the collection's development.

Data concerning samples in the gene bank can be as important as the samples themselves.



Therefore, policies are needed for:

types of data to be collected and managed;

system for organization of data, and standards for documentation and metadata;

protection of privacy, security, confidentiality, intellectual property or other rights;

access to and sharing of data: how and when to share data an*d* with whom; and

data storage: where to be maintained, and how to be secured.

Data Policy

Thank you

Elements of a gene banking strategy

S.J. Hiemstra, Centre for Genetic Resources, the Netherlands (CGN)

WAGENINGEN
UNIVERSITY & RESEARCH

Introducing myself

- Director - Centre for Genetic Resources, the Netherlands (CGN) of Wageningen UR
  - Plant Genetic Resources
  - Forest Genetic Resources
  - **Animal Genetic Resources**
- National Coordinator for Animal Genetic Resources (FAO Global Plan of Action)
- Chair – Steering Committee of the European Regional Focal Point (ERFP) - European Network of National Coordinators

WAGENINGEN
UNIVERSITY & RESEARCH

ERFP

CONVENTION ON BIOLOGICAL DIVERSITY

Elements of the gene banking strategy

- Animal gene banking is a comprehensive and dynamic process
- Strategy should conform with the country's objectives for AnGR management and consider all important elements of gene bank operation:
    - sampling
    - storage organization
    - utilization
    - rationalization
    - communication and awareness raising

Sampling

- A gene bank must periodically review the inventory of their collections, compare to objectives, and plan sampling accordingly
- The following aspects must be considered:
    - Species
    - Genetic information and diversity
    - Collection updating
    - Tissue types
    - Sanitary status

Storage organization

Gene banks must guarantee safe long-term storage of genetic material and associated data

- Centralization and distribution
  - security, ease of access, electricity and liquid nitrogen sources, costs
- Duplication and back-up
- Storage of material
  - number and size of tanks, distribution across tanks
- Associated data
  - information needs to be both protected and shared

Utilization

- Gene banks are more powerful when used by a wide range of stakeholders for a variety of purposes
- The following factors must be considered in the strategy:
    - Conditions for access
    - Usage scenarios
    - Tracking sample use and impact
        - ➢ information and future material to be provided by user

Genebank Rationalization – what is it?

- Defining and evaluating the genebank objectives and strategy (*"ex ante" and "ex post")*
- "Demand" side
    - Current and future societal and stakeholder needs
    - Future use scenario's
- "Supply" side
    - Genetic optimization
    - Technical options
    - Cost efficiency

WAGENINGEN
UNIVERSITY & RESEARCH

IMAGE
Innovative Management of Animal Genetic Resources

Rationalization of gene bank strategies – **questions**

- What have we done so far (achievements) ?
- Are we doing the right thing (objectives) ?
- Stakeholder perspectives ?
- Genetic diversity captured in collections ?
- Sufficient material stored ?
- Can we improve efficiency and cost-effectiveness ?
- Priorities for further development ?

WAGENINGEN
UNIVERSITY & RESEARCH

IMAGE
Innovative Management of
Animal Genetic Resources

Thank you for your attention

Food and Agriculture Organization
of the United Nations

Strategic considerations for multi-country gene banking

Paul Boettcher
FAO, Rome

IMPLEMENTING THE GLOBAL PLAN OF ACTION FOR ANIMAL GENETIC RESOURCES

Background

- The overwhelming majority of current animal gene banks are national or sub-national in scope
- Certain circumstances could favor multi-country banking:
  - group of countries pooling resources to establish a single physical gene bank
  - single country offering gene banking services to others
  - several countries agreeing on a common strategy for cryoconservation of a transboundary breed
  - two or more countries agreeing to use each other's facilities as a back-up
    - or prior agreement for extraordinary circumstances
- Multi-country gene banking introduces new elements to consider in a strategy

General considerations

- Objectives may need to be altered somewhat
  - storage of material in another country may decrease access, making the utilization of material to actively manage an *in situ* population more difficult
- Cooperation with another country may increase the range of tissue types collected (if the cooperating country uses advanced tools)
- Will likely be necessary to apply the sanitary standards of the strictest country to all samples, regardless of the origin
- Long-term institutional commitment remains critical
  - trust in host country to continue support
  - donor countries must remain dedicated
- Multi-country gene banking may start as part of a development project (e.g. AU-IBAR), but gene banking is an ongoing process that will require financial maintenance long after such projects end
- Governance issues will be more complex

Governance

- May be simplest when one country hosts for others
  - provision of service with clear contractual obligations
- Shared back-up collections may also be relatively straight-forward
  - simple objective
  - neighboring countries with similar economic and sanitary situations
- Cooperation among several countries “owning” a single gene bank will be the most complex situation
  - conservation goals may differ across countries
  - access and benefit sharing may be an issue
  - financial contributions should be equitable and clearly agreed upon
  - multi-country stakeholder board is recommended

Benin

Burkina Faso

Côte d'Ivoire

Guinée

Guinée Bissau

Mali

Niger

Togo

West African Regional Animal Gene Bank

I. Houaga[1,2] G-K. Dayo[2] S. Sanogo[2]

[1] CTLGH, Edinburgh, UK
[2] CIRDES, Bobo-Dioulasso, Burkina Faso

FAO Webinar on establishing a gene banking strategy
18-05-2022

Food and Agriculture Organization of the United Nations | SUSTAINABLE DEVELOPMENT GOALS

Speaker

- From Benin Republic
- **2021-to date:** Royal Society Newton International Postdoctoral Fellow
- Centre for Tropical Livestock Genetics and Health/HLab, Roslin Institute, UK
- Developing genomic selection strategies for smallholder crossbred dairy cattle in East Africa (ADGG)
- **2018-2020:** Focal Point West African Regional Animal Gene Bank at CIRDES, Burkina Faso.

PLAN

1. Framework of establishment of the Gene bank

2. Infrastructure/Equipment and Capacity building

3. Challenges

4. Strategies and future plans

1. Framework of Establishment of the Gene Bank

- Conservation of irreplaceable African genetic resources is highly critical for diversity benefits and to face climate change effects

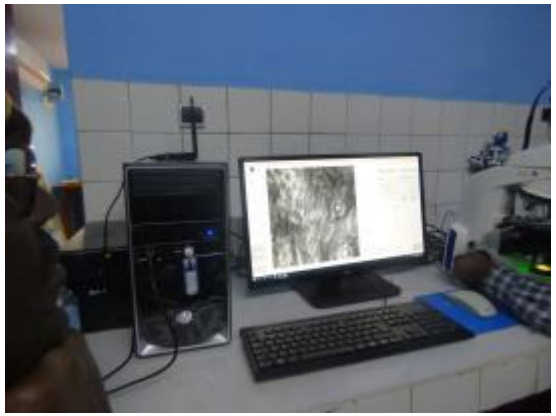
- CIRDES selected as Host of West African Regional Animal Gene bank in November 2015 (AnGRs Focal point Meeting, Dakar, Senegal)

- **Objective:** To provide regional *ex situ* conservation facilities to enable Member States to conserve their AnGRs and address the threat of loss of their diversity

- West African Regional Animal Gene bank established under the AU-IBAR Genetics project and officially launched on 19/07/2019

2. Infrastructures, Equipment & Capacity building

- Various equipment acquired for semen collection, analysis and conservation



2. Infrastructures, Equipment & Capacity building

- **Semen collection area at CIRDES experimental farm**

- **Online data base** http://www.cirdes.org/banque-de-genes/

2. Infrastructures, Equipment & Capacity building

In vivo Conservation: Transboundary breeds with conserved semen at CIRDES

Zebu Peulh of Burkina

Baoulé lobi-Burkina Faso

N'Dama of Mali

Lagunaire of Benin

Borgou of Benin

Somba of Togo

2. Infrastructures, Equipment & Capacity building

- **Technicians from the 15 ECOWAS countries trained on semen collection, quality control and cryoconservation**

- **Technicians (women and men) trained on utilisation and maintenance of the gene bank equipment**

3. Challenges

- Funding stopped since July 2019,
- No external financial support for the maintenance of the large equipment (such as the liquid nitrogen production), for ensuring the costs of electricity or the generator and the salary costs for the permanent staff on the gene bank,
- Lack of legal and regulatory frameworks to govern the collection, use and exchange of genetic materials between ECOWAS countries
- ECOWAS countries are yet to have their cryogenic tanks (-196° C) in the regional gene bank → *Semen collected are from animals at CIRDES.*

4. Strategies and future plans

- Transformation ongoing of regional gene banks into Africa Union Animal Resources Seed Centers of Excellence
- Development of the governance (administrative) structure for the African Union Animal seed Centres of Excellence
- Development of the legal and regulatory framework
- Development of a road map for the operationalization of the African Union Animal seed Centres of Excellence : Advocacy with ECOWAS

Future Plans:

- Develop a joint programme with support from FAO, AU-IBAR and ECOWAS for the operationalisation of the West-African Centre
- Strengthen capacities of national and regional institutions to develop strategies preventing the loss of these valuable AnGRs and promoting their sustainable use
- Involve the private sector (Breeding companies, Inseminators Associations)

THANK YOU FOR LISTENING