PRO-GRACE

PROMOTING A PLANT GENETIC RESOURCE COMMUNITY FOR EUROPE

DELIVERABLE 2.4

A blueprint for a capacity building programme for genebanks and *in situ*/on-farm conservation networks

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Table of contents

Abbreviations

DOI	Digital object identifier
ECPGR	European Cooperative Programme for Crop Genetic Resources Networks
EURISCO	European Search Catalogue for Plant Genetic Resources
FAO	Food and Agriculture Organization of the UN
ITPGRFA	International Treaty for Plant Genetic Resources for Food and Agriculture
IUCN	International Union for the Conservation of Nature and Natural Resources
MAWP	Most Appropriate Wild Population
NBSAP	National Biodiversity Strategy and Action Plan
OECM	Other effective area-based conservation measures
PA	Protected area
PGR	Plant genetic resource
PGRFA	PGR for food and agriculture

Executive Summary

This Deliverable presents an in-depth analysis of strategies aimed at supporting relevant stakeholders in achieving established quality standards through targeted capacity-building interventions. It builds upon the minimum quality standards for genebank operations defined in Deliverable 2.1 and underscores the pressing need for a robust, integrated system for the conservation of diverse plant genetic resources (PGR).

National, regional, and international genebanks play a pivotal role in ensuring the long-term conservation and accessibility of PGR for a wide range of users. To fulfil this mandate effectively, the adoption of a comprehensive quality management system is essential—one that encompasses clearly defined operational procedures, effective monitoring frameworks, and mechanisms for continuous improvement.

The Capacity Building Blueprint developed within this Deliverable is designed to be applicable to all key stakeholders engaged in PGR conservation at global level. It addresses the specific needs of international, regional, and national genebanks, as well as specialised germplasm collections, including those managed by non-governmental organisations. The Blueprint is relevant across all modes of conservation: *ex situ, in situ*, and on-farm.

To inform the Blueprint, a structured questionnaire was developed, covering six core thematic areas central to effective PGR conservation. The results revealed not only a strong and widespread demand for capacity strengthening, but also a notable—and currently underutilised—potential for peer-to-peer knowledge exchange within the European PGR community.

1. Introduction

Plant genetic resources (PGR) are fundamental to the sustainability of crop production and play a critical role in ensuring food and nutritional security both in the present and for future generations. Genetic diversity is essential for evolutionary processes in nature and is equally indispensable for advancements in plant breeding (Harlan, 1975). Consequently, the loss of biological and genetic diversity in PGR may pose a substantial threat to the long-term sustainability of agricultural production in certain regions. Furthermore, PGR serve as unique and irreplaceable sources of genetic material for enhancing the biological and economic potential of agricultural crop varieties.

PGR encompass cultivated varieties, landraces, breeding materials, genetic research lines, related wild species, and ancestral species of agricultural crops. The conservation of cultivated PGR is primarily the responsibility of national genebanks, which implement *ex situ* conservation methods. Additionally, landraces are often preserved by farmers through on-farm conservation efforts, however, farmers are *senso stricto* not conservationists and may discontinue their cultivation. The wild gene pool, which is gaining increasing attention from genetic research and breeding initiatives, occupies an interdisciplinary space between agricultural and environmental sectors. Crop wild relatives (CWR) are wild plant taxa closely related to cultivated crops and represent potential sources of valuable genes and traits for crop improvement (Maxted *et al*., 2006). Wild food plants (WFP) and wild-harvested plants (WHP) refer to non-cultivated plant species collected from natural habitats for consumption as food or beverages or for other uses.

The CBD in Article 12 recognises that, "Contracting Parties ... shall ... establish and maintain programmes for scientific and technical education and training in measures for identification,

conservation and sustainable use of biological diversity and its components and provide support for such education and training ..." (CBD, 1992).

The establishment of an effective and comprehensive conservation system for these diverse genetic resources is of great importance. No single genebank, *in situ* or on-farm conservation network, or individual country possesses the capacity to conserve the global diversity of PGR independently. Instead, countries and their conservation management systems are interdependent in terms of access to genetic resources. National, regional, and international genebanks are tasked with the conservation and availability of PGR for relevant stakeholders. Complementary to this, *in situ* and on-farm conservation networks focus on maintaining PGR diversity within their original ecological and agricultural contexts. These conservation entities must be able to rely on one another through the adoption of mutually agreed standards and quality benchmarks. To facilitate this, the implementation of a comprehensive quality management system is essential, outlining procedural execution, monitoring mechanisms, and continuous improvement strategies (van Hintum, 2024). The successful realization of such a system on the required scale necessitates adequate capacity-building initiatives at all levels.

Deliverable 2.1 establishes the minimum quality standards for genebank operations, while Deliverable 2.4 analyzes and outlines the strategies necessary to support relevant actors in meeting these standards through capacity-building efforts. Historically, European PGR conservation has been almost exclusively *ex situ*, mostly based on population sampling and seed storage (Maxted *et al.*, 2020). *In situ* and on-farm conservation techniques are only now beginning to be applied across the continent. Therefore, D2.4 needs to address also these aspects.

2. Lack of Conservation Training in Europe

The shortage of specialist skills in European plant genetic conservation and utilisation has long been recognised. Maxted (1999) highlighted that the lack of appropriately trained technicians and scientists was already limiting effective conservation and use of plant genetic resources (PGR) in Europe. With the closure of specialised breeding and PGR-focused master's courses, the situation today appears even more constrained. This skills deficit is further exacerbated by the critical threats of genetic erosion and extinction facing European PGR diversity. Moreover, the inadequate application of conservation techniques across the region is concerning; for instance, 95% of PGR taxa remain under-conserved in ex situ genebanks (Castañeda-Álvarez et al., 2006), and there are currently no *in situ* or on-farm conservation sites that meet industry certification standards (Iriondo et al., 2012).

The growing urgency to train a new generation of PGR professionals—researchers, technicians, and managers—is clear. These individuals need both theoretical and practical skills to conserve and use plant diversity effectively. However, training is not a one-size-fits-all activity. It can take many forms, from long-term doctoral research to short, hands-on workshops. Training must be tailored to professional roles: while managers and technicians may benefit from general or practical courses, researchers require more specialised instruction.

Current and Potential PGR Training Modalities:

Ph.D. and M.Phil. Research Training: Focused on priority PGR issues; e.g., through initiatives like the Marie Curie Doctoral Network.

M.Sc. Training: In fields such as PGR science, applied genetics, plant breeding, biotechnology, biodiversity, and food security.

Continuing Professional Development (CPD) Short Courses: Covering a wide range of practical topics including conservation strategies, data management, genomics, plant exploration, and seed conservation.

Specialist Short Courses: Focusing on advanced or niche topics such as genebank certification, population sampling, GRIN-Global application, or on-farm varietal development.

Distance Learning Courses: Offering flexibility for trainees to build skills while remaining in their home institutions. These can include virtual M.Sc. modules and CPD courses, complemented by in-person practical placements.

Individual Training Placements: Providing personalised training in centres of excellence, fostering active research capacity in countries with rich PGR diversity but limited resources.

Centres of Excellence Twinning: Linking experienced genebanks with others to share knowledge and capacity, ideally including formalised training components.

While all these approaches are valuable, there is a notable shift toward practical, hands-on training to ensure immediate applicability of skills. Additionally, regional training—such as NordGen's lecture series on Crop Wild Relatives (CWR)—offers a model for locally relevant, language-appropriate instruction. A 'train-the-trainer' approach can multiply impact by enabling trained professionals to establish regional training hubs.

The long-term goal of a coordinated European PGR infrastructure must include the development of sustainable training capacity. In the short term, priority can be given to establishing Ph.D. programmes, specialist courses, individual placements, and twinning arrangements. Over time, more comprehensive initiatives such as M.Sc. degrees and distance learning programmes should be developed.

Challenges to M.Sc. Programme Development Include:

- Only academic institutions can confer degrees.
- High costs of training (tuition and living expenses).
- Limited universities possess sufficient breadth of PGR expertise.
- Trainees are often removed from their home institutions and families for extended periods.

While institutions like NordGen Alnarp (Sweden) and CGN Wageningen (Netherlands) offer strong programmes, few universities can independently support a full M.Sc. in PGR. The decentralised distance-learning model may offer a practical alternative, particularly when coordinated through established centres and involving contributions from various experts across Europe. Earlier efforts, such as those from the University of Birmingham and the former IPGRI, could inform this renewed effort.

Such a decentralised programme could provide foundational, refresher, and advanced training, offering flexible, inclusive opportunities for professionals while maintaining connectivity with their institutions and families. This model could also serve the global PGR community, enhancing cost-effectiveness and broadening impact.

Exploring Erasmus Mundus for Genetic Resources Training:

An ERASMUS Mundus master's programme focused on genetic resources—akin to the existing plant breeding programme (https://emplant-master.eu/)—could raise awareness and capacity at the European level. This would facilitate university collaboration and improve access to expertise.

Implementation Considerations:

To successfully expand training opportunities, coordination and collaboration across institutions are essential. Partnerships between national and regional PGR centres of excellence, biodiversity institutes, universities, and stakeholders should form the backbone of a European training network. External teaching contributions and existing training resources—such as the Crop Genebank

Knowledge Base (http://cropgenebank.sgrp.cgiar.org/)—can support curriculum development and initial operations.

The Knowledge Base provides:

- Peer-reviewed best practices in germplasm conservation.
- Guidelines on genetic identity, quality assurance, and risk management.
- Training materials including handbooks, videos, modules, and field exercises.

While the Knowledge Base focuses on ex situ conservation and may require updates, it serves as a strong foundation for building Europe-specific teaching modules. These could include comprehensive curriculum plans, lecture notes, bibliographies, and both field and laboratory exercises.

The expansion and modernisation of PGR training infrastructure is a pressing need. With coordinated effort, Europe can strengthen its conservation capacity and leadership in safeguarding plant genetic diversity for future generations.

3. Objectives of Training in Plant Genetic Resources (PGR) Conservation

The overarching objective of PGR conservation training in Europe is to equip participants with both theoretical knowledge and practical skills necessary for the identification, conservation, characterisation, use, and sustainable management of plant genetic diversity. This training supports sustainable development and enables each country in the region to fulfil its international obligations (e.g. CBD, 1992; ITPGRFA, 2001), European commitments (e.g. EU Biodiversity Strategy for 2030 [EC, 2020b]; Farm to Fork Strategy [EC, 2020b]; Climate Action policies [Meredith and Hart, 2019]; Common Agricultural Policy [EU, 2020]; EU Forest Strategy for 2030 [EC, 2021]), and national policy objectives.

The specific objective of the training component is to strengthen the capacity of European genebanks to ensure the long-term conservation of plant genetic resources (PGR), achieve relevant certifications, safeguard genetic integrity, and minimize the risk of biodiversity loss, while simultaneously advancing the implementation of robust quality management systems.

Training will target three primary beneficiary groups:

- professional PGR practitioners,
- trainers of PGR professionals, and
- other PGR stakeholders.

The programme aims to develop a well-trained regional workforce with the capacity to manage PGR activities effectively, while also training trainers who can disseminate acquired knowledge and skills both within their countries and across the wider region. Participants will be drawn from national and regional PGR programmes, biodiversity and education institutions.

A critical component of this training initiative is to raise public awareness about PGR conservation. Engaging the wider public—particularly farmers and NGOs—is essential to facilitate the work of professionals. Informed communities play a key role in supporting and sustaining conservation initiatives.

Once trained, professional PGR practitioners are expected to form the backbone of national and regional efforts to meet the challenges posed by the CBD and ITPGRFA. Trainees should develop the ability and confidence to:

- Understand taxonomic and genetic variation within PGR diversity;
- Formulate effective policies and strategies for PGR conservation;
- Identify, classify, and revise PGR taxa;
- Compile inventories of local PGR diversity;
- Implement complementary *ex situ, in situ*, and *in vitro* conservation strategies;

- Manage *ex situ* collections (primarilly genebanks) and *in situ/on-farm* populations;
- Apply plant breeding and biotechnology techniques to support sustainable development;
- Utilize modern technologies for data management, GIS, and statistical analysis;
- Participate actively in the international PGR conservation and utilisation community;
- Navigate ethical and moral considerations in the conservation and use of PGR diversity for global benefit.

4. Who Requires Training?

For PGR conservation to be both efficient and effective, enhanced education and awareness are required across sectors—professionals, collaborating stakeholders but also interested farmers, and public. Historically, professionals working across various PGR-related fields—policy, *ex situ* and *in situ* conservation, genetic research, and applied science—have often operated in isolation from each other. Meanwhile, end-users, including consumers, have generally lacked understanding of PGR's role in food security. This disconnect has impeded collaboration and limited the potential of conservation efforts.
Bridging this gap is essential. Conservation success depends on community support, as biodiversity is ultimately conserved or lost at the local level. While policies may be enacted nationally, their implementation depends on local engagement. Therefore, awareness at the community level is critical. Public awareness can be promoted through various strategies, including:

- Media campaigns (print, radio, television, online);
- Educational materials and outreach;
- Public visits to genebanks, genetic reserves, and on-farm conservation sites;
- Community and school programmes (e.g., biodiversity gardens, local ranger schemes, amateur naturalist clubs);
- Eco-tourism and ethnobotanical projects;
- Local conservation grants and designations of areas for special scientific interest.

Support from an informed public is a valuable asset that must be cultivated through coordinated efforts of formal and informal conservation actors.
Building awareness, education, and capacity among professional stakeholders is equally essential. Universities, colleges, and specialist agencies such as National Agricultural Research Centres (NARCs), sub-regional institutions like NordGen, and European CGIAR centres (e.g. the Alliance of Bioversity International and CIAT) play a central role in delivering formal training.

Training can take the form of:

- Specialist modules within broader biology or environmental courses;
- Programmes specifically tailored to PGR conservation professionals.

It is crucial that professionals across the biological sciences, agronomy, and conservation disciplines receive foundational instruction in PGR principles, genetic conservation, and sustainable use. This necessitates the integration of core PGR modules into vocational and undergraduate training programmes.

Key Considerations for PGR Capacity Building in Europe

- **Review current training offerings and needs:** This could involve commissioning a consultant to evaluate existing activities in collaboration with national institutions, ECPGR, and regional IARCs.

- **Prioritise training topics:** Within the interdisciplinary PGR field, identify subjects requiring immediate attention.
- **Designate training centres of excellence:** Select universities capable of offering postgraduate vocational degrees and practical short courses in PGR. Establishing such programmes will require curriculum development, staff training, and adequate resources. Delivery in local languages is encouraged to ensure accessibility.
- **Designate PGR research centres of excellence:** These may include research institutes, NGOs, and universities with strong PGR expertise, capable of offering specialised training independently or in partnership with academic institutions.
- **Identify priority personnel for training:** Establish mechanisms to identify key individuals and determine the appropriate training levels and durations. This may include M.Sc. and Ph.D. programmes.
- **Strengthen the research base of training centres:** Ensure long-term funding to support a robust research environment that enhances the centre's training reputation.
- **Foster partnerships between centres:** Encourage twinning arrangements between centres of excellence and other PGR facilities to facilitate skill and technology exchange.
- **Engage International Agricultural Research Centres (IARCs):** Collaborate with IARCs to expand training opportunities and include participants from beyond Europe where feasible.
- **Develop sustainable training frameworks:** Regional centres should coordinate short courses in priority topics with support from national and regional partners. Long-term funding must be secured to ensure continuity.
- **Monitor and evaluate outcomes:** Regular assessment of training impact is essential. Trainees should be supported post-training to effectively apply their new knowledge and skills.
- **Increase public engagement:** Strengthening extension services and launching awareness campaigns is crucial to secure community and farmer involvement in conservation efforts.

A European genebank quality management system should aim to establish a robust network of high-quality genebanks. Achieving this requires equipping all relevant institutions and professionals with the necessary knowledge and skills for the effective conservation and sustainable use of PGR. A structured capacity-building process—beginning with baseline assessments and followed by tailored training initiatives—can ultimately lead to certification and best practice adoption across *ex situ, in situ*, and on-farm conservation domains.

5. Previous Activities Supporting Capacity Building for Genebanks

The foundation for capacity building in European genebanks has already been laid through several key initiatives led by the European Cooperative Programme for Plant Genetic Resources (ECPGR). Among these, the outcomes of monitoring activities conducted during peer review exercises—funded under Horizon projects—have played a significant role (see: ECPGR Peer Visits).

A major milestone was the development of a genebank "peer review" mechanism, first conceptualised at the 2018 workshop *"Assessing Current Practices and Procedures to Strengthen AEGIS"* in Madrid, Spain. This concept involves mutual visits between genebanks, with each visit resulting in a report containing observations and actionable recommendations to enhance genebank performance. The first cycle of peer reviews was piloted in early 2019 through the GenRes Bridge project, involving three genebanks.

Building on this, the AGENT project organized four additional peer review cycles, during which 12 genebanks were reviewed. ECPGR has compiled and made publicly available the findings of these

evaluations, which have proven invaluable in identifying key areas where training and capacity building are most urgently needed.

Another crucial reference is the **Plant Genetic Resources Strategy for Europe** (ECPGR, 2021). This strategic document outlines specific areas within PGR conservation and utilisation that require further development, thus guiding the focus of capacity-building efforts. The strategy explicitly emphasizes the importance of education and both short- and long-term training programmes as integral components of a robust conservation system.

The PGR Strategy is closely aligned with the **Genetic Resources Strategy for Europe**, developed under the GenRes Bridge initiative. Together, these strategies reinforce and complement actions and objectives set out under broader EU policy frameworks, such as the **EU Green Deal**, **Farm to Fork Strategy**, and the **EU Biodiversity Strategy for 2030**.

A key outcome of the strategy in relation to capacity building is the promotion of **knowledge exchange on methodologies and protocols** for characterisation and evaluation. This involves stronger collaboration between genebanks, crop research institutions, breeding programmes, and farmers' organisations—ensuring that best practices are widely shared and effectively implemented across the entire PGR value chain.

6. The Scope of the Capacity Building Blueprint

This Capacity Building Blueprint is designed to be applicable to all key stakeholders involved in plant genetic resources (PGR) conservation globally. It addresses the needs of international, regional, and national genebanks, as well as specialised germplasm collections and collections managed by non-governmental organisations. The Blueprint is relevant to all types of conservation efforts, preferably ***ex situ,*** but also ***in situ***, and **on-farm** approaches. While it also broadly covers ***in vitro*** collections, it does **not** include guidance on **cryopreservation** techniques.

The overarching aim is to support PGR conservation actors in developing the competencies and systems necessary to potentially attain certification. While certification is not mandatory, it is encouraged as a desirable outcome—serving as a benchmark for operational quality and commitment to international standards. Certification should particularly be considered by:

- **National genebanks**, receiving substantial government or institutional support.
- **Consortia of decentralized genebanks** operating under national or regional coordination frameworks.
- **Specialised genebanks** with unique or nationally significant collections.

Another kind of certification process should be considered also for:

- **Actors involved in targeted *in situ*/on-farm conservation initiatives**, particularly those maintaining locally adapted landraces or crop wild relatives.

The Blueprint aims to address all key thematic areas necessary for strengthening institutional capacity and for supporting genebanks and conservation networks in reaching and sustaining high-quality operational standards. To inform this programme, a structured questionnaire has been developed to

assess the current status and capacity-building needs of genebanks and *in situ*/on-farm networks across participating countries.

7. The Quality Management System in Genebanks

Quality management is the act of overseeing all activities, tasks and processes that are required to maintain a desired level of quality of products and/or services. Several genebanks have adopted the ISO 9001 standard for quality management, thereby ensuring compliance with established protocols, effective risk mitigation, and the integration of continuous improvement mechanisms—including procedures for handling user feedback and complaints (van Hintum, 2025, in press). The Global Crop Diversity Trust has developed the Genebank Quality Management System (GQMS) and has actively supported its implementation across CGIAR genebanks (Lusty et al., 2021). Furthermore, the **FAO Genebank Standards** (FAO, 2014) define a set of essential requirements for the proper functioning of genebanks, providing a common framework for quality assurance. Practical aspects of genebank operations are addressed in the *Manual of Seed Handling in Genebanks* (Kameswara Rao et al., 2006).

The plant genetic resources (PGR) community in Europe is notably diverse, comprising hundreds of genebanks with varying objectives, sizes, and operational methodologies (FAO, 2025). This heterogeneity has resulted in widely differing levels of operational capacity and quality among European genebanks. A genebank seeking to be certified will need to implement a quality management system that allows an auditor to assess whether the genebank operates at an adequate quality level and complies with the requirements as formulated in the Genebank Quality Standards (van Hintum, et al. 2025).

In addition to existing standards and guidelines, it is critical to integrate genebank operations and quality management into broader capacity-building efforts. The capacity building should highlight enhancing transparency regarding the composition, management, and utilization of genebank collections. It would greatly contribute to the optimization and rationalization of genebank systems and their long-term sustainability.

8. Relation to the GRACE Research Infrastructure

This Capacity Building Blueprint was developed under the framework of the EU-funded project **PRO-GRACE**, which is working to prepare the foundation for the proposed pan-European **GRACE Research Infrastructure (GRACE-RI)**. GRACE-RI aspires to connect and enhance collaboration among European institutions engaged in the conservation and characterisation of PGR.

As part of the PRO-GRACE deliverables, this document—**Deliverable D2.4, "Blueprint for Capacity Building Programme for Genebanks and *In situ*/On-Farm Conservation Networks"**—serves as a foundational reference for supporting the **certification process** in genebanks and conservation networks. It forms a key element in ensuring that GRACE-RI is supported by a network of competent, well-resourced actors capable of meeting the quality standards required for participation in a pan-European infrastructure.

The proposed European Capacity Building Programme, envisioned to be coordinated through GRACE-RI's central hub, will act as a **template for national capacity-building initiatives**. These national programmes should be **translated into local languages** and adapted to reflect **country-specific legal, institutional, and environmental contexts**. The supporting questionnaire conducted under this framework has mapped existing capacities and highlighted country-specific needs.

Importantly, while this Blueprint is part of the PRO-GRACE project, it is designed to be **implementable independently** of GRACE-RI's formal establishment. This ensures flexibility and immediate usability by any interested stakeholder.

A central objective of GRACE-RI is to **enhance the role of genebanks in research and development**, including active participation in genomic characterisation and data-driven analysis. This may entail the generation and interpretation of **genotyping and phenotyping data**, as well as the development of **pipelines for predictive analysis** aimed at identifying traits of interest for sustainable agriculture and breeding.

9. Eligibility of Genebanks and Conservation Networks

Eligibility for inclusion in the Capacity Building Programme will be determined with the overarching goal of supporting all European genebanks in achieving the quality standards required for certification. This, in turn, will enhance their ability to contribute effectively and transparently to the long-term conservation of plant genetic resources (PGR) and to guarantee full access to conserved materials.

Training materials developed under the programme will be made openly available to all interested users. However, the GRACE Research Infrastructure (GRACE-RI) may also offer **targeted workshops and training sessions** for institutions in member countries, tailored to their specific needs and capacities.

The capacity building framework consists of **two levels of implementation**:

- **Central-level programmes**, coordinated by GRACE-RI's central hub, will focus on general, cross-cutting topics that benefit from pan-European alignment and knowledge exchange.
- **National-level initiatives** will address country-specific needs, contextualised to national policies, legal frameworks, institutional capacities, and linguistic environments. These initiatives should prioritise **national PGR networks and genebanks** maintaining collections of national significance.

In countries with **decentralised PGR systems**, where collections are maintained across multiple institutions, eligibility will require the presence of a **coordinating structure**—such as a national PGR programme or a designated authority mandated by the relevant ministry (e.g. agriculture or environment).

By contrast, **small-scale seed-saving initiatives or farmer-led activities not primarily focused on conservation** are not considered eligible for direct capacity building support within the scope of this programme. However, **specialised crop genebanks**, particularly those maintaining comprehensive collections of **locally significant or endangered genetic resources**, **may qualify** for support, subject to national coordination.

This eligibility framework has been informed by the outcomes of multiple peer reviews conducted within the **HORIZON 2020 AGENT project (grant agreement no. 862613)**. These reviews revealed that a major priority for capacity building is the need to **clarify operational standards and certification thresholds**, particularly for both ***ex situ*** and ***in situ*/on-farm** conservation actors.

10. Selection Criteria for Target Genebanks

Support under the Capacity Building Programme will be directed mainly to genebanks but also to *in situ*/on-farm conservation networks that fulfil the following eligibility and selection criteria:

10.1. Priority Target Groups

- **National genebanks** that conserve plant genetic resources (PGR) of national importance.
- **Institutions operating under the umbrella of a national PGR programme** or officially authorised by relevant national or regional ministries (e.g. agriculture, environment).
- **Decentralised networks**, such as those in Spain or France, will be addressed at the network level through collaboration with **network coordinators**, rather than via support to individual institutions.
- **Small and local genebanks,** and ***in situ*/on-farm conservation networks** holding collections predominantly composed of local material crucial for rescue and conservation purposes. These entities often have **greater training needs** than large, well-established genebanks.

10.2. Minimum Operational Standards for Genebanks

To be eligible, institutions must meet the following minimum requirements:

- **Collection size**: A minimum of **1,000 accessions** is recommended.
- **Financial stability**: A clear financial strategy ensuring long-term sustainability, with stable funding sources (e.g., national governments, institutional support, or long-term grants) covering core operational needs, such as staff, infrastructure, and conservation activities.
- **Infrastructure and quality commitment**:
    - Appropriate storage facilities (e.g., seed storage rooms, in vitro laboratories).
    - Functional laboratories and equipment for germplasm viability testing.
    - Secure and transparent **documentation and data management systems**.
- **Risk management**: Established **agreements with partner institutions** for long-term safety duplication and contingency planning for emergencies (natural disasters, political risks, financial instability).
- **Legal and ethical compliance**:
    - Willingness to share germplasm under the **Standard Material Transfer Agreement (SMTA)**.
    - Adoption of **internationally recognized best practices** in conservation and access.

10.3. Requirements for *In Situ*/On-Farm Networks

In situ/on-farm conservation networks must meet the following criteria:

- Focus on the **conservation of crop wild relatives (CWR), landraces, or traditional varieties** aligned with national, regional, or international PGR strategies and priorities.
- Possess a **coordinating structure** (e.g., national conservation programme, farmers' association, or research institution) and demonstrate long-term commitment, including the presence of trained personnel or stakeholders.
- Maintain **up-to-date records** of conserved populations, their locations, status,
- **Financial stability**: A clear financial strategy ensuring long-term sustainability, with stable private or other funding sources covering core management needs.
- **Risk management**: Established **agreements with National genebank/ National Programme for PGR conservation** for sustainable, long-term conservation and contingency planning for emergencies (natural disasters, political risks, financial instability).
- Maintain **up-to-date records/databases** of conserved populations, their locations, status, and management practices. The databases are recommeded to be linked to the national documentation system.
- Participate directly in **national and international PGR databases** to ensure transparency and accessibility of conservation data.

- **Legal and ethical compliance**:
    - Sharing germplasm under the **Standard Material Transfer Agreement (SMTA)** directly or via liason institution (Genebank)
    - Adoption of internationally recognized best practices in conservation and access.

In case of *in situ*/on-farm networks the capacity building should increase knowledge of involved stakeholders that should lead to a proper way of sustainable conservation of material in order to keep its genetic intergrity. It may also lead to the certification, but it is not the primary aim as it is in case of genebans.

11. Program Components of Capacity Building

11.1. Genebank Assessment

Conduct comprehensive assessments of selected genebanks to identify specific needs and gaps through structured peer reviews.

• **Form assessment teams:** Include experts in genebank management, genetic resource conservation, and data management.
• **Develop assessment criteria:** Standardized criteria should cover infrastructure, equipment, staffing, procedures, and compliance with international standards.
• **Conduct site visits:** Evaluate genebanks in person to gather data and insights.
• **Stakeholder interviews:** Engage with staff, management, and stakeholders to understand challenges and opportunities.
• **Data analysis:** Identify strengths, weaknesses, and areas for improvement.
• **Report findings:** Produce a detailed report for each genebank with specific, actionable recommendations.

11.2. Capacity Building for National /Recognized Genebanks

Provide targeted support to national genebanks, based on assessment findings.

• General capacity building for genebanking
• Quality management systems and implementation
• Development of tailored genebank management plans
• Training in operations and strategic management
• Addressing specific needs identified in peer reviews

11.3. *In Situ*/On-Farm Assessment

Evaluate the structure and functioning of *in situ* and on-farm conservation networks.

• **Form assessment teams:** Include *ex situ* crop curators, genebank experts, agroecologists, botanists, genetic resource specialists fro academia, conservation practitioners, and optionally social scientists (for farmer engagement) and legal experts (for compliance).
• **Develop assessment criteria:** Include diversity conserved (CWR, landraces, traditional varieties), suitability of conservation practices, knowledge transfer, financial stability, and alignment with legal/institutional frameworks (e.g., ITPGRFA, Nagoya Protocol).
• **Conduct site visits:** Evaluate site management, threats (e.g. land use, climate risks), and ecosystem fit.
• **Stakeholder interviews:** Engage with farmers, communities, cooperatives, NGOs, policymakers, and collaborating institutions.
• **Data analysis and reporting:** Identify needs for infrastructure, training, or policy support. Report findings and recommendations per network.

11.4. Capacity Building for *In Situ*/On-Farm Networks

Deliver tailored support to strengthen local conservation systems with respect:

• To cover all needs for sustainable conservation mechanism, all processes and logistics

- To cover all desired materials (selected most appropriate populations, all available landraces)
- Technical support, e.g., development or enhancement of monitoring tools

• Training and knowledge exchange between genebank crop curators, researchers, practitioners, and farmers

11.5. Trainings and Workshops

Organize structured trainings across all dimensions of PGR conservation.
Topics include:

• Genebank operations and quality management
• Seed handling and storage (e.g., optimal drying, manipulation, longevity techniques)
• Germination and viability testing using international standards; optional automation (robotics, imaging)
• Collection and documentation of PGR
• Conservation biology and ecology – updates on methods for CWR, WFP, WHP
• Seed science and longevity
• Conservation site management – disturbance, succession, sustainability
• Regeneration of seed-propagated plants – plot size, isolation, pest control, etc.
• Management of vegetatively propagated crops – herbs, bulbs, tubers, trees, vineyards
• Characterization and evaluation using descriptors and multi-year trials
• PGR documentation systems – requirements for national/international integration (e.g., EURISCO, GRIN-Global)
• Collection planning and handling – mission planning, data collection, processing
• *In vitro* conservation – protocols, media, temperature, passaging
• Voucher specimens – herbarium, seed/fruit/spike collections, regeneration cycle traceability
• On-farm management – integration with national policies, GB collaboration, access to material
• *In situ* conservation – governance (ENVI/AGRO), site management, liaison with GBs
• Monitoring – indicators for conservation status and system performance
• Cryopreservation – principles, protocols for vegetative species, regeneration capacity

11.6. Mentorship and Internships

Facilitate hands-on learning and knowledge transfer.

• Pair junior professionals with experienced mentors in genebanks or *in situ*/on-farm contexts
• Enable staff exchanges between institutions
• Organize internships and consultancies
• Provide targeted expert guidance on technical or strategic topics

11.7. Online Learning and Web Resources

Develop digital infrastructure to support long-term learning.

• Comprehensive website with manuals, SOPs, and training resources
• Online courses and webinars on conservation topics (*ex situ, in situ*, on-farm)
• In-person courses delivered with partner institutions on a regular basis

11.8. Recommendations for Upgrades

Provide expert recommendations to bring operations in line with international standards.

• Modernize seed-banking infrastructure
• Improve management systems and germination testing
• Enhance or introduce cryopreservation technologies where applicable

11.9. Networking and Collaboration

Strengthen professional and institutional collaboration.

• Establish a dynamic expert network across *ex situ, in situ*, and on-farm conservation
• Organize a recurring programme of events: annual assemblies, thematic workshops, and webinars

11.10. Fellowship Programme

Promote capacity development through research and training opportunities.

- Offer fellowships for early-career researchers and practitioners
- Focus areas: advanced PGR research, genebank innovation, *in situ*/on-farm conservation strategies

12. Target Audience:

The capacity building programmes will be tailored to the distinct needs of various target groups, acknowledging that each community plays a unique role in the conservation and sustainable use of plant genetic resources (PGR). Programmes will address both general and specialized competencies.

Target groups include:

- **Researchers** affiliated with national genebanks or partner institutions (e.g., coordinating bodies, universities, research organizations)
- **Practitioners** working in national genebanks, seed companies, agricultural organizations, and conservation networks.
- **Practitioners** working in *in situ*/on-farm conservation networks.
- **Students** pursuing advanced degrees in plant biology, genetics, agronomy, biodiversity, or related fields.
- **Government officials** responsible for agriculture, biodiversity, and environmental policy.
- **The general public**, especially those engaged in citizen science, local conservation initiatives, or seed saving.

Each group is expected to have specific capacity building needs. Therefore, dedicated training tracks and content will be developed for managers, researchers, students, policymakers, and broader audiences.

13. Questionnaire on Capacity Building Needs

Survey Structure

A key step in designing an effective capacity building programme is validating the actual needs of stakeholders. To this end, a structured questionnaire was developed covering six core thematic areas relevant to PGR conservation.

To go beyond identifying needs, the questionnaire also assessed the **existing capacity** within the community that could support peer-to-peer learning. Thus, each topic was addressed by **paired questions**:

- **Odd-numbered questions** assessed **capacity building needs** (e.g., "Do you NEED training in...?")
- **Even-numbered questions** assessed whether the respondent could **offer capacity building** in that area (e.g., "Can you PROVIDE training in...?").

Table 1. Questionnaire Structure and Thematic Areas

Topic no	Question	**Topic content**
1	Q. 5, 6	**General information**

		General information on PGR conservation needs, international agreements (CBD, FAO, CGRC, ITPGRFA, ECPGR,…)
2	Q. 7, 8	***Ex situ* conservation of seed propagated spp.** Quality management: improved management of genebank/ *in situ*/on-farm collections
	Q. 9, 10	Seed conservation: documentation of seed handling processes, standards and thresholds in genebanks
	Q. 11, 12	Regeneration processes for self and outcrossing spp, planning and execution of regeneration cycles, space and technical isolation, pollination, pollinators
	Q. 13, 14	Characterization and evaluation: Plot size, descriptor lists, replication, uploading of mean data, storing of annual data
3	Q. 15, 16	***Ex situ* conservation of vegetatively propagated spp.** Quality management: improved management of vegetatively propagated ex situ collections/ *in situ*/on-farm collections
	Q. 17, 18	Field nurseries, orchards, vineyards, hop plantations etc. Methodology, minimum/optimum numbers, evaluation, pest management, sample distribution
	Q. 19, 20	*In vitro* techniques: methodology, general and specific protocols.
	Q. 21, 22	Cryopreservation: safety duplication for mainly vegetatively propagated crops, methodology, general and specific protocols
4	**4** Q. 23, 24	**Documentation** Passport, characterization and evaluation data, seed storage system data, data on regeneration cycles, documentation of plots/trees of vegetatively propagated spp.
5	**5** Q. 25, 26	**On-farm conservation** Basic principles, different methodologies, national specificities, main or secondary collection to ex situ, distribution
6	**6** Q. 27, 28	***In situ* conservation** Basic principles, within/ouside of protected areas, collaboration with environmental sector, availability of samples, availability via liaison institute/Genebank, via ex situ, monitoring
7	7 Q. 29, 30	**Technical support, equipment and staff needs** Need for technical support /advice
	Q. 31, 32	Equipment for sustainable PGR conservation: advice for necessary minimum or advanced equipment

Survey Implementation

The questionnaire was developed in collaboration with ECPGR using Google Forms under the title *"Quick Survey on Capacity Building for Genebanks."* It was distributed by email to a broad European PGR stakeholder network, targeting three main groups:

- Forum of Genebank Managers
- On-Farm Conservation Working Group (ECPGR)
- *In Situ* Conservation of Crop Wild Relatives (CWR) Working Group (ECPGR)

Response Rate:
A total of **28 responses** were received from stakeholders across the European region.

Respondents were also given the opportunity to elaborate on their answers in free-text form, specifying particular **needs** or **offers** in capacity building.

These qualitative and quantitative responses are summarized by topic in **Appendix 3**, with detailed tables highlighting the specific areas where support is most needed and where capacity exists to support others.

13.1. The needs

Table 2. General information on PGR (I)

Q. No.	Answers	Respondent
5	Just periodic updates	CRA-W Fruit, BE
5	General information on PGR conservation needs, ECPGR	GB Medic, SI
5	in all international agreements, for the young employees.	GB Suceva, RO
5	PGR conservation needs -seed drying	GB Tbilisi, GZ
5	PGR conservation needs and International agreements	GB Tirana, AL
5	PGR conservation	GB, AZ
5	Capacity building is always useful to learn about new developments in the field or to train new/younger colleagues in all the specified areas.	KIS, Ljublana, SI
5	Documents on *in situ* and on-farm conservation planning and implementation	N. Maxted, UK
5	it would be useful to have advice on new developments around ITPGRFA and CBD etc.	NatFruit, UK
5	international agreements, ECPGR	RI Pitesti, RO
5	mainly get information regarding those agreements comming into practice PGR managment, like ECPGR, CBD.	VSUO Holovousy, CZ

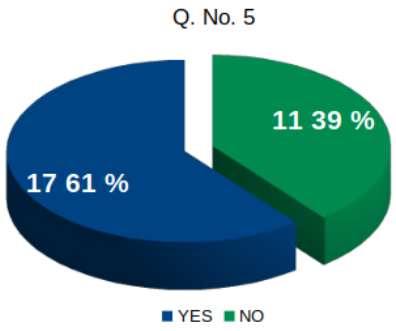

Figure 1. Responds to question 5. **General information**
In total, 17 respondents (61%) of expressed the needs for capacity building in General topics, often for new and young staff. There is a need for periodical updating information on ECPGR, ITPGRFA, CBD and other relevant organisations.

Table 3. EX SITU – seed propagated species (I)

Q. No.	Answers	Respondent
7	Quality management training of genebank and on-farm collections; how are on-farm collections established and maintained; any agreements that are required with third parties for the management of these collections; regeneration activities and how regeneration is managed, particularly for species with poor reproductive potential and correspondingly small wild populations.	GB Malta, MT
7	we need capacity building on improved management of genebank	GB Min Serbia, RS
7	in all areas, for the young employees.	GB Suceva, RO
7	Quality systems for genebanks	GB Tbilisi, GZ
7	quality management of ex situ collection	Hop RI, SI
7	Capacity building in all the areas would be useful as for the reasons indicated above (new developments in the field, to train younger staff members).	KIS, Ljublana, SI
7	phytosanitary tests, germination tests, molecular sequencing (we hand these activities over to external partners) because of the lack of infrastructure	ProSpRara, CH
7	but French BRC4Plantgenebanks conserving seeds would like to participate in a group to share experiences	RarePlants, FR
9	Yes; training on seed handling of small seeded species such as Papaver, Poa or Valerianella seeds; training on establishing thresholds for storage of germplasm for small island populations.	GB Malta, MT
9	Yes: documentation of seed handling processes, standards and thresholds in genebanks	GB Medic, SI
9	Yes, we need capacity building on seed conservation	GB Min Serbia, RS
9	Yes, seed conservation documentation, standards, and thresholds in genebanks: Seed Handling & Processing Documentation, - Genebank Standards & Quality Control - Data Management & Digital Records	GB Piestany,SK
9	Seed conservation: documentation of seed handling processes, standards and thresholds in genebanks'	GB Tbilisi, GZ
9	Yes; standards and thresholds in genebanks	GB Tirana, AL
9	Yes, seed conservation	GB, AZ
9	Yes. Standards and thresholds in genebanks	GB, AZE
9	For younger colleagues, to get experience also from other genebanks.	KIS, Ljublana, SI
9	Yes in terms of In *situ* and on-farm conservation planning and implementation, and ex situ backup storage	N. Maxted, UK
9	Yes when it comes to a standardization to be informed about new standards and how to apply them	ProSpRara, CH
9	No, but French BRC4Plant genebanks conserving seeds would like to participate in a group to share experiences	RarePlants, FR
13	Yes; training particularly for techniques for the characterization of yet unregistered landraces, and characterization of CWR; training on pre-breeding selection for CWR	GB Malta, MT
13	Yes: descriptor lists, replication, uploading of mean data, storing of annual data	GB Medic, SI
13	Yes, we need capacity building on characterization and evaluation	GB Min Serbia, RS

13	Yes, Trial Design – Optimal plot size, replication, and layout for accurate evaluation. - Descriptor Lists – Standardized trait documentation for characterization. - Data Management – Uploading, storing, and managing annual data effectively.	GB Piestany,SK
13	Yes, for the young employees, in all areas,	GB Suceva, RO
13	Yes. Data management and statistics	GB Tapio, HU
13	Yes - Characterization and evaluation: Plot size, descriptor lists, replication, uploading of mean data, storing of annual data for wheat crops	GB Tbilisi, GZ
13	Yes: Characterization and evaluation; uploading of mean dat, storing of annual data	GB Tirana, AL
13	Yes. Methods of characterization and evaluation	GB, AZE
13	Yes, for younger colleagues to get experience from other genebanks and other crops.	KIS, Ljublana, SI
13	Yes to certain extend. We do that already on an national level.	ProSpRara, CH
13	No, but French BRC4Plant genebanks conserving seeds would like to participate in a group to share experiences	RarePlants, FR
13	Yes, storing of annual data	VSUO Holovousy, CZ

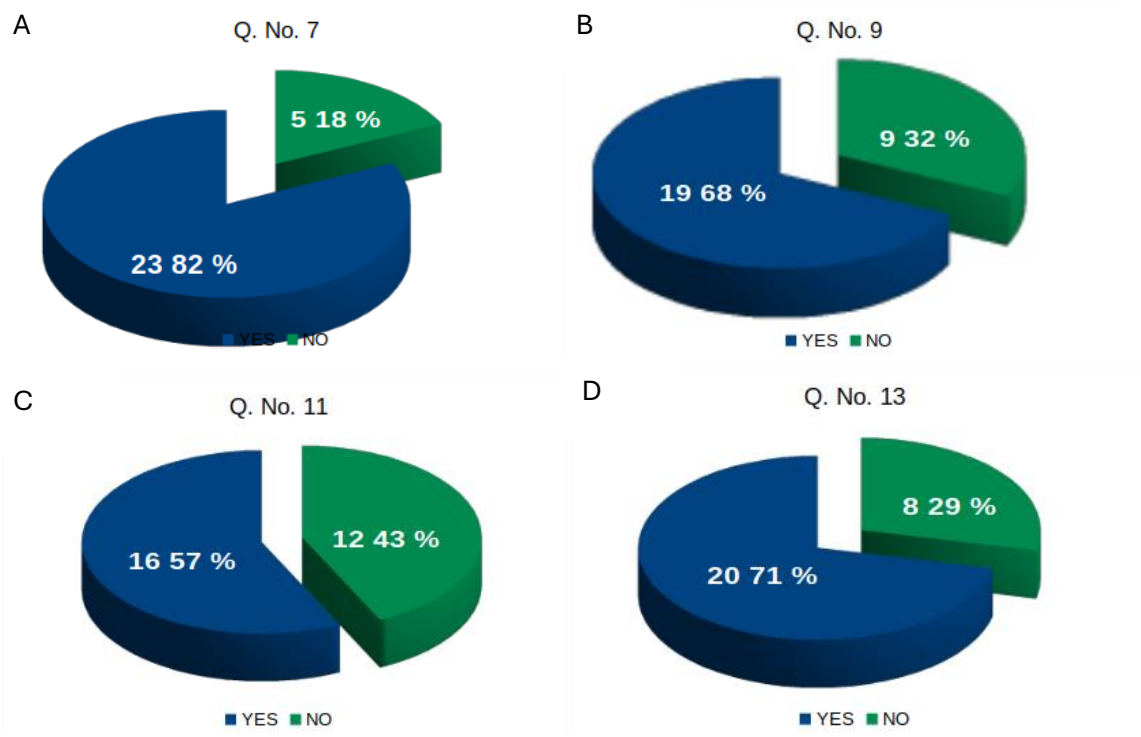

Figure 2. A) Responds to question 7. Quality management. B) Responds to question 9. Seed conservation. C) Responds to question 11, Regeneration processes. D) Responds to question 13. Characterization/evaluation

Within the topic 2 – *Ex situ* conservation of seed propagated plants, 19 respondents (68%) expressed the needs for capacity building in quality management. It shows a very good will of respondents to evaluate and improve their genebanking processes.

The question 9 mentioned 16 respondents (82%) and expressed the needs for capacity building in genebanking a documentation. Similarly, many responses were on the questions 11 and 13 – requesting regeneration and characterisations capacity building.

Table 4. EX SITU – vegetatively propagated species (I)

Q. No.	Answers	Respondent
15	Yes, all of the above mentioned	AGES, AT
15	Yes: *in situ*, on-farm collections	GB Medic, SI
15	Yes, on quality management of vegetatively propagated ex-situ collections	GB Min Serbia, RS
15	Yes, improved management of vegetatively propagated - *Ex Situ* Collection Management – propagation, and disease-free material maintenance. - Field management, farmer participation, and sustainability. - Quality Control – Health testing, genetic integrity, and data documentation.	GB Piestany,SK
15	Yes, for the young employees, in all areas.	GB Suceva, RO
15	Yes; Improved management of vegetatively propagated ex situ collections	GB Tirana, AL
15	Yes, quality management of vegetatively propagated ex situ collection	GB, AZ
15	Yes, especially for management of *in situ*/on-farm collections.	KIS, Ljublana, SI
15	Yes - *In situ* and on-farm conservation planning, implementation and management	N. Maxted, UK
15	Yes - in terms of general management standards	NatFruit, UK
15	only when it comes to cryo-conservation	ProSpRara, CH
15	No, but French BRC4Plant genebanks conserving vegetatively propagated crops would like to participate in a group to share experiences	RarePlants, FR
15	YES (*ex situ* collections for fruit trees species, rootstocks and small berries)	RI Pitesti, RO
15	Yes- *in situ* conservation.	VSUO Holovousy, CZ
17	Yes; training on management of regenerated accessions; how to prevent genetic drift if plot areas available are small; how to manage quality for on-farm collections if these are subcontracted to third parties;	GB Malta, MT
17	Yes: Methodology, pest management, sample distribution	GB Medic, SI
17	Yes, for the young employees, in all areas.	GB Suceva, RO
17	Yes. Evaluation and pest management.	GB Tapio, HU
17	Yes. Methodology, evaluation	GB, AZ
17	Yes, paticularly related to sample distribution (e.g. vineyards, phytosanitary regulation)	KIS, Ljublana, SI
17	Yes in *in situ* or onfarm sample distribution	N. Maxted, UK
17	Yes - in terms of general management standards	NatFruit, UK
17	No, but French BRC4Plant genebanks conserving vegetatively propagated crops would like to participate in a group to share experiences	RarePlants, FR
19	Yes. *In vitro* culture of fruit crops	GB Tapio, HU

21	Yes; training on meristem extraction and storage protocols under LN2	GB Malta, MT
21	Yes: safety duplication for mainly vegetatively propagated crops	GB Medic, SI
21	Yes, we need capacity building on cryopreservation	GB Min Serbia, RS
21	Yes, for all areas.	GB Suceva, RO
21	Yes : Cryopreservation of vegetatively propagated crops	GB Tirana, AL
21	Yes, cryopreservation	GB, AZ
21	yes, for the areas indicated.	KIS, Ljublana, SI
21	Yes - I think it is important that this is done in a coordinated way (and possibly through centralized facilities)	NatFruit, UK
21	NO we couldn't build up this infrastructure	ProSpRara, CH
21	No, but French BRC4Plant genebanks conserving vegetatively propagated crops would like to participate in a group to share experience, particularly on difficult genera such as Rosa or Pyrus	RarePlants, FR
21	Yes, specific protocols	RI Pitesti, RO
21	Yes, some practical knowledge a special protocols are welcome.	VSUO Holovousy, CZ

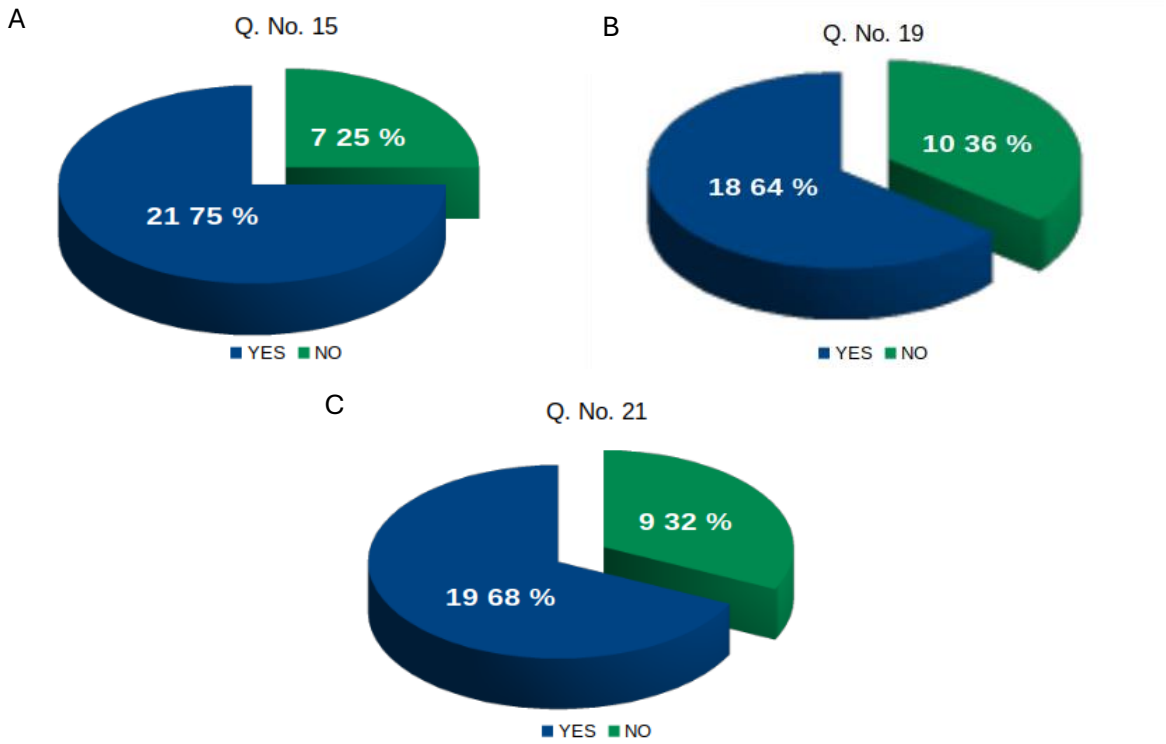

Figure 3. A) Responds to question 15. *Ex situ* conservation of vegetatively propagated spp. - Quality management. B) Responds to question 19. *In vitro* methodology. C) Responds to question 21. Cryoconservation

Within the topic 3 – *Ex situ* conservation of vegetatively propagated plants, 21 respondents expressed demands again for capacity building in quality management of field collections. 18-19 respondents requested update of knowledge in all processes of collection maintenance, including *in vitro* and cryoconservation.

Within topic 4 – Documentation, all components were in demand for capacity building - Passport, characterization and evaluation data, seed storage system data, data on regeneration cycles. In addition, capacity building on documentation of plots/trees of vegetatively propagated spp. belong to the most requested.

Table 5. Documentation (I)

Q. No.	Answers	Respondent
23	Yes; training on data management for storing diverse data, such as herbarium data, genetic data, seed distribution, etc. using systems like GRIN-Global	GB Malta, MT
23	Yes: characterization and evaluation data, seed storage system data, data on regeneration cycles, documentation of plots/trees of vegetatively propagated spp.	GB Medic, SI
23	Yes, we need capacity building on data management	GB Min Serbia, RS
23	Yes Passport, characterization and evaluation data, seed storage system data, data on regeneration cycles, documentation of plots for annual crops	GB Tbilisi, GZ
23	Yes, Seed storage system, data on regeneration, documentation atc	GB Tirana, AL
23	Yes, documentation of characterization and evaluation data	GB, AZ
23	For younger colleagues to get experience from other genebanks.	KIS, Ljublana, SI
23	Yes *in situ* or on-farm documentation	N. Maxted, UK
23	No but we would be open to learn new techniques or about new databasestructures that support these activities.	ProSpRara, CH
23	No, but French BRC4Plant genebanks would be happy to participate in a dedicated group to share their experience	RarePlants, FR
23	Yes, data on regeneration cycles	RI Pitesti, RO

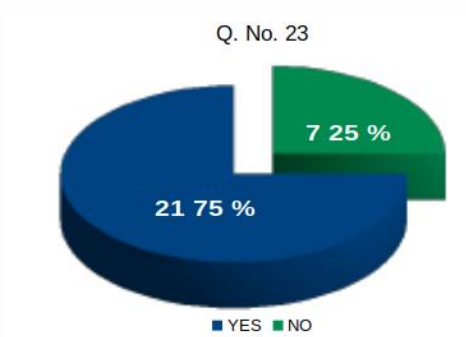

Figure 4. Responds to question 23. Documentation**.**

Within the topic 5 – On-farm conservation there was a demand for capacity building in 18 respondents, mainly basic principles and key concepts, including approaches, methodologies, management, stakeholder participation, and connection to *ex situ* collections. Distribution of seed/plant material to users is another desired item. national-specific strategies.

Table 6. ON-FARM conservation (I)

Q. No.	Answers	
25	Yes, we need capacity building on on-farm conservation	GB Min Serbia, RS
25	Yes on-farm methodologies and management	N. Maxted, UK
25	Yes, needs to be implemented first	AGES, AT
25	Yes; training on basic principles and methodologies for managing and ensuring quality in on-farm collections, particularly if establishing partnerships with third parties for the maintenance of CWR and LR.	GB Malta, MT
25	Yes: Basic principles, different methodologies, national specificities, main or secondary collection to ex situ	GB Medic, SI
25	Yes, On-Farm Conservation Principles – Key concepts and approaches. Methodologies – Management, farmer participation, and integration with ex situ collections. Distribution – Seed/plant material sharing and national-specific strategies.	GB Piestany,SK
25	Yes. Basic principles from other countries	GB Tapio, HU
25	Yes, ex-situ to on distribution methodologies	GB Tbilisi, GZ
25	Yes ; Principles and methodologies to ex situ distribution	GB Tirana, AL
25	Yes. Different methodologies	GB, AZE
25	Yes, especially for different methodologies, national specificities, main or secondary collection to *ex situ*, distribution.	KIS, Ljublana, SI
25	Yes - on basic principles	NatFruit, UK
25	Yes, just *in situ* conservation.	VSUO Holovousy, CZ

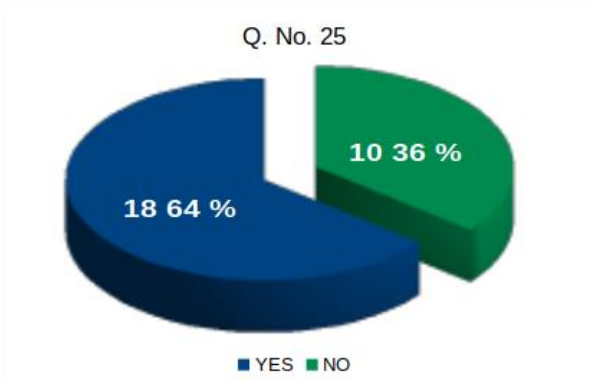

Figure 5. Responds to question 25. On-farm conservation

Within the topic 6 – *In situ* conservation of CWR there was a demand for capacity building on Basic principles, within/outside of protected areas, collaboration with environmental sector, availability of samples, directly or via liaison institute/genebank, via ex situ, monitoring, health of *in situ* populations and others.

Table 7. IN SITU conservation (I)

Q. No.	Answers	Respondent
27	Yes *in situ* methodologies and management	N. Maxted, UK
27	Yes, needs to be implemented first	AGES, AT
27	Yes; training on monitoring of genetic health of *in situ* populations and ex situ collections over time through molecular techniques	GB Malta, MT

27	Yes: Basic principles, within/outside of protected areas, collaboration with environmental sector, availability of samples, availability via liaison institute/genebank, via ex situ, monitoring	GB Medic, SI
27	Yes, we need capacity building on in-situ conservation	GB Min Serbia, RS
27	Yes, - Conservation Strategies – In and outside protected areas. - Collaboration – Working with the environmental sector and genebanks. - Sample Availability & Monitoring – Access, distribution, and tracking.	GB Piestany,SK
27	Basic principles, within/outside of protected areas, collaboration with environmental sector, availability of samples, availability via liaison institute/genebank, via ex situ, monitoring'	GB Tbilisi, GZ
27	Yes; Principles of management of protected areas	GB Tirana, AL
27	Yes. Collecting, monitoring	GB, AZE
27	Yes, for all the areas indicated except basic principles.	KIS, Ljublana, SI
27	Yes - we have very few projects like that	ProSpRara, CH
27	Yes, collaboration with environmental sector, availability via liaison institute/genebank	RI Pitesti, RO
27	Yes, *in situ* conservation, distribution via ex situ.	VSUO Holovousy, CZ
27	*in situ* management of PGRFA (collection, documentation)	GB, AZE

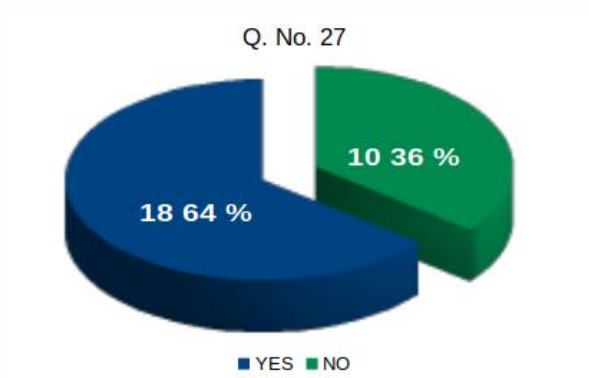

Figure 6. Responds to question 27. *In situ* conservation

Within the topic 7 – Technical support there was a wide range of demands on capacity building. Recommendation, showing best practises, advice for necessary minimum or advanced equipment were withing the frequent requests.

Table 8. TECHNICAL support

Q. No.	Answers	Respondent
29	Yes, for all.	GB Suceva, RO
31	Yes, for advanced equipment.	GB Suceva, RO
31	Yes. We miss modern green house and phenotyping system. Tractors, laboratory equipment	GB Tapio, HU
29	YES Technical support /advice'	GB Tbilisi, GZ
31	YES what kind of Equipment we need /advice	GB Tbilisi, GZ
29	Yes, but the question is not clear for us! What kind of support/advice do you mean?	GB Tirana, AL
31	Yes: We need equipment for safety conservation of germplasm accessions	GB Tirana, AL

29	Yes, technical support	GB, AZ
29	Yes. Use of new equipment	GB, AZ
29	Yes, for younger colleagues.	KIS, Ljublana, SI
31	Yes, for younger colleagues.	KIS, Ljublana, SI
29	Yes *in situ* or onfarm methodologies and management	N. Maxted, UK
31	Yes *in situ* or onfarm methodologies and management	N. Maxted, UK
29	No (but I don't really understand what this means)	NatFruit, UK
29	Yes - datamanagement, integrating digital sequencing information	ProSpRara, CH
31	Probably Yes. it depends on new developments on this field. At them moment no	ProSpRara, CH
29	No, but French BRC4Plant genebanks would be happy to participate in a dedicated group to share their experience	RarePlants, FR
31	No, but French BRC4Plant genebanks would be happy to participate in a dedicated group to share their experience	RarePlants, FR
29	Yes, technical support/advice	RI Pitesti, RO

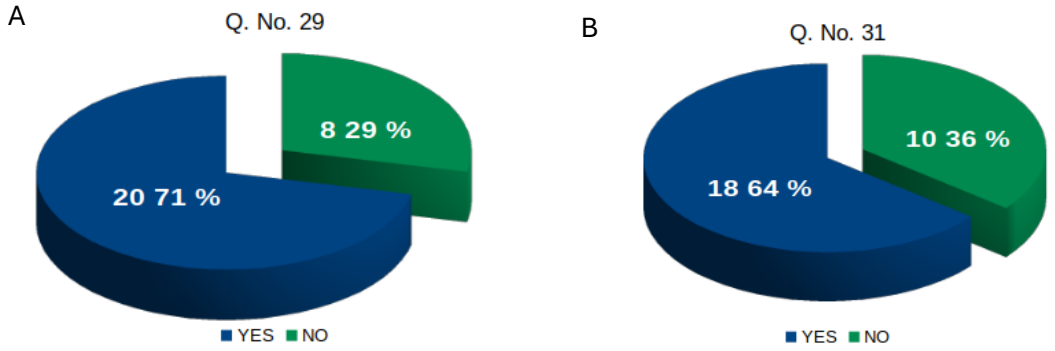

Figure 7. A) Responds to question 29, Technical questions. B) Responds to question 31. Equipment for sustainable PGR conservation.

13.2. **What the respondents can provide.**

The following tables summarize the offers made by genebankers and other stakeholders, ranging from the sharing of practical knowledge to sophisticated expertise provided by university staff.

Table 9. General information on PGR

Q. No.	Answers	Respondent
6	Yes, ITPGRFA & ECPGR	CRA-W Fruit, BE
6	yes - we have the expertise in all areas but not the capacity or infrastructure for providing training etc.	GB CGN, NL
6	Yes: PGR conservation needs	GB Medic, SI
6	Yes ; we can provide capacity building on PGR needs, but we do not have financial capacities to contract national experts for training on this field	GB Tirana, AL
6	Yes, international agreements	GB, AZ
6	No/ yes if needed	GB, CARC, CZ
6	Only to a very limited extent, with some experience in chairing the ECPGR working group.	KIS, Ljublana, SI
6	Yes - *In situ* and on-farm conservation planning and implementation	N. Maxted, UK

6	Yes for other CSB (community seed banks)	ProSpRara, CH
6	We can share knowledge, especially on French laws	RarePlants, FR
6	Yes, international agreements, ECPGR	RI Pitesti, RO

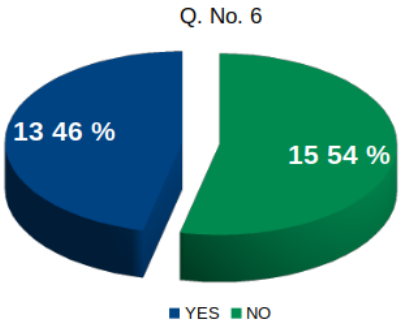

Figure 8. Responds to question 6. General information,

Altogether 13 respondents (46%) of offered capacity building in General topics, expertise in all areas often for new and young staff. There is a need for periodical updating information on ECPGR, ITPGRFA, CBD and other relevant organisations.

Table 10. Ex situ, seed propagated species (II)

Q. No.	Answers	Respondent
8	Yes, on-farm duplication of ex-situ collection, dedicated to fruit tree landraces genetic resources	CRA-W Fruit, BE
8	yes - we have the expertise in all areas but not the capacity or infrastructure for providing training etc.	GB CGN, NL
8	Yes, I can provide capacity building in: 1. Genebank Management & Seed Conservation – Storage, viability testing, regeneration protocols.	GB Piestany,SK
8	Yes, for all areas.	GB Suceva, RO
8	Quality management: improved management of genebank/ *in situ*/on-farm collections'	GB Tbilisi, GZ
8	Yes, ex situ conservation	GB, AZ
8	Yes, genebanking, seed handeling	GB, CARC, CZ
8	To a very limited extent. We have experience with quality management systems (ISO 9001 and ISTA), but less experience with improved genebank management (especially not much for *in situ*/on-farm collections).	KIS, Ljublana, SI
8	Yes (e.s. monitoring tools for on-farm management) etc.	ProSpRara, CH
8	French BRC4Plant genebanks conserving seeds could share their knowledge and know-how in a group dedicated to this type of conservation	RarePlants, FR
10	yes - we have the expertise in all areas but not the capacity or infrastructure for providing training etc.	GB CGN, NL
10	Yes: seed handling processes,	GB Medic, SI
10	Yes, for all areas.	GB Suceva, RO
10	Yes. We are open to share our practice	GB Tapio, HU
10	Yes; We can provide capacity building but we do not have financial capacities to pay national experts to carry out the training	GB Tirana, AL
10	Yes, SOP	GB, AZ

10	In part, to a limited extent.	KIS, Ljublana, SI
10	French BRC4Plant genebanks conserving seeds could share their knowledge and know-how in a group dedicated to this type of conservation	RarePlants, FR
12	yes - we have the expertise in all areas but not the capacity or infrastructure for providing training etc.	GB CGN, NL
12	Yes. We are open to share our practice	GB Tapio, HU
12	Regeneration processes for outcrossing spp, planning and execution of regeneration cycles, space and technical isolation, pollination, pollinators'	GB Tbilisi, GZ
12	Yes ; We can provide capacity building but we do not have financial capacities to pay national experts to carry out the training	GB Tirana, AL
12	In part, for the species that we are conserving.	KIS, Ljublana, SI
12	French BRC4Plant genebanks conserving seeds could share their knowledge and know-how in a group dedicated to this type of conservation	RarePlants, FR
14	Yes, especially on fruit tree genetic resources	CRA-W Fruit, BE
14	yes - we have the expertise in all areas but not the capacity or infrastructure for providing training etc.	GB CGN, NL
14	Yes, I can provide training in: - Trial Design – Plot size, replication strategies, and experimental layout. - Data Management – Uploading, storing, and managing annual and mean data.	GB Piestany,SK
14	Characterization and evaluation: Plot size, descriptor lists, replication, uploading of mean data, storing of annual data for Maize and Legumes	GB Tbilisi, GZ
14	In part, to a limited extent, as form our own experience.	KIS, Ljublana, SI
14	Yes for other CSB	ProSpRara, CH
14	French BRC4Plant genebanks conserving seeds could share their knowledge and know-how in a group dedicated to this type of conservation	RarePlants, FR

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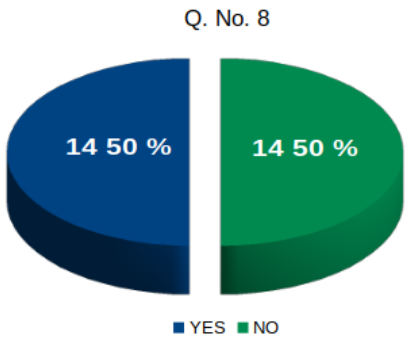

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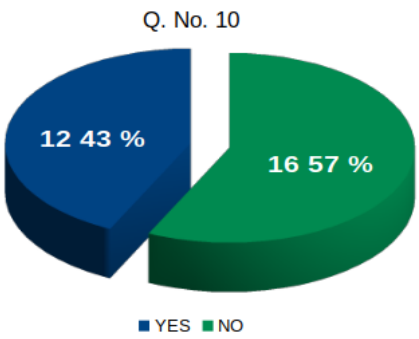

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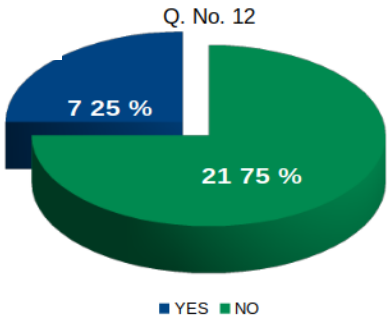

Figure 9. A) Responds to question 8 Ex situ, seed propagated species, quality management. B) Responds to question 10. Seed conservation methodology. C) Responds to question 12. Regeneration methodology.

About 7-14 % respondents (61%) of offered any kind of capacity building in Genebank Management & Seed Conservation topics, including regeneration, characterization of PGR and trial design.

The weakest topic—capacity building on ex situ conservation of vegetatively propagated species—turned out to have a relatively high number of offers. Approximately 29–39% of respondents offered support in areas such as improved management of vegetatively propagated ex situ collections, including their propagation, regeneration, and characterization. Additionally, 46% of respondents indicated they could share experience in managing **in vitro** collections, and, perhaps surprisingly, 20% reported expertise in **cryopreservation**.

Table 11. Ex situ, vegetatively propagated species (II)

Q. No.	Answers	Respondent
16	Yes, collection/conservation/utilization of fruit tree genetic resources	CRA-W Fruit, BE
16	Yes, quality management of vegetatively propagated ex situ collection	GB, AZ
16	Yes. Management of vegetatively propagated ex situ collections	GB, AZE
16	Yes, our experience	GB, CARC, CZ
16	In part, only for management of vegetatively propagated ex situ collections, obtained from our own experience (i.e. experience from collections managed within the public service on plant genetic resources in Slovenia)	KIS, Ljublana, SI
16	Yes - *In situ* and on-farm conservation planning, implementation and management	N. Maxted, UK
16	Yes – The Pome fruit and roses BRC genebank and the other French BRC4Plant genebanks conserving ex situ propagated crops could share their experience on managing such collections	RarePlants, FR
16	YES (ex situ collections for fruit trees species, rootstocks and small berries)	RI Pitesti, RO
16	No. Only on-farm collections, we have experiences.	VSUO Holovousy, CZ
18	Yes, on fruit tree genetic resources propagations methods, nursery, methodology, minimum/optimum numbers, evaluation, pest management, sample distribution on fruit tree genetic resources and vineyards	CRA-W Fruit, BE
18	Yes, our experience	GB, CARC, CZ
18	Yes, especially colleagues who manage hop genetic resources within the public service in Slovenia, but they should be contacted themselves.	KIS, Ljublana, SI
18	Yes in *in situ* or onfarm sample distribution	N. Maxted, UK
18	Yes for those species we are mandated for in Switzerland. Berries, fruit trees, weadows, vine. We collaborate closely with nurseries when it comes to propagation and commercialization.	ProSpRara, CH

18	Yes – The Pome fruit and roses genebank and the other French BRC4Plant genebanks conserving ex situ propagated crops could share their experience on such topics	RarePlants, FR
18	Yes, nursery, methodology, evaluation, pest and diseases management)	RI Pitesti, RO
18	Yes. All topics we can provide.	VSUO Holovousy, CZ
20	Yes, on potato, forest, ornamental ans fruit tree sp.	CRA-W Fruit, BE
20	Yes, in methodology.	GB Suceva, RO
20	Yes. We are open to share our practice	GB Tapio, HU
20	Yes ; We can provide capacity building but we do not have financial capacities to pay national experts to carry out the training	GB Tirana, AL
20	Yes, metodology	GB, AZ
20	Yes, safety duplication for vegetatively propagated crops, methodology, protocols	GB, AZ
20	Yes: methodology, general protocols	IICG URJ Spain
20	Yes, for potato, Allium.	KIS, Ljublana, SI
20	Yes – The Pome fruit and roses genebank and the other French BRC4Plant genebanks conserving ex situ propagated crops could share their experience on such topics	RarePlants, FR
20	Yes – The Pome fruit and roses genebank and the other French BRC4Plant genebanks conserving ex situ propagated crops could share their experience on such topics	RarePlants, FR
22	Yes, methodology, general protocols	RI Pitesti, RO
22	Yes, we can do training in the topic of cryopreservation budwoods.	VSUO Holovousy, CZ

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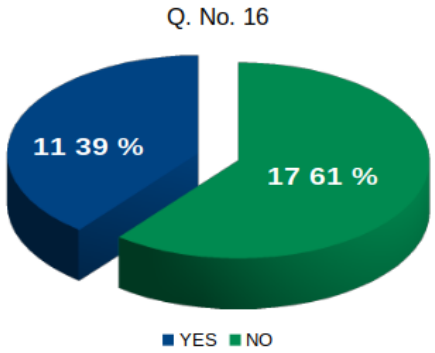

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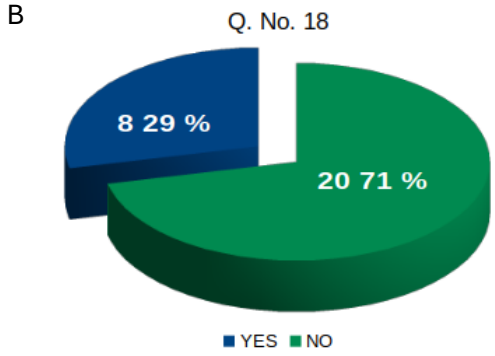

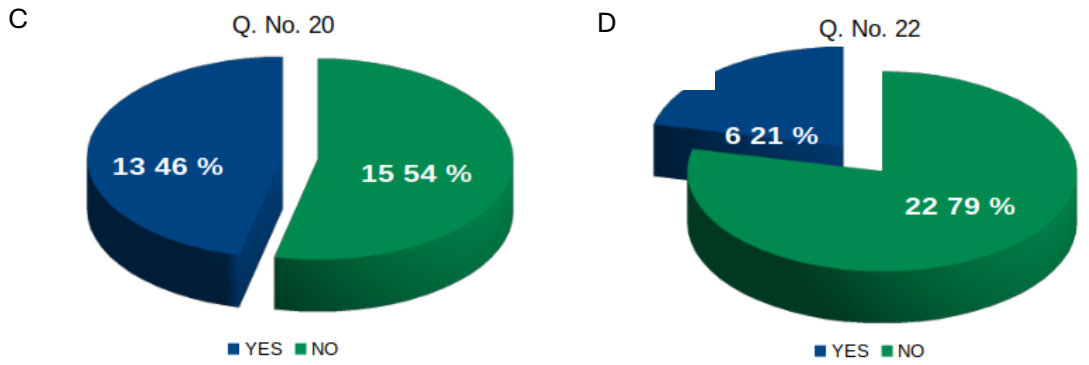

Figure 10. A) Responds to question 16 Ex situ, vegetatively propagated species, quality management. B) Responds to question 18. Field nurseries, methodology, evaluation, pest management, sample distribution. C) Responds to question 20. *In vitro* techniques, methodology. D) Responds to question 22. Cryopreservation.

Altogether 13 partners offered sharing experience from documentation, especially on passport, characterization and evaluation data. Among them the most valuable can be experience with documentation of plots/fruit trees and ornamentals of vegetatively propagated spp.

Table 11. Documentation (II)

Q. No.	Answers	Respondent
24	Yes, on Passport, characterization and evaluation data, data on regeneration cycles, documentation of plots/fruit trees and ornamentals of vegetatively propagated spp.'	CRA-W Fruit, BE
24	yes - we have much documentation expertise but not the capacity or infrastructure for providing training etc.	GB CGN, NL
24	Yes, for all areas.	GB Suceva, RO
24	Passport, characterization and evaluation data, seed storage system data, data on regeneration cycles, documentation of plots for perennial crops	GB Tbilisi, GZ
24	Yes, Passport data, seed storage system data	GB, AZ
24	Yes, experience with GRIN Czech	GB, CARC, CZ
24	In part, as from our own experience.	KIS, Ljublana, SI
24	Yes *in situ* or onfarm documentation	N. Maxted, UK
24	Yes – The French BRC4Plant genebanks could share its experience on such topics	RarePlants, FR
24	Yes, passport, characterization and evaluation data	RI Pitesti, RO

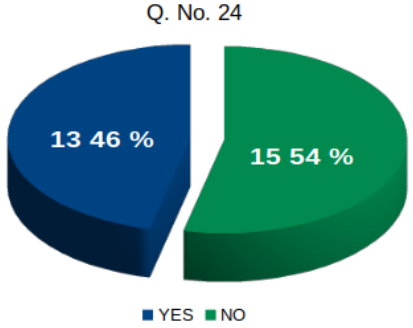

Figure 10. Responds to question 24. documentation

On-farm conservation is for most of genebanks not in their responsibility, but at least 7 respondents have experience possible to share. N. Maxted and CRA-W could provide both, wide theorethical and practical teaching.

Table 12. On-farm conservation (II)

Q. No.	Answers	Respondent
26	Yes, especially dedicated to fruit tree genetic resources and its wild-relatives sp.	CRA-W Fruit, BE
26	Yes, for all areas.	GB Suceva, RO
26	Yes, national specificities,	GB Tbilisi, GZ
26	Yes, our experience	GB, CARC, CZ
26	Yes on-farm methodologies and management	N. Maxted, UK

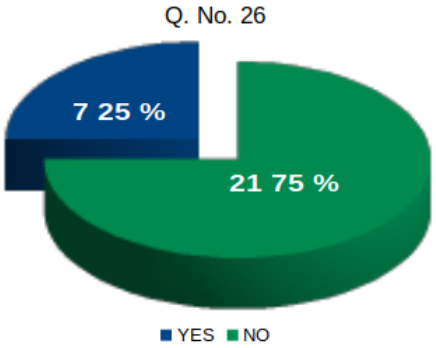

Figure 11. Responds to question 26. On-farm conservation.

In situ conservation is for most of genebanks not in their responsibility, but 10 respondents have experience possible to share. University teachers and experts like N. Maxted could provide both wide theorethical and practical teaching.

Table 13. In situ conservation (II)

Q. No.	Answers	
28	Yes, basic principles, within/outside of protected areas, collaboration with environmental sector, availability of samples, availability via liaison institute/genebank, via ex situ, monitoring on wild relatives of fruit trees sp., Fruit and ornamental tree species.	CRA-W Fruit, BE
28	Yes. Availability via liaison institute/genebank, via ex situ, monitoring	Forest Service, LT
28	Yes: outside of protected areas, collaboration with environmental sector, availability via liaison institute/genebank, via ex situ, monitoring	GB Medic, SI
28	Yes, for all areas.	GB Suceva, RO
28	Yes. Basic principles, within/outside of protected areas,	GB Tbilisi, GZ
28	Yes; We can provide capacity building but we do not have financial capacities to pay national experts to carry out the training	GB Tirana, AL
28	Yes, our experience	GB, CARC, CZ

28	Yes: Basic principles, within/outside of protected areas, collaboration with environmental sector, availability of samples, availability via liaison institute/genebank, via ex situ, monitoring	IICG URJ Spain
28	Yes *in situ* methodologies and management	N. Maxted, UK
28	Yes, basic principles, availability of samples, monitoring	RI Pitesti, RO
28	No, we are beginners.	VSUO Holovousy, CZ

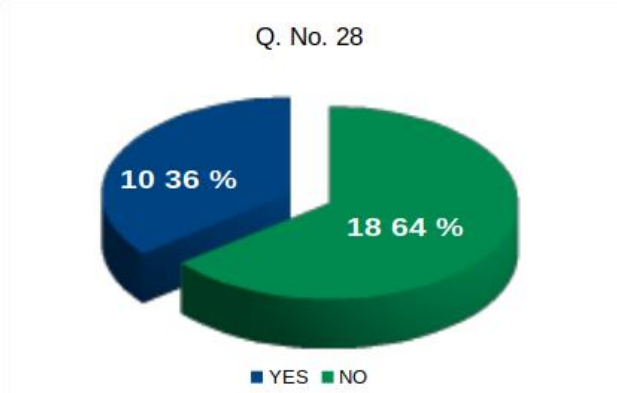

Figure 12. Responds to question 28. *In situ* conservation.

Within the topic 7 – Technical support including equipment, up to 11 respondents could share experience and participate in the capacity building.

Table 14. Technical support

Q. No.	Answers	Respondent
30	Yes, Technical support /advice on collecting, propagating, conservation, characterisation and evaluation of old fruit tree ganatic resources and wild relatives.	CRA-W Fruit, BE
30	Yes. Classical taxonomy support	GB Tapio, HU
30	Technical support /advice	GB Tbilisi, GZ
30	Yes, advice	GB, AZ
30	yes, share our experience	GB, CARC, CZ
30	To a limited extent, as from our own experience.	KIS, Ljublana, SI
30	Yes *in situ* or onfarm methodologies and management	N. Maxted, UK
30	Yes when it comes to manage pgr and animal genetic resources on-farm	ProSpRara, CH
30	Yes – The different collections of BRC4Plants can share their experiences	RarePlants, FR
30	Yes, technical support/advice	RI Pitesti, RO
32	Yes, team management and collection management of Fruit tree sp., fruit tree wild relatives collections	CRA-W Fruit, BE
32	for the drying	GB Tbilisi, GZ
32	yes, share our experience	GB, CARC, CZ
32	To a limited extent, as from our own experience.	KIS, Ljublana, SI
32	Possibly Yes *in situ* or on-farm methodologies and management	N. Maxted, UK
32	Yes – The different collections of BRC4Plants can share their experiences	RarePlants, FR

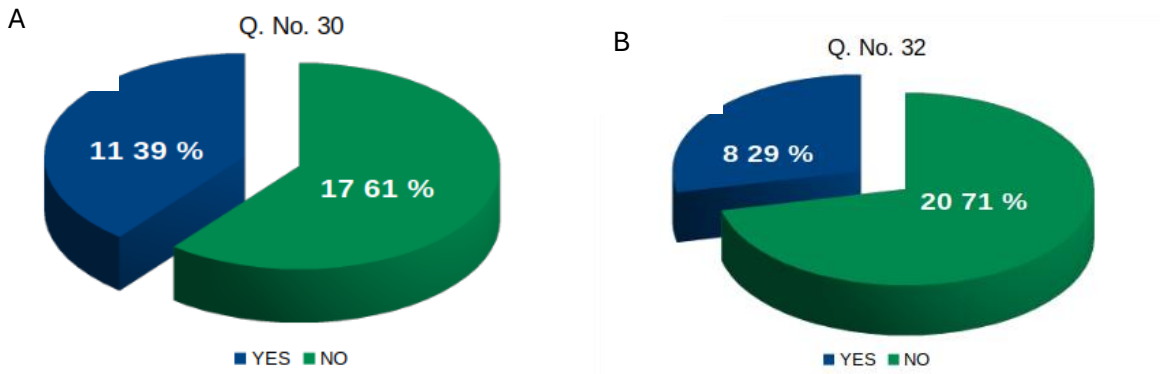

Figure 13. A) Responds to question 30. Technical support. B) Responds to question 32. Equipment for sustainable PGR conservation.

13.3. Insights from the Survey: Capacity to Contribute to Capacity Building

The survey responses revealed not only the **needs for capacity building** but also a significant and perhaps underutilized **potential for peer-led knowledge exchange** within the European PGR community.

The responses clearly distinguish between **regular PGR practitioners** (e.g. genebank staff, local conservation managers) and **experts** such as long-serving national PGR coordinators, university professors, and senior researchers. The latter group represents a valuable **backbone for the delivery of capacity building activities**, offering decades of practical and academic experience.

Critically, the questionnaire uncovered a **key opportunity**:

A substantial number of respondents—particularly professional genebank managers and curators—demonstrated **deep expertise** in PGR conservation and expressed a **strong willingness to share their knowledge**.

This willingness extends beyond simply showcasing **national experiences or best practices**. Respondents indicated they could also offer:

- **General methodologies** and training frameworks
- **Expert knowledge in specialized areas** such as taxonomy, genetics, data systems, and legal frameworks
- **Insights into national specialities and local traditions** in both ex situ and especially on-farm conservation

Notably, many respondents reported **both** a broad need for capacity building **and** the ability to contribute to it. This duality underscores the value of a **community-based training model**, where knowledge-sharing is embedded and reciprocal.

These findings support a strategic approach in which the capacity building programme:

- **Identifies and mobilizes internal expertise**, especially within the European region
- **Promotes knowledge exchange between experienced and early-career professionals**

- **Builds on national and regional strengths**, incorporating unique traditions and contexts into training design

14. Expected Outcomes:

The capacity building programme is expected to deliver the following key outcomes:

A holistic and integrated conservation strategy, bridging *ex situ, in situ*, and on-farm approaches to ensure the long-term safeguarding of plant genetic resources.

Strengthened capacity and improved quality management of national genebanks, leading to more effective conservation practices and **enhanced user access** to high-quality, well-documented genetic material.

Strengthening capacity of European genebanks should lead **to achieve relevant certifications**

Adoption and implementation of best practices in genebank operations, including standardized data management, safety duplication, and quality assurance procedures.

Increased efficiency and effectiveness of conservation efforts across all strategies—*ex situ, in situ*, and on-farm—through targeted training, technical support, and shared methodologies.

Enhanced protection of landraces, traditional varieties, and crop wild relatives (CWR) in their natural habitats, contributing to biodiversity conservation and sustainable agriculture.

Capacity development of researchers, practitioners, and stakeholders, fostering a knowledgeable and well-connected community of PGR professionals.

Creation of reusable, high-quality training materials, adaptable for use within national programmes and translatable into national languages of partner countries.

Introduction of technical and organizational innovations in the management of PGR collections, as well as the **development of new user-oriented services**.

Increased public awareness and appreciation of the significance of plant genetic resources and their role in food security and climate resilience.

Improved coordination and collaboration within European and global PGR networks, such as ECPGR, FAO, and ITPGRFA, enhancing regional coherence and international alignment.

15. Implementation Plan:

The successful rollout of the Capacity Building Programme for PGR conservation requires a structured and well-coordinated implementation plan. Key components include:

Comprehensive Planning and Timeline

A detailed implementation roadmap will be developed, outlining key milestones, deliverables, and timelines for each phase of the programme. This will include:

- Preparatory phase: needs assessments, stakeholder consultations, and resource development
- Pilot phase: initial roll-out of training modules and assessment protocols
- Full implementation: broad delivery across partner countries and institutions
- Review and adaptation: regular reviews to refine and adapt the programme

• *Establishment of a Central Hub within GRACE RI*

The programme will be anchored within the GRACE Research Infrastructure (RI) through the creation of a **Central Hub**. This hub will serve as the coordination and oversight body, operating under the guidance of:

- The GRACE General Assembly
- Advisory boards and a stakeholder forum composed of key actors from national genebanks, in situ/on-farm networks, academia, and policy sectors

• *Partner and Collaborator Engagement*

Implementation will rely on strong collaboration across various sectors. Key partners may include:

- National PGR programmes and genebanks
- Research institutions and universities
- NGOs and civil society organizations involved in agro-biodiversity
- International networks such as ECPGR, FAO, and CGIAR centres

• *Monitoring and Evaluation (M&E)*

A robust monitoring and evaluation framework will be developed to track the effectiveness and impact of the programme. This will involve:

- Defining performance indicators and success criteria for each programme component
- Regular feedback loops with participants and stakeholders
- Mid-term and final evaluations to assess progress, identify challenges, and guide adjustments
- Integration of lessons learned into future programming and policy recommendations

16. Budget for capacity building in PGR conservation

Based on responses from 28 genebank representatives, over 60% expressed a need for capacity building in the conservation and use of Plant Genetic Resources (PGR). While the majority require updates and refresher training, approximately 20–30% expressed interest in comprehensive educational programs. The proposed budget aims to address this range of needs through a diverse set of capacity-building activities.

Table 15. Budget for capacity building.

Budget Item	Estimated Share (%)	Details
Training and Workshops	20%	Organization of physical and regional training sessions, materials, logistics.
Mentorship and Internship Programs	15%	Stipends for interns, travel costs, mentor honoraria, coordination expenses.
Online Courses and Webinars	10%	Development of e-learning content, platform maintenance, webinar hosting.
Networking and Collaboration Activities	15%	Annual meetings, expert exchanges, travel support, joint initiatives.
Public Awareness Campaigns	10%	Outreach materials, social media, public events, educational tools.

Program Administration and Management	20%	Staffing, coordination, reporting, Central Hub operations within GRACE RI.
Monitoring and Evaluation	5%	Tools and expert services for performance tracking and assessment.
Contingency	5%	Reserve for unexpected costs or emerging opportunities.

Justification and Strategic Relevance:

- **Respondent Feedback:** Over 60% of surveyed genebanks highlighted the need for improved skills and updated knowledge in PGR conservation.
- **Diverse Training Needs:** While some participants require only basic updates, a significant portion (20–30%) seek comprehensive training, justifying the range of methods proposed (online, in-person, mentorships).
- **Sustainable Capacity Building:** This budget aims to create scalable and long-term knowledge-sharing mechanisms, including e-learning and professional networks.
- **Integration with GRACE RI:** All initiatives will align with GRACE RI's goals to strengthen coordination and harmonize conservation efforts across regions.

17. Additional Considerations

17.1. Crop Genebank Knowledge Base (CGKB)

Explore potential collaboration with CGIAR to integrate, contribute to, or assume management of the **Crop Genebank Knowledge Base** (CGKB) as part of GRACE RI's knowledge dissemination strategy.
The CGKB offers a valuable platform of methodologies and standard procedures that can be expanded to include **in situ** and **on-farm** conservation practices.

17.2. Quality Management System (QMS)

Support all participating genebanks and *in situ*/on-farm conservation networks in establishing or refining a **QMS** aligned with international standards (e.g., FAO Genebank Standards, ISO).
Include the development of documentation, SOPs, and internal audit procedures.
Promote QMS as a requirement for certification within the GRACE framework.

17.3. Monitoring and Evaluation (M&E)

Implement a **comprehensive M&E system** to track:

- Institutional development
- Quality assurance
- Technical improvement
- Use of conserved materials

Encourage **periodic external assessments** and **recertification cycles**, modeled after ISO-type processes.

17.4. Challenges and Risks

Table 16. Mitigation of risks

Challenge	Mitigation Strategy
Funding Limitations	Diversify funding sources (EU programmes, national co-financing, public-private partnerships).
Resistance to Change	Early stakeholder engagement, participatory planning, highlighting benefits through success stories.
Technical Issues	Establish dedicated technical support teams, offer troubleshooting guidance and peer learning.

17.5. Resource Assessment & Mobilization

- Conduct a **detailed resource audit** during the first phase to map current assets (equipment, infrastructure, human resources).
- Develop a **resource mobilization strategy**, including grant applications, partnerships, and pooled procurement opportunities.

17.6. Proposed Timeline

Table 17. Proposed Timeline

Year	Activity
1	Assessment of genebanks and *in situ*/on-farm networks; stakeholder mapping.
2-3	Implementation of tailored capacity-building programs; QMS development; mentoring.
4	Certification of genebanks and networks; evaluation and refinement of approaches.

17.7. Success Metrics

- Number of genebanks and *in situ*/on-farm networks **certified**.
- Documented **improvement in conservation standards** and **genetic diversity** coverage.
- Level of **user satisfaction** and material accessibility.
- Quantity and quality of **training sessions** delivered and reused nationally.
- Strengthened **networking and collaboration** at European and global levels.

18. Capacity building towards certification

The primary objective of the capacity building programme is to equip genebanks and *in situ*/on-farm conservation networks with the necessary knowledge, skills, and systems to achieve certification successfully. For genebanks, certification is addressed in Deliverable 2.1, which defines the minimum quality standards for genebank operations. This process will improve operational quality and ensure alignment with international protocols, thereby supporting long-term sustainability and institutional credibility.

For *in situ*/on-farm conservation networks, the development of a certification system will require extensive discussion, as current methodologies vary significantly across countries. Therefore, any proposed certification framework will need to be based on broadly defined, general requirements to accommodate diverse national contexts.

KeyFocus Areas

- **Quality Management**
  - Implementation of comprehensive **Document Management Systems**.
  - Development and adherence to **Standard Operating Procedures (SOPs)**.
  - Maintenance of **staff training records** and continued professional development.
- **Technical Protocols**
  - Standardized procedures for **seed storage**, **cryopreservation**, and **regeneration**.
  - Monitoring and control of **physical storage conditions** (e.g. temperature, humidity).
- **Data Management**
  - Establishment and maintenance of robust **databases** and **digital records**.
  - Implementation of **data backup protocols** and **data sharing policies** aligned with international norms.
- **Infrastructure**
  - Evaluation and optimization of **facility layouts** for operational efficiency.
  - Installation and upkeep of **climate control systems**, **security infrastructure**, and **equipment maintenance schedules**.
- **Compliance**
  - Systematic **documentation of compliance** with international agreements (e.g. FAO Genebank Standards, ITPGRFA, Nagoya Protocol).
  - Regular **internal reviews** and updates to remain in alignment with evolving standards.

By implementing the comprehensive capacity building and support framework, genebanks will be well-positioned to:

- Successfully **pass certification audits**,
- **Continuously improve** their operational standards,
- **Strengthen their contribution** to national and international efforts in plant genetic resource conservation.

In situ/on-farm conservation networks will be equipped with the knowledge and skills necessary to ensure the sustainable conservation of diverse genetic resources and will be prepared to undergo the certification process once it has been developed.

19. Conclusions

The proposed capacity building programme is designed to strengthen the capabilities of genebanks and *in situ*/on-farm conservation networks across Europe and beyond. It specifically addresses the needs of managers, researchers, practitioners, and policymakers by offering tailored support through training, mentorship, collaborative research, and awareness-raising activities.

By implementing this programme, the efficiency, quality, and resilience of plant genetic resources (PGR) conservation systems will be significantly enhanced. This, in turn, will:

- Foster the integration of ex situ and *in situ* conservation strategies,
- Promote the adoption of international best practices,
- Improve user access to high-quality genetic material,
- Support the long-term sustainability of conservation networks.

Moreover, the programme provides a structured pathway toward certification, helping institutions establish:

- Quality management systems,
- Documented operational procedures,
- Technical and data management standards that align with international frameworks.

The Research Infrastructure (RI), particularly within the GRACE framework, will play a central role in supporting and coordinating these efforts. By doing so, it can help ensure systematic improvements in quality, visibility, and collaboration, ultimately securing the reliable conservation and full accessibility of plant genetic resources.

This manual provides the foundational steps and guidance required for capacity development, serving as a standard reference for operational excellence in PGR conservation.

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Appendix 1. Training and workshop program

The program is designed to provide customized training and workshops to address specific needs identified during assessments, focusing on germplasm handling, data management, *in situ*/on-farm, and other areas.
The program could initially covercover six main topics:

1. ***Ex situ* conservation** covers the main topics of *ex situ* conservation including:
    - **Genebanking**: describes the processes of seed handling in genebanks, including:
    - GB processes: outlines the procedures for seed handling in genebanks to achieve the highest longevity.
    - Required conditions: discusses the necessary environmental conditions, such as temperature, humidity, and light, for seed storage.
    - Standard and threshold values: explains the standard and threshold values for seed quality, including germination rates, purity, and viability.
    - **Regeneration processes**: covers the planning and execution of regeneration cycles, including:
    - Planning regeneration cycles
    - Keeping viability germination threshold
    - Minimum numberamount of seeds in storage
    - Biologically safe regeneration under phytosanitary control and seed handling
    - Isolation methods (self-crossing, outcrossing, auto-incompatibility)
    - Pollination methods (wind pollination, insect pollination)
    - **Documentation system**: emphasizes the importance of documenting PGR data, including:
    - Passport data
    - Characterization and evaluation data
    - Seed storage data
    - Documentation of regeneration trials
2. **On-farm conservation**: covers the basic principles of on-farm conservation, including in under auspices of National programme or national genebank)::
    - Dynamic versus static conservation
    - Preferably under traditional farming systems
    - On-farm as primary or secondary conservation (backup)
    - Material availability
    - Introduction and re-introduction of PGR in a value chain (sustainable use)
3. ***In situ* conservation**: describes the basic principles of *in situ* conservation, including:
    - In protected areas or outside
    - Collaboration with ENVI sector (environmental sector)
    - CWR (Crop Wild Relative) are desired by AGRI sector (agricultural sector), so they should be in the hands of AGRI
4. **Documentation of PGR conservation (*ex situ,* on-farm and *in situ*)**: emphasizes the importance of documenting *ex situ,* on-farm and *in situ* conservation activities, including:
    - Under national documentation system or separated

- Output to EURISCO or another EU database: highlights the need to report conservation activities to EURISCO or another EU database (e.g., WIEWS).

5. **Networking and collaboration**: This topic encourages collaboration and information exchange among genebanks and *in situ*/on-farm network conservation managers to promote the sharing of best practices and knowledge.
6. **Monitoring**: This topic aims to monitor the progress of gene banks and *in situ*/on-farm conservation network efforts and evaluate their level of achievement in PGR conservation. This point is connected to the certification and post-certification evaluation.

Appendix 2. Questionaire for capacity building

Quick Survey on Capacity Building for Genebanks

With this survey, we aim to identify your capacity-building needs and the specific areas where support is required. Additionally, we would like to know if you have expertise in certain areas and are willing to provide training to other genebanks on these topics

Please provide your answer to questions:

Respondent information

Q. 1 Genebank name _____*If you are not a collection holder, please provide the name of your institution*

Q. 2 Country of your genebank _____

Q. 3 Your genebank status (national, local, NGO, etc.) _____*If you are not a collection holder, please provide your institution status, e.g. university/academia, botanic garden etc.*)

Q. 4 Your name and email_____

Capacity building

Topic no. Question no	**Topics**	**Need Capacity Building?** (Yes/No) – If Yes, Specify Areas for Training Question number	**Can provide capacity building?** (Yes/No) – If Yes, Specify Areas for Training Question number
1	**General information** General information on PGR conservation needs, international agreements (CBD, FAO, CGRC, ITPGRFA, ECPGR,…)	**Q. 5**	**Q. 6**
2	**Ex situ conservation of seed propagated spp.** Quality management: improved management of genebank/ *in situ*/on-farm collections	**Q. 7**	**Q. 8**
2.2	Seed conservation: documentation of seed handling processes, standards and thresholds in genebanks	**Q. 9**	**Q. 10**
2.3	Regeneration processes for self and outcrossing spp, planning and execution of regeneration cycles, space and technical isolation, pollination, pollinators	**Q. 11**	**Q. 12**
2.4	Characterization and evaluation: Plot size, descriptor lists, replication, uploading of mean data, storing of annual data	**Q. 13**	**Q. 14**

3 3.1	**Ex situ conservation of vegetatively propagated spp.** Quality management: improved management of vegetatively propagated ex situ collections/ *in situ*/on-farm collections	**Q. 15**	**Q. 16**
3.2	Field nurseries, orchards, vineyards, hop plantations etc. Methodology, minimum/optimum numbers, evaluation, pest management, sample distribution	**Q. 17**	**Q. 18**
3.3	In vitro techniques: methodology, general and specific protocols.	**Q. 19**	**Q. 20**
3.4	Cryopreservation: safety duplication for mainly vegetatively propagated crops, methodology, general and specific protocols	**Q. 21**	**Q. 22**
4 4.1	**Documentation** Passport, characterization and evaluation data, seed storage system data, data on regeneration cycles, documentation of plots/trees of vegetatively propagated spp.	**Q. 23**	**Q. 24**
5 5.1	**On-farm conservation** Basic principles, different methodologies, national specificities, main or secondary collection to ex situ, distribution	**Q. 25**	**Q. 26**
6 6.1	***In situ* conservation** Basic principles, within/ouside of protected areas, collaboration with environmental sector, availability of samples, availability via liaison institute/Genebank, via ex situ, monitoring	**Q. 27**	**Q. 28**
7 **7.1**	**Technical support, equipment and staff needs** Need for technical support /advice	**Q. 29**	**Q. 30**
7.2	Equipment for sustainable PGR conservation: advice for necessary minimum or advanced equipment	**Q. 31**	**Q. 32**

Appendix 3. Questionaire for capacity building - Answers

Topic	Q. no. 1	Name of your genebank	GB Tbilisi, GZ	CRA-W Fruit, BE	RI Pitesti, RO	GB Piestany,SK	GB Suceva, RO	AGES, AT	RI Holovousy, CZ	IICG URJ Spain	N. Maxted, UK	GB Tirana, AL	GB, CH	GB Min Serbia, RS	NatFruit, UK	GB, CARC, CZ	Hop RI, SI	GB CGN, NL	ProSpRara, CH	GB, CICYTEX, ES	GB, AZ	GB, AZE	KIS, Ljublana, SI	GB Medic, SI	Forest Service, LT	GB Piestany, SK	RarePlants, FR	GB Sadovo, BG	GB Malta, MT	GB Tapio, HU
	2	Country of your genebank	GEORGIA	BELGIUM	ROMANIA	SLOVAKIA	ROMANIA	AUSTRIA	CZECHIA	SPAIN	U.KINGDOM	ALBANIA	SWITZERLAND	SERBIA	UK	CZECHIA	SLOVENIA	NETHERLANDS	SWITZERLAND	SPAIN	AZERBAIJAN	AZERBAIJAN	SLOVENIA	SLOVENIA	LITHUANIA	SLOVAKIA	FRANCE	BULGARIA	MALTA	HUNGARY
	3	Status your genebank	LOCAL	REGIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	LTD,COMP. UNIVERSITY	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NGO LOCAL/NAT.	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NAT./LOCAL	NATIONAL	NATIONAL
1. General info	**5**	NEED: General information on PGR conservation needs, international agreements (CBD, FAO, CGRC, ITPGRFA, ECPGR,)	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO	YES	YES	NO	NO	NO	NO	YES	NO	YES	YES	No.	YES	NO	YES	NO	NO
	6	PROVIDE: General information on PGR conservation needs, international agreements (CBD, FAO, CGRC, ITPGRFA, ECPGR,…)	YES	YES	YES	YES	No.	NO	YES	NO	YES	YES	NO	NO	NO	YES	NO	YES	YES	NO	YES	NO	YES	YES	NO	NO	NO	NO	NO	NO
2. Ex situ, seed coll.	**7**	NEED: Quality management: improved management of genebank/ in situ/on-farm collections	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	NO	YES	NO	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES
	8	PROVIDE: Quality management: improved management of genebank/ in situ/on-farm coll.	YES	YES	NO	YES	YES	NO	YES	YES	YES	NO	NO	NO	NO	YES	NO	YES	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	NO	NO
	9	NEED: Seed conservation, documentation of seed handling processes, standards, thresholds in GBs	YES	YES	NO	YES	NO	YES	NO	YES	YES	YES	NO	YES	NO	NO	NO	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO
	10	PROVIDE: Seed conservation: documentation of seed handling, standards and thresholds in GBs	YES	NO	NO	NO	YES	NO	NO	NO	NO	YES	NO	NO	NO	YES	NO	YES	YES	NO	YES	NO	YES	YES	YES	NO	YES	NO	NO	YES
	11	NEED: Regeneration processes for self and outcrossing spp, planning and execution of regeneration cycles, space and technical isolation, pollination, pollinators	YES	YES	NO	YES	YES	YES	NO	NO	NO	YES	NO	YES	NO	NO	YES	NO	YES	YES	NO	NO	YES	YES	NO	YES	YES	YES	YES	NO
	12	PROVIDE: Regeneration processes for self and outcrossing spp, planning and execution of regeneration cycles, space and technical isolation, pollination, pollinators	YES	NO	NO	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO	YES	NO	YES	NO	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	YES
	13	NEED: Characterization and evaluation: Plot size, descriptor lists, replication, uploading of mean data, storing of annual data	YES	NO	NO	YES	YES	YES	YES	NO	NO	YES	NO	YES	NO	YES	YES	NO	YES	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES
	14	PROVIDE: Characterization and evaluation: Plot size, descriptor lists, replication, uploading of mean data, storing of annual data	YES	YES	NO	YES	NO	NO	NO	NO	NO	NO	NO	NO	NO	YES	YES	YES	YES	NO	NO	NO	YES	NO	YES	NO	YES	NO	NO	NO

Topic	Q. no. 1	Name of your genebank	GB Tbilisi, GZ	CRA-W Fruit, BE	RI Pitesti, RO	GB Piestany,SK	GB Suceva, RO	AGES, AT	RI Holovousy, CZ	IICG URJ Spain	N. Maxted, UK	GB Tirana, AL	GB, CH	GB Min Serbia, RS	NatFruit, UK	GB, CARC, CZ	Hop RI, SI	GB CGN, NL	ProSpRara, CH	GB, CICYTEX, ES	GB, AZ	GB, AZE	KIS, Ljublana, SI	GB Medic, SI	Forest Service, LT	GB Piestany, SK	RarePlants, FR	GB Sadovo, BG	GB Malta, MT	GB Tapio, HU
	2	Country of your genebank	GEORGIA	BELGIUM	ROMANIA	SLOVAKIA	ROMANIA	AUSTRIA	CZECHIA	SPAIN	U.KINGDOM	ALBANIA	SWITZERLAND	SERBIA	UK	CZECHIA	SLOVENIA	NETHERLANDS	SWITZERLAND	SPAIN	AZERBAIJAN	AZERBAIJAN	SLOVENIA	SLOVENIA	LITHUANIA	SLOVAKIA	FRANCE	BULGARIA	MALTA	HUNGARY
	3	Status your genebank	LOCAL	REGIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	LTD.COMP.	UNIVERSITY	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NGO	LOCAL/NAT.	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NAT./LOCAL	NATIONAL	NATIONAL
3. Ex situ, vegetativ. Propagat.	**15**	NEED: Quality management: improved management of vegetatively propagated ex situ collections/ in situ/on-farm collections	NO	NO	YES	YES	YES	YES	YES	NO	YES	YES	NO	YES	YES	YES	YES	NO	YES	NO	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES
	16	PROVIDE: Quality management: improved management of vegetatively propagated ex situ collections/ in situ/on-farm collections	NO	YES	YES	NO	NO	NO	YES	NO	YES	NO	NO	NO	NO	YES	NO	NO	YES	NO	YES	YES	YES	NO	YES	NO	YES	NO	NO	NO
	17	NEED: Field nurseries, orchards, vineyards, hop plantations etc. Methodology, minimum/optimum numbers, evaluation, pest management, sample distribution	NO	NO	NO	YES	YES	NO	NO	NO	YES	NO	NO	NO	YES	YES	YES	NO	NO	NO	NO	YES	YES	YES	NO	YES	YES	NO	YES	YES
	18	PROVIDE: Field nurseries, orchards, vineyards, hop plantations etc. Methodology, minimum/optimum numbers, evaluation, pest management, sample distribution	NO	YES	YES	NO	NO	NO	YES	NO	YES	NO	NO	NO	NO	YES	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO
	19	NEED: In vitro techniques: methodology, general and specific protocols	NO	NO	YES	YES	YES	NO	YES	NO	NO	YES	NO	YES	NO	YES	NO	NO	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES
	20	PROVIDE: In vitro techniques: methodology, general and specific protocols	NO	YES	YES	NO	YES	NO	YES	YES	NO	YES	NO	NO	NO	YES	YES	NO	NO	NO	YES	NO	YES	NO	YES	NO	YES	NO	NO	YES
	21	NEED: Cryopreservation: safety duplication for mainly vegetatively propagated crops, methodology, general and specific protocols	NO	YES	YES	YES	YES	NO	YES	NO	NO	YES	NO	YES	YES	NO	YES	YES	NO	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	NO
	22	PROVIDE: Cryopreservation: safety duplication for mainly vegetatively propagated crops, methodology, general and specific protocols	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	YES	NO	NO	NO	YES	NO	YES	NO	NO	NO

Topic	Q. no. 1	Name of your genebank	GB Tbilisi, GZ	CRA-W Fruit, BE	RI Pitesti, RO	GB Piestany,SK	GB Suceva, RO	AGES, AT	RI Holovousy, CZ	IICG URJ Spain	N. Maxted, UK	GB Tirana, AL	GB, CH	GB Min Serbia, RS	NatFruit, UK	GB, CARC, CZ	Hop RI, SI	GB CGN, NL	ProSpRara, CH	GB, CICYTEX, ES	GB, AZ	GB, AZE	KIS, Ljublana, SI	GB Medic, SI	Forest Service, LT	GB Piestany, SK	RarePlants, FR	GB Sadovo, BG	GB Malta, MT	GB Tapio, HU
	2	Country of your genebank	GEORGIA	BELGIUM	ROMANIA	SLOVAKIA	ROMANIA	AUSTRIA	CZECHIA	SPAIN	U.KINGDOM	ALBANIA	SWITZERLAND	SERBIA	UK	CZECHIA	SLOVENIA	NETHERLANDS	SWITZERLAND	SPAIN	AZERBAIJAN	AZERBAIJAN	SLOVENIA	SLOVENIA	LITHUANIA	SLOVAKIA	FRANCE	BULGARIA	MALTA	HUNGARY
	3	Status your genebank	LOCAL	REGIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	LTD.COMP.	UNIVERSITY	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NGO	LOCAL/NAT.	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NAT./LOCAL	NATIONAL	NATIONAL
4. Documentation	23	'Passport, characterization and evaluation data, seed storage system data, data on regeneration cycles, documentation of plots/trees of vegetatively propagated spp.'	YES	NO	YES	YES	NO	YES	NO	NO	YES	YES	NO	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO
	24	PROVIDE: Passport, characterization and evaluation data, seed storage system data, data on regeneration cycles, documentation of plots/trees of vegetatively propagated spp	YES	YES	YES	NO	YES	NO	NO	NO	YES	NO	NO	NO	NO	YES	NO	YES	YES	NO	YES	YES	YES	NO	YES	NO	YES	NO	NO	NO
5. On farm	25	NEED: Basic principles, different methodologies, national specificities, main or secondary collection to ex situ, distribution	YES	NO	NO	YES	NO	YES	YES	NO	YES	YES	NO	YES	YES	YES	NO	NO	NO	YES	NO	YES	YES	YES	YES	YES	NO	YES	YES	YES
	26	PROVIDE: Basic principles, different methodologies, national specificities, main or secondary collection to ex situ, distribution	YES	YES	NO	NO	YES	NO	NO	NO	YES	NO	NO	NO	NO	YES	NO	NO	YES	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	NO
6. In situ	27	NEED: Basic principles, within/outside of protected areas, collaboration with environmental sector, availability of samples, availability via liaison institute/genebank, via ex situ, monitoring	YES	NO	YES	YES	NO	YES	YES	NO	YES	YES	NO	YES	NO	YES	NO	NO	YES	YES	NO	YES	YES	YES	YES	YES	NO	YES	YES	NO
	28	PROVIDE: Basic principles, within/outside of protected areas, collaboration with environmental sector, availability of samples, availability via liaison institute/genebank, via ex situ, monitoring	YES	YES	YES	NO	YES	NO	NO	YES	YES	YES	NO	NO	NO	YES	NO	NO	NO	NO	NO	NO	NO	YES	YES	NO	NO	NO	NO	NO

Topic	Q. no. 1	Name of your genebank	GB Tbilisi, GZ	CRA-W Fruit, BE	RI Pitesti, RO	GB Piestany,SK	GB Suceva, RO	AGES, AT	RI Holovousy, CZ	IICG URJ Spain	N. Maxted, UK	GB Tirana, AL	GB, CH	GB Min Serbia, RS	NatFruit, UK	GB, CARC, CZ	Hop RI, SI	GB CGN, NL	ProSpRara, CH	GB, CICYTEX, ES	GB, AZ	GB, AZE	KIS, Ljublana, SI	GB Medic, SI	Forest Service, LT	GB Piestany, SK	RarePlants, FR	GB Sadovo, BG	GB Malta, MT	GB Tapio, HU
	2	Country of your genebank	GEORGIA	BELGIUM	ROMANIA	SLOVAKIA	ROMANIA	AUSTRIA	CZECHIA	SPAIN	U.KINGDOM	ALBANIA	SWITZERLAND	SERBIA	UK	CZECHIA	SLOVENIA	NETHERLANDS	SWITZERLAND	SPAIN	AZERBAIJAN	AZERBAIJAN	SLOVENIA	SLOVENIA	LITHUANIA	SLOVAKIA	FRANCE	BULGARIA	MALTA	HUNGARY
	3	Status your genebank	LOCAL	REGIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	LTD.COMP.	UNIVERSITY	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NGO	LOCAL/NAT.	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NATIONAL	NAT./LOCAL	NATIONAL	NATIONAL
Technical support	**29**	NEED: 'Technical support /advice'	YES	NO	YES	YES	YES	YES	NO	NO	YES	YES	NO	YES	NO	YES	NO	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	NO	NO
	30	PROVIDE: Technical support /advice'	YES	YES	YES	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	YES	NO	NO	YES	NO	YES	NO	YES	NO	YES	NO	YES	NO	NO	YES
	31	NEED: Equipment for sustainable PGR conservation: advice for necessary minimum or advanced equipment	YES	NO	NO	YES	YES	YES	NO	NO	YES	YES	NO	YES	NO	YES	NO	YES	YES	YES	NO	NO	YES	YES	YES	YES	YES	YES	NO	YES
	32	PROVIDE: Equipment for sustainable PGR conservation: advice for necessary minimum or advanced equipment	YES	YES	NO	NO	NO	NO	NO	NO	YES	NO	NO	NO	NO	YES	NO	NO	YES	NO	NO	NO	YES	NO	YES	NO	YES	NO	NO	NO