CGIAR

Genebanks

Full design document

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List of acronyms

ABS	Access and benefit sharing
ACIAR	Australian Centre for International Agricultural Research
AFPBA	African Plant Breeding Academy
AfSTA	African Seed Trade Association
AI	Artificial Intelligence
AOCC	African Orphan Crops Consortium
AoW	Area of Work
APSA	Asian Pacific Seed Association
ARI	Advanced Research Institutes
ARTC	Andean Root and Tuber Crops
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
AU	African Union
BMGF	Bill & Melinda Gates Foundation
BMS	Breeding Management System
BOLD	Biodiversity for Opportunities, Livelihoods and Development
BOLDER	Building Opportunities for Lesser-known Diversity in Edible Resources project
CATIE	Tropical Agricultural Research and Higher Education Center
CBD	Convention on Biological Diversity
CePaCT	Centre for Pacific Crops and Trees
CGN	Centre for Genetic Resources, the Netherlands
CGRFA	Commission on Genetic Resources for Food and Agriculture
CIAT	International Center for Tropical Agriculture
CIFOR-ICRAF	Center for International Forestry Research and World Agroforestry
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
CLIPnet	CGIAR Legal and IP Network
CoP	Community of Practice
CORAF	West and Central Africa Council for Agricultural Research and Development
CRP	CGIAR Research Programs
CSO	Civil Society Organization
CWANA	Central and West Asia and North Africa

DOI	Digital Object Identifier
DSI	Digital Sequence Information
EBS	Enterprise Breeding System
eGWAS	Environmental genome-wide association studies
EPPO	European and Mediterranean Plant Protection Organization
FAIR	Findability, accessibility, interoperability and reusability
FAO	Food and Agriculture Organization of the United Nations
FCDO	UK Foreign, Commonwealth & Development Office
FFAR	Foundation for Food & Agriculture Research
GCBC	Global Centre on Biodiversity for Climate
GGCE	GRIN-Global Community Edition
GHU	Germplasm Health Units
GIGWA	Genotype Investigator for Genome-Wide Analyses
GIZ	German Development Cooperation
GMO	Genetically Modified Organism
GRC	Genetic Resources Centre
GRIN	Germplasm Resource Information Network
HTS	High-throughput screening
IAEA	International Atomic Energy Agency
IAES	Independent Advisory and Evaluation Service
ICARDA	International Center for Agriculture Research in the Dry Areas
ICBA	International Center for Biosaline Agriculture
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IEC	International Electrotechnical Commission
IITA	International Institute of Tropical Agriculture
ILRI	International Livestock Research Institute
IPPC	International Plant Protection Convention
IRD	French National Research Institute for Sustainable Development
IRG	International Rice Genebank
IRRI	International Rice Research Institute
ISDC	Independent Science for Development Council
IPPC	International Plant Protection Convention
ISO	International Organization for Standardization
ISPM	International Sanitary and Phytosanitary Measures

ISTA	International Seed Testing Association
ITC	International Musa Germplasm Transit Centre
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
LEED	Leadership in in Energy and Environmental Design
LPA	Long-term partnership agreement
LTG	Long-term Grant
MEL	Monitoring, Evaluation, and Learning
MELIA	Monitoring, Evaluation, Learning, and Impact Assessment
MLS	Multilateral System
MTA	Material Transfer Agreement
NARES	National Agriculture Research and Extension Systems
NBPGR	National Bureau of Plant Genetic Resources (India)
NDRE	Normalized Difference Red Edge
NDVI	Normalized Difference Vegetation Index
NGS	Next generation sequencing
NORAD	Norwegian Agency for Development Cooperation
NPPO	National Plant Protection Organizations
ORT	Online Reporting Tool
PCR	Polymerase chain reaction
PGRFA	Plant Genetic Resources for Food and Agriculture
QMS	Quality management systems
RDA	Rural Development Administration (South Korea)
SADC	Southern African Development Community
SDG	Sustainable Development Goals
SMTA	Standard Material Transfer Agreement
SOP	Standard operating procedures
SPGRC	SADC Plant Genetic Resources Centre
SQM	Seed quality management
ToC	Theory of Change
USDA	US Department of Agriculture
VACS	Vision for Adapted Crops and Soil
WIEWS	World Information Early Warning System
WorldVeg	The World Vegetable Center

1. Executive summary

As global temperature increases surpass the 1.5ºC threshold, we enter unchartered territory. We will require unprecedented resilience to survive climate challenges and mass biodiversity extinction. As part of its Zero Hunger goal, the UN has set a target for the genetic diversity of crops to be maintained and made accessible from soundly managed genebanks. Under the Plant Treaty, CGIAR has a legal obligation to conserve in the long term and make available the crop diversity in collections managed by 11 Centers in 13 countries. In this proposal, these 11 CGIAR and the World Vegetable Center genebanks come together in one package, Genebanks, to make this target achievable.

Thanks to associated germplasm health units (GHU) and their strategic location in diversity hotspots, **Genebanks** connect widely with users in low- and middle-income countries, making accessible more than 3,500 plant species to researchers, breeders, extension programs, local communities, schools, and farmers around the world, supporting them to deal with intensifying challenges on local to global scales and to explore a multitude of options for a more resilient, diverse and environmentally sound agriculture and landscape.

Genebanks, through five Areas of Work, will enable more sustainable conservation, smarter and more targeted use of diversity for impact, and a supportive policy environment while controlling phytosanitary risks. The genebanks will share their expertise and capacity with regional and national partners to connect and integrate collections on a global scale and create a more vibrant and dynamic two-way flow between in situ and ex situ.

Frontier technologies and innovations in genomics, phenomics, artificial intelligence (AI), and cryopreservation are enhancing the relevance of genebanks, placing our generation in a position of responsibility to explore and use genetic diversity more effectively and on a much wider scale than previously, so as to reverse the narrowing of the base upon which food security and diets now rests. In 2023, the genebanks distributed over 200,000 germplasm samples to more than 60 countries. Over the next six years, through strengthened partnerships with **Breeding for Tomorrow, Multifunctional Landscapes,** and other users, **Genebanks** will develop enriched digital resources and harness artificial intelligence and machine learning to deploy the diversity in collections to its full potential. To support this ambition, **Genebanks** will strengthen open data policies and help build the capacity of potential genebank users to access and use the genetic and data resources available to them. More intensive and widespread use of such resources will lead to diversification in farmers' fields and household gardens. This will strengthen adaptation to climate change, improve nutrition and food security, incomes, environmental health, and support social inclusion, marginalized people, and communities.

By conserving and making available biodiversity, **Genebanks** directly contributes to CGIAR's Collective Target 11, UN Sustainable Development Goal 2.5, Kunming-Montreal Global Biodiversity Framework Targets 4, 10, 13, and 20, and the FAO's *Global Plan of Action on Plant Genetic Resources for Food and Agriculture* (PGRFA).

2. High-level vision in response to challenges and megatrends

2.1. Challenges and megatrends

Unprecedented rates of biodiversity loss and climate change are the defining global challenges of our time. Reduced biodiversity is undermining agrifood systems and landscapes' resilience and putting future crop improvement at risk. The homogenization of landscapes and farming systems is contributing to the simplification of diets and malnutrition. Climate change is exposing farming systems to novel and intensifying biotic and abiotic stresses. Rapidly occurring climate-related events and inter-related socioeconomic change demand immediate, localized solutions, as well as more profound responses to create more resilient agricultural systems and environments.

Crop diversity, as a source of genetic variation, novel traits for research, breeding, direct use, and diverse foodstuffs is a shared resource ready to contribute to developing novel responses to existing and future challenges. Widescale public and private investment has supported the collection of unique farmers' varieties and wild species over the past century. Millions of samples are held in national, international, and community genebanks in the form of seeds, plants, trees, and tissue culture samples. Investment in keeping these resources alive has not been consistent and many genebanks are at risk of losing much of these collections. At the same time, unique crop diversity is being lost due to severe genetic erosion occurring in farmers' fields and natural ecosystems. Without strong controls, the movement and sharing of these genetic resources across borders brings risks of spreading quarantine-risk pests and diseases.

2.2. High-level vision

As part of its Zero Hunger goal, the UN set a target for the genetic diversity of crops to be maintained and made accessible from soundly managed genebanks. CGIAR and World Vegetable Center genebanks have unique global roles in achieving this target as custodians of the world's most diverse, publicly accessible crop germplasm collections and points of exchange of clean source material through associated germplasm health units (GHU). These genebanks and GHUs (see Appendix 1 for summary details on each genebank/GHU), strategically located in diversity hotspots, provide genetic variation across more than 3,500 plant species to researchers, breeding teams, extension programs, local communities and farmers around the world, supporting them to find their own solutions for a more resilient, diverse and environmentally sound agriculture and landscape.

Over the next six years, **Genebanks** will ensure unique crop diversity is conserved and available in the long term in the most efficient and effective way possible. The Program will work as a community to enable smarter and more targeted use of diversity for impact in the face of climate change, reach out proactively to a wide range of users worldwide and develop enriched data, tools, and entry points to deliver new traits and genetic diversity to meet specific needs. **Genebanks** will address emerging challenges and opportunities represented by digital sequence information (DSI) and artificial intelligence (AI) and the political and capacity implications surrounding them. **Genebanks** will strengthen the whole community of crop diversity conservationists around the world by providing knowledge products online courses and facilitating capacity sharing within regions. **Genebanks** will strategically partner with national genebanks and communities, who are conserving unique diversity on-farm and in situ, to build and share capacity to conserve and make resources available to their own users more effectively.

2.3. What is new in Genebanks?

Innovations in genomics, phenomics, diagnostics, data analytics, artificial intelligence, and cryopreservation enhance the relevance of genebanks for finding solutions to food and agriculture-related challenges. This places our generation in a position of responsibility to explore and use genetic diversity more effectively and on a much wider scale than previously and reverse the narrowing of the base upon which food security and diets now precariously rest. Genebanks must understand their future users better and transition to digital genebanks, managing large-scale datasets ready for processing by machine learning and AI models.

While trends push toward open data and FAIR principles, the Global South is pressing for more equal opportunities to benefit from DSI. Clear evidence of CGIAR's engagement in policy, appropriate use of data, and efforts to build capacity and appreciate divergent viewpoints will be crucial to advance discussions and uptake of new technologies and to nurture the general willingness and support for international collaboration.

3. Evidence-based and demand-led prioritization

CGIAR genebanks have a legal obligation to respond to all requests for germplasm relating to food and agriculture. Such obligations are regardless of geography or user as long as the provisions of the Plant Treaty or other relevant international policy are respected. Since 2012, CGIAR genebanks have sent germplasm to tens of thousands of requesters in more than 120 countries worldwide, with approximately 80% going to low- and middle-income countries. Details on germplasm distributions are reported annually on the CGIAR Results Dashboard.

Annual trends in requests and distributions are unpredictable. In 2023 alone, distributions exceeded 200,000 samples. This distribution rate occurs without any advertising, any prominence online, or any active outreach to potential users. Trends in germplasm demand have not been rigorously studied to date but appear to be influenced by external factors such as technological advances, new projects, changing capacities, and needs. Emerging pests and diseases (e.g., wheat blast), newly funded research (e.g., allele mining, genotyping projects), or the availability of specific products (e.g., inbred lines, synthetic hybrids) can lead to large-scale screening of collections on the one hand or long-term demand for specific products on the other.

Much of what is or was known about crop diversity that helped in its deployment is locked inside the minds of previous centuries' plant collectors and inheritors of traditional knowledge. Such knowledge is transferred effectively through cultural rather than digital mechanisms. Genomic and phenomics information, however, is beginning to exert influence in visualizing and mining genetic diversity for useful traits and novel applications. A new project to be sponsored by the Chinese Government called "Genotype 2 Phenotype" aims to convene partners worldwide to explore genetic diversity through collaborative

genotyping and phenotyping, following in the footsteps of other global initiatives such as DivSeek and the Generation Challenge Program. The genetic basis of traits and the confluence of environmental and other factors have proved to be complex, and the vast potential of crop diversity remains largely untapped.

Nevertheless, the momentum of the genomics revolution empowered by AI will inevitably change how we understand and use genetic diversity and, subsequently, how we use crop diversity in genebanks. There is massive scope for improving the knowledge and use of genetic diversity in genebanks worldwide, and genebanks will make their most valuable contributions to impact by being reactive and responsive to emerging needs rather than being deterministic. Schemes to prioritize or focus efforts are counterintuitive to the role genebanks are currently designed to play in conserving the widest possible diversity for the widest possible needs.

4. Comparative advantage

CGIAR and the World Vegetable Center manage collections of 770,000 accessions of more than 450 crop species representing the diversity collected from more than 200 territories over the past five or more decades, including farmers' varieties, wild species, legacy varieties, trees, and forage species. While not fully representative of the world's crop genetic resources, they represent the diversity of globally important staple crops available under the Plant Treaty. Originating from many countries, they can neither belong to the CGIAR nor any country since they are entrusted to the global community through the Plant Treaty. They are a unique global resource that will always be available for sharing through CGIAR's responsible management. Compared to most other sources, collections managed by CGIAR and World Vegetable Center genebanks are representative of crop gene pools, well-documented with high-quality germplasm free of quarantine-risk pests and diseases. Every year, these genebanks are called upon by users worldwide, frequently as the only reliable source of genetic resources available. Together, CGIAR genebanks and breeding programs are the source of almost 90% of all plant genetic resources for food and agriculture (PGRFA) exchanged under the Plant Treaty's Multilateral System of Access and Benefit Sharing.

There is a widely held aspiration for a stronger global system of community, national, and international genebanks that can provide services to interconnected communities of users. CGIAR primarily services an intercontinental network of regional, national, and other genebanks for specific globally important crops and national providers who, in turn, service the wide range of constituents within their borders and regions for crops of specific national or regional interest.

The Independent Science for Development Council (ISDC) looked at applying the comparative advantage methodology specifically to **Genebanks** and concluded that it was not applicable. Their report states that *"ministries of agriculture support their own genebanks, which preserve and provide parent material to domestic and international requesters*.

"These entities do not generally have an obligation to respond to requests; many do not meet international standards of quality and documentation; and individual countries sometimes lack the proper policy framework to provide genetic materials with the same facility as [CGIAR genebanks]. [CGIAR] is the only institution with the institutional (Treaty), physical, and human capitals (including the GHUs), and incentive structure required to provide this deliverable. In fact, it is the only global source of genebank materials that is mandated to provide these materials to all eligible users (demand partners)."

The ISDC report goes on to state that *"the current model requires the demand partner to specify their needs; the [CGIAR genebanks comply]. However, increased interactions with demand partners would allow [genebank] scientists to become aware of the process of genetic innovation for development and the need for germplasm at various stages of the innovation pipeline. These interactions might enable finer tailoring of deliverables to meet the specific needs of demanders and save costs of development down the line. Such "boutique" requests would expand the scope of the deliverables, and the genebanks likely have a clear CA in filling this expanded scope. This service might be separated, but the degree of coordination with the genebanks themselves would likely dictate a close collaboration. An additional consideration looking forward is aggressive outreach to reach more potential demand partners. Such outreach would expand the network externalities associated with the Platform. Outreach might be provided by a yet-to-be-identified innovation partner with CA in this realm."*

The comparative advantage analysis of **Genebanks**'s high-level outputs is provided in Appendix 2. Most of the high-level outputs relate to CGIAR and World Vegetable Center's unique conservation and germplasm distribution work or support activities to improve internal processes, efficiency, policy compliance, and germplasm health. In these cases, no partner has been identified as having a comparative advantage to carry out these activities on behalf of CGIAR. The Area of Work on Strengthening Capacity for in Situ and Ex Situ Conservation Globally is relevant to the comparative advantage analysis, and there are important partners identified in this space. In addition, **Genebanks** is proposing to be more proactive in identifying and engaging target users and refining approaches to suit their specific needs. The Area of Work on Strategic User Engagement will analyze data available from past requests, characterize user typologies, survey existing and potential users, and develop and deploy a strategy for more proactive outreach that includes the development of products and tools for improving target users' experience. **Genebanks** will conduct a thorough comparative advantage analysis as part of developing this approach.

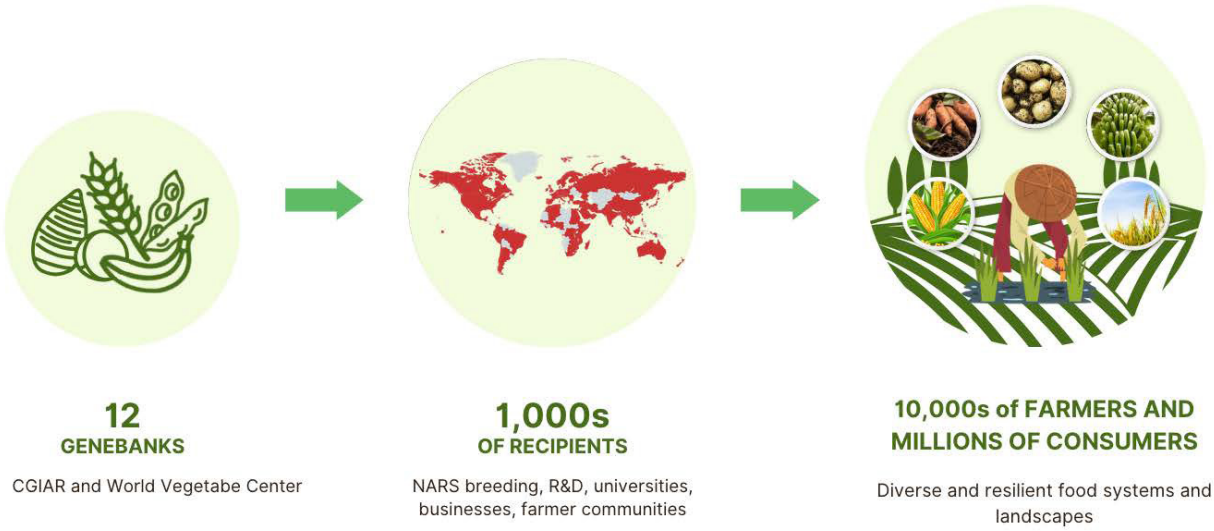
The costs of providing genebank services also need to be considered. CGIAR genebank operations are relatively well analyzed in this regard and have undergone two costing reviews in 2010 and 2020. The average annual per accession cost of CGIAR seed genebanks is approximately 33% less than those of benchmarked genebanks, while operations occur at a higher rate. Over the past decade, there has been a successful movement to bring all CGIAR genebanks to the same high standards of operation while controlling operating costs. Opportunities exist to improve genebank efficiency as a system and to consolidate conservation activities, but responding to such opportunities would require careful assessment of the net benefits and institutional and legal implications.

5. Theory of change

Genebanks aims to ensure the reliability of CGIAR's and the World Vegetable Center's conservation and genebank services and to build a stronger global system of policies, mechanisms, institutions, and conservationists making genetic diversity more widely available. Area of Work 1 (AoW 1) on Biodiversity Conservation supports the genebanks' operations and the improvement or strengthening of processes, collections, facilities, and long-term funding mechanisms to enable smarter and more sustainable conservation. CGIAR is uniquely placed to pilot and refine new conservation and related technologies across diverse locations and crops. The Area of Work on Strategic User Engagement adopts a proactive approach to enable smarter and more targeted use of diversity for impact, opening the genebanks to new users. Enriched information, products, and responsible AI innovation will help users identify materials and improve their experience ordering and obtaining germplasm, which is expected to facilitate breeding and research and potentially radically speed up breeding processes. Successful outcomes here could trigger various changes in germplasm distribution that will impact biodiversity conservation**.** Increased outreach could lead to increased distribution to more users. However, more precise accession selection could lead to decreases in the number of samples distributed. Other trends and external factors will also have a strong influence on germplasm distribution, creating challenges for determining suitable targets for this key output and creating a risk of setting up perverse incentives. Successful user engagement may also generate opportunities to attract funding and sponsorship to support long-term conservation. AoW 3 (Genetic Resources Policy) and AoW 4 (Germplasm Health) will ensure compliance with policy and national quarantine laws as materials move across international borders and ensure CGIAR breeding, research, and collaborations continue to comply with and benefit from an enabling policy environment.

AoW 5 (Strengthening Capacity for In Situ and Ex Situ Conservation Globally) will contribute to more effective, integrated ways of conserving and using diversity worldwide. Capacity needs relating to plant genetic resources conservation and use are expressed in detail by regions, countries, and institutions (national genebanks, breeding programs, civil society organizations, regional networks, etc.) in submissions to the Plant Treaty Governing Body, FAO State of the World reports, reports on the Global Plan of Action, crop strategies and genebank reviews undertaken by the Crop Trust, and reviews of national breeding capacity undertaken by the Accelerated Breeding Initiative. There is tremendous demand for increased capacity sharing and strengthened mechanisms for partnership and networking from CGIAR genebanks and GHUs. CGIAR and the World Vegetable Center have an expansive reach for supporting countries worldwide to conserve and use their genetic resources and ensure national breeding programs and diverse users benefit. Germplasm distribution and capacity-sharing activities will benefit thousands of genebank users and beneficiaries annually, who in turn will distribute germplasm and share knowledge with thousands of their own users (Figure 1). In this way, **Genebanks** activities will lead to a stronger overall global system of international and national institutions, policies, and mechanisms contributing to the conservation of unique plant genetic resources, responding to SDG 2.5 and the targets of the Kunming-Montreal Global Biodiversity Framework, and giving hundreds of thousands of new users access to plant diversity sources.

Figure 1. CGIAR and World Vegetable Center genebanks distribute crop diversity to a wide range of recipients, including national genebanks, universities, and communities, who share crop diversity with a wide range of end users.

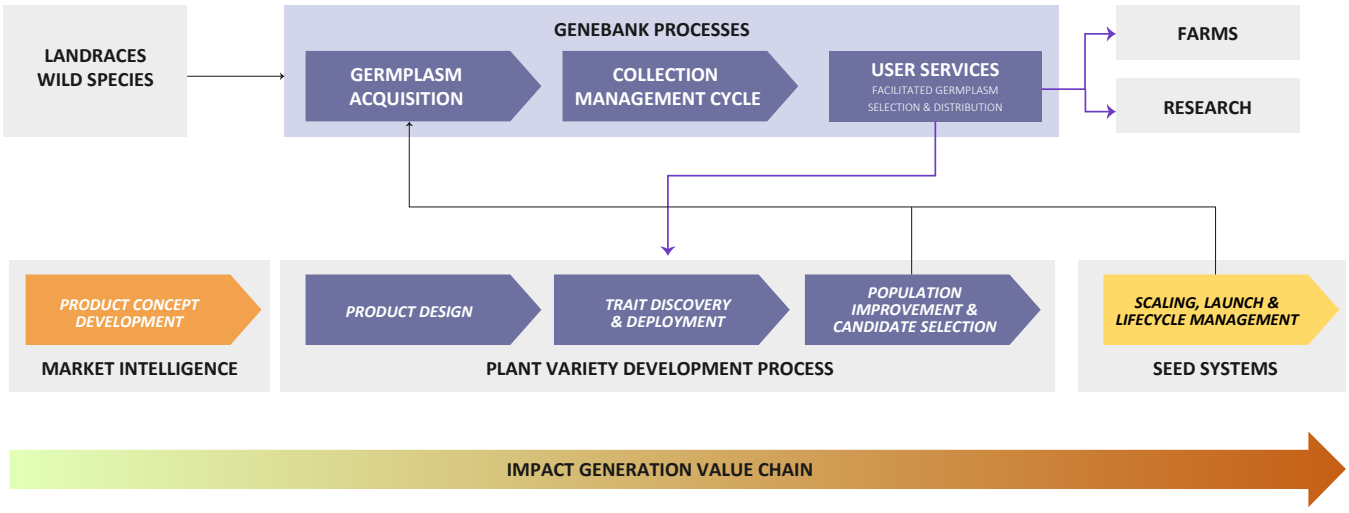


The impact pathway of the germplasm disseminated annually from genebanks is not easily tracked. It is notoriously difficult to keep track of materials as they pass through phases of evaluation, selection, crossing, or passing on to other researchers and national partners. Although all CGIAR and World Vegetable Center genebanks have implemented digital object identifiers (DOI) minted by the Plant Treaty, so far, few breeding programs have adopted the same DOI. Ideally, this would change, and standards developed between **Genebanks** and **Breeding for Tomorrow** would improve sample tracking and data gathering. A few pedigree tracing studies have been carried out and indicate that genebank materials have introduced important traits and genetic diversity into breeding lines, contributing to genetic gain (Villanueva et al., 2020,[1] Sellitti et al., 2020,[2] Bernal-Galeano et al., 2020[3]).

In general, genebanks respond to requests and do not direct where materials are sent or what they are used for. They are the upstream provider of services, introducing genetic variation into a potentially long breeding pipeline, with impact only measurable after several years. **Genebanks** aim is to ensure that genebanks and GHUs provide good quality services and offer genetic variation of value. In addition, **Genebanks** will strive to adopt a more dynamic curatorial approach to structuring collections, which will enable conservation of specialist collections and genetic stocks on a temporary basis. Finding cost-efficient solutions to testing and cleaning clonal crop materials is a shared priority for breeders, GHUs, and genebanks, and it will be beneficial if tackled in a collective approach.

The use of genebanks and genetic diversity can be increased through the improvement of data and screening tools and undertaking trait discovery studies, such as genome-wide association studies, which help to speed up the process of identifying useful traits and genetic variation of relevance for target product profiles (Figure 2). AI approaches promise to facilitate more effective and large-scale screening of genetic diversity for new traits. Diversity studies for different crops have repeatedly illustrated that current breeding efforts have only tapped into a small part of the genetic diversity available in the cultivated crop gene pools, let alone the diversity represented in wild relatives. A considerable genetic reservoir of potential solutions lies untapped in genebanks, which may be made more accessible through enriched data and selection mechanisms. Breeding for Tomorrow will carry out trait discovery and be a major contributor to generating data. **Genebanks** will amalgamate data as well as seeds and partner with researchers to enrich and manage data resources in a harmonized way.

Figure 2. Different pathways for genebanks to contribute to impact.



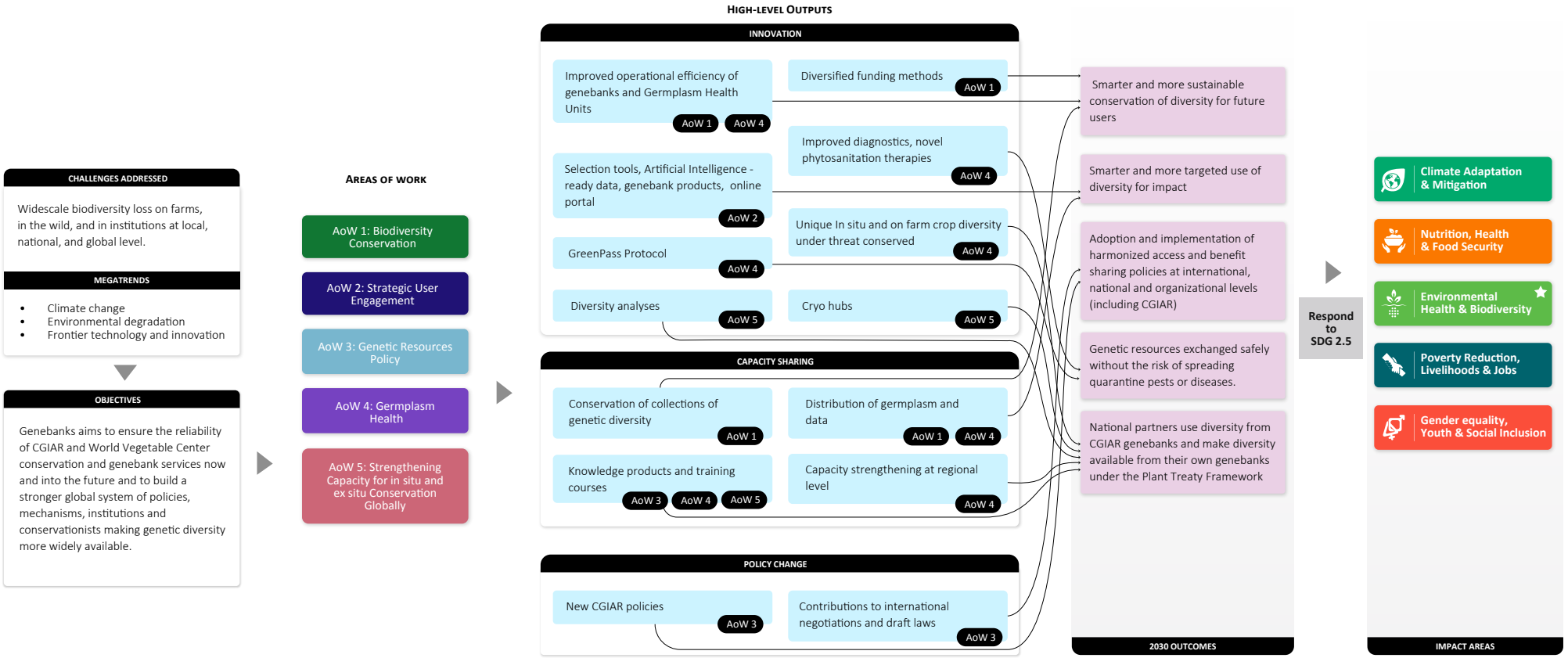
For some crops, however, there is a much shorter impact pathway to the ultimate beneficiaries than for well-resourced staple crops such as rice. This is the case for crops of regional or localized importance (e.g., ulluco, oca, winged bean, bambara groundnut, jute mallow, barnyard millet); roots, tubers and bananas, for which virus-clean material contributes directly to increased yields; varieties for niche uses or specialized markets; forages; trees; heritage varieties repatriated to communities; crops for which breeding is challenging or which have been historically under-resourced (e.g., amaranth, okra) and crops in which farmers' varieties have important applications in specific environments (e.g., banana, yams, cassava, yacón). There is also evidence that the movement of farmers' varieties with specific climatic or biotic adaptations to new geographical locations experiencing climate change or disease pressure has significant benefits, as does introducing genetic diversity from crop Centers of origin across continents to geographies where diversity is lacking (e.g., cassava in Asia). In all these instances, the genebanks have not articulated or elaborated where their contributions may have high returns on investment. The current phase of work proposes a more proactive strategy under Strategic User Engagement to identify use cases where genebanks can play a direct role in facilitating the smarter use of diversity for impact.

[1] Villanueva et al. (2020) The contribution of the International Rice Genebank to varietal improvement and crop productivity in Eastern India. Food Security, 12: 929–943
[2] Sellitti et al. (2020) The contribution of the CIAT genebank to the development of iron-biofortified bean varieties and well-being of farm households in Rwanda. Food Security, 12: 975–991

Table 1. Partners, assumptions, and indicators.

ToC element #	Statement	Areas of Work #	Partners and roles	Assumption	Indicator and target
OP	See Section 6	1–5	See Section 6		
2030-OC	Smarter and more sustainable conservation of diversity for future users	1	Plant Treaty, African Union, NARES	Enabling mechanisms in place at System and Center levels to incentivize efficiency	Global investment per collection (Controlled costs and sustained funding)
2030-OC	Smarter and more targeted use of diversity for impact	2	Breeding for Tomorrow	Continued and varied demand for genebank services	User satisfaction (More users, more satisfaction)
2030-OC	Adoption and implementation of harmonized access and benefit-sharing policies at international, national, and organizational (including CGIAR) levels	3	As above	External factors or reputational impacts do not disable the successful development of policy and negotiations	Policy change (New policies adopted)
2030-OC	Genetic resources are exchanged safely without the risk of spreading quarantine pests or diseases	4	Sustainable Farming, Breeding for Tomorrow, FAO- International Plant Protection Convention, National Plant Protection Organizations (NPPOs), EPPOs, universities, agricultural research institutes (ARIs), (NARES)	Enabling phytosanitary policies for import and export	Incidence of pests and diseases associated with germplasm movement (Controlled)
2030-OC	National partners use diversity from CGIAR and World Vegetable Center genebanks and make diversity available from their own genebanks under the Plant Treaty Framework	1-5	FAO, International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), and CBD	Support for NARES partners from governments	Change in the availability of crop diversity worldwide (Increased)

Figure 3. Genebanks ToC.



6. Areas of Work

Genebanks builds directly on the CGIAR Genebanks Initiative (2022-2024), the CGIAR Genebank Platform (2017–2021) and the Genebank CGIAR Research Program (2012–2016). It ties together genebank operations and services, policy, germplasm health, and capacity sharing across Centers, enabling individual genebanks to operate but ensuring appropriate coordination across Centers. The 2025-30 **Genebanks** include the operations of CIFOR-ICRAF and World Vegetable Center (ICRISAT was already included in 2024). The activities in the Areas of Work apply to any genebank as long as the budget is commensurate with the genebanks' needs. Moving from 10 to 12 genebanks requires a corresponding increase in budget. The ISDC and Independent Advisory and Evaluation Service reviews have previously recommended expanding the scope of the Genebanks Platform/Initiative to partners and new crops, and there are strong arguments for expanding the Genebanks Program to include additional genebanks at a minor cost relative to the total Program costs. CIFOR-ICRAF genebanks and World Vegetable Center genebanks are international genebanks, operating under the same standards, using the same data management system and performance targets as CGIAR genebanks. Both require support to reach and sustain performance targets and would benefit from being fully integrated into the collective activities of CGIAR **Genebanks**.

The involvement of the World Vegetable Center and CIFOR-ICRAF expands the scope of work and food groups, adding over 400 vegetables and their wild relatives and 200 fruit and multipurpose tree species, enabling CGIAR to respond more effectively to the needs of users seeking a wider range of crops and solutions to nutritional and climate-related challenges. The World Vegetable Center also brings experience connecting to different user types in private and societal sectors.[4]

The impact of this genebank group would be even further increased by including additional international genebanks such as the Centre for Pacific Crops and Trees in Fiji, which manages a global collection of taro, among other crops, and The Tropical Agricultural Research and Higher Education Center (CATIE) in Costa Rica, which manages unique collections of coffee, cacao, tropical fruits, and vegetables. A longer-term roadmap could eventually include closer integration of such genebanks into this Program.

6.1. AoW 1: Biodiversity Conservation

6.1.1. Planned outcomes

CGIAR and World Vegetable Center genebanks will conserve diversity for future generations in smarter and more sustainable ways. The status of the collections with respect to established performance targets will either be sustained or improved while enabling the increased inflow of new materials and the outflow of germplasm samples in response to requests from users. At the same time, efficiencies will be gained, both in individual genebanks and as a group, so that operating costs may be controlled. The gene pools of specific crops, crop wild relatives, and crops of regional or local importance will be better represented in collections (See Annex 3 on CGIAR genebanks' representation of crop gene pools). Genebank processes and curation approaches will be dynamized to (i) mainstream modernizing technologies, (ii) respond to improved understanding of genetic diversity and breeders' needs for genebank services, and (iii) build collaborations with and increase the capacity of national genebanks and other partners.

6.1.2. Objectives

Effective long-term conservation requires continuous action to manage the genetic integrity, quality, health, and longevity of seeds, tissue culture, and plants in long-term storage, cryopreservation, and field genebanks while also making samples readily available in sufficient quantities to requesters. Routine conservation operations represent, by far, the largest part of **Genebanks** in terms of staff time and funding. However, it is also critical for genebanks to prepare for the future. Biodiversity Conservation will enable CGIAR and the World Vegetable Center to pursue the following objectives:

- Sustain operations and standards and reach for and sustain performance targets with the support of harmonized quality management systems (QMS).
- Actively seek and implement efficiencies in operations through testing, mainstreaming, and sharing new technologies and approaches.
- Support the improvement of collection composition, structure, and curation within and among genebanks.
- Support coordinated approaches to the improvement of data quality, management, and availability.
- Manage shared risks and determine ways of enhancing the sustainability of genebank operations across Centers through coordination and increasing long-term funding.

6.1.3. Activities

Output 1.1: All collections reach and sustain performance targets. Individual genebanks will be supported to undertake the essential day-to-day operations depicted in the Genebank Process Model (Figure 4). Genebank activities are well-defined and conform to international standards (Annex 4). Performance targets dictate that CGIAR and World Vegetable Center genebanks should sustain 90% of accessions at international availability standards, as well as safety duplication and documentation. For collections not yet at performance targets, support will be provided to elevate operation rates (e.g., regeneration, health testing) to reach targets by 2030.

Output 1.2: Improved operational efficiency. In 2014, the Crop Trust and CGIAR co-developed a genebank quality management system, which national and other international genebanks have since adopted. Continuing to build the QMS, genebanks will document new and regularly update existing standard operating procedures (SOPs), complying with evolving international standards (FAO, 2014). The approach enables continuous improvement, exchange of best practices, and harmonization of terminology and processes across Centers. Harmonized workflows and data standards build stronger cooperation and create opportunities for sharing data, data management systems, tools, and a common online portal for managing germplasm requests. Genebank staff across Centers are responsible for specific processes convene in Process Teams, which meet regularly and provide an enabling mechanism for mainstreaming new practices and sharing experiences. Members of the Process Teams will self-organize to conduct peer-to-peer audits of each other's SOPs. Risk management is a requirement of the genebank QMS and is critical to responding

[3] Bernal-Galeano et al. (2020) Andean potato diversity conserved in the International Potato Center genebank helps develop agriculture in Uganda: the example of the variety Victoria. Food Security, 12:959-973
[4] Stoilova T et al. (2019) Connecting genebanks to farmers in East Africa through the distribution of vegetable seed kits. Plant Genetic Resources: Characterization and Utilization 17:306-309.

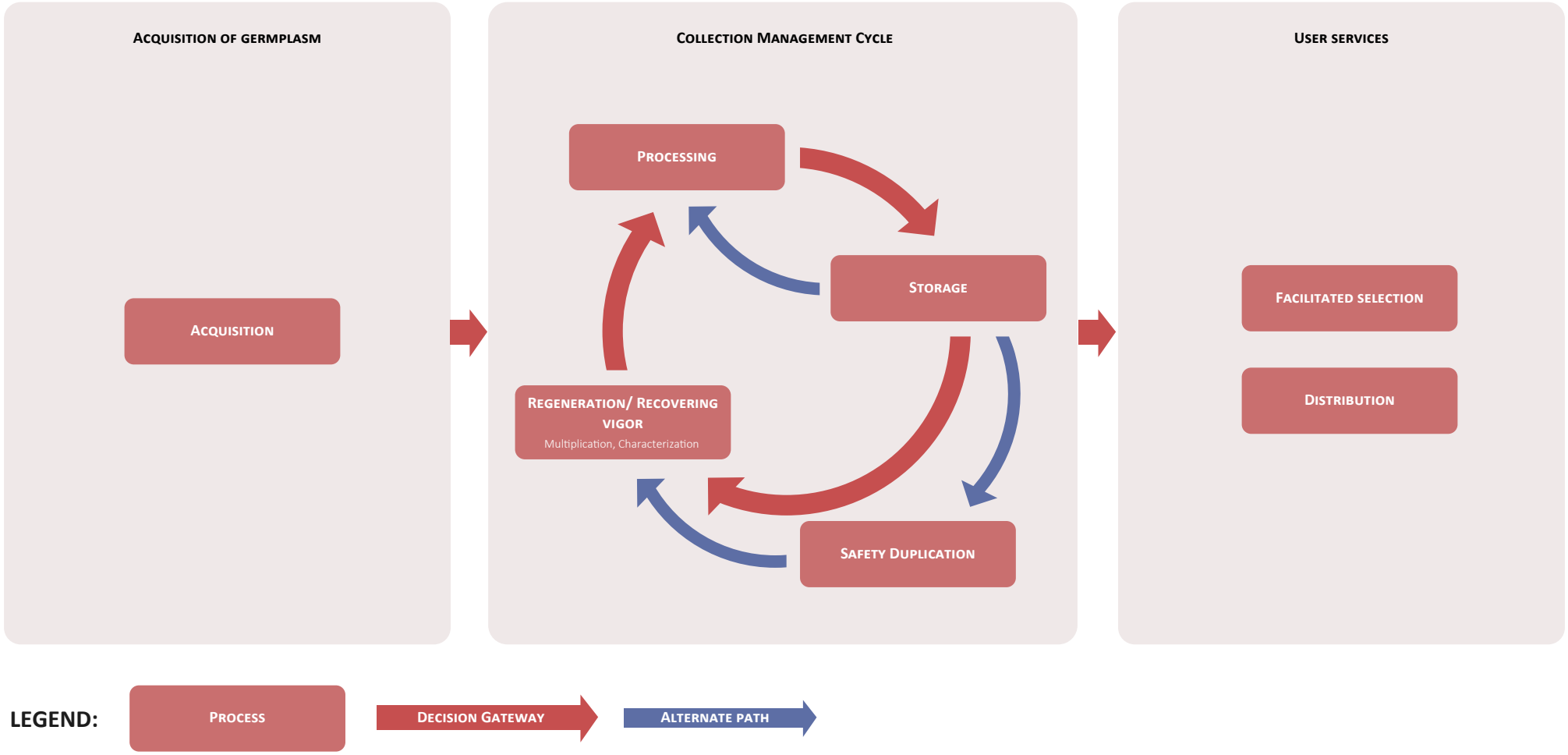
to a wide range of events. In the past ten years alone, the genebanks have sustained and recovered from multiple events, including the pandemic and country lockdowns, two civil wars, multiple incidences of unrest, four transfers of collections to new locations, many adverse weather events and the retirement of at least 20 long-serving managers and senior staff.

Building on the Genebank Platform and Initiative, AoW 1 (Biodiversity Conservation) will continue to mainstream new best practices through seed quality management (SQM) and a Clonal Crop Community of Practice (CoP):

Seed quality management: Individual genebanks focus on specific bottlenecks in processes and carry out small projects to determine optimal subprocesses or protocols in workflows in collaboration with Aarhus University (e.g., alternative post-harvest treatments to ensure maximum seed longevity in storage, customizing viability monitoring intervals, germination protocols for wild species, etc.). Currently, the SQM community of practice is testing and scaling out the use of VideometerLab, a multispectral imaging technology that has the potential to radically transform seed monitoring and phenotypic information for multiple crops.

Clonal crops: Standards in conserving clonal crops are relatively underdeveloped compared to seed crops. Advancements in in vitro culture and cryopreservation can still have a radical impact on genebank processes and costs. In the next six years, the main focus will be on cryopreservation, ensuring trueness-to-type, and finding more effective ways of conserving crop wild relatives. Collection-wide genetic diversity studies will present options for developing safe approaches to rationalizing clonal crop collections where there appears to be unnecessary redundancy within or between collections.

Figure 4. CGIAR Genebanks Process Model illustrating the general cycle of materials for seed and clonal crop collections.



Output 1.3: Strengthened collection composition and structure to represent crop gene pools. Building on previous outputs of the Genebank Platform and Initiative, geographical and taxonomic analyses of crop gene pools (see Annex 4) and new genetic diversity studies will inform curators where varietal groups may be over- or under-represented in or among collections. A published archiving policy now allows genebank managers to make critical decisions about accessions that are confirmed to be duplicates or redundant. Working across Centers on shared curation strategies for crops in common will not only enable efficient collection curation but also improve the availability of relevant data for searching and selecting accessions of interest. In addition, more dynamic curation approaches will encourage more structured collections to respond to demand from breeders to conserve breeding lines on a short-term basis. Refined acquisition procedures, assisted by imaging and precision identification tools, will ensure introductions complete gaps in the collection and respond to calls for action to prevent unique crop diversity on-farm or in situ being lost.

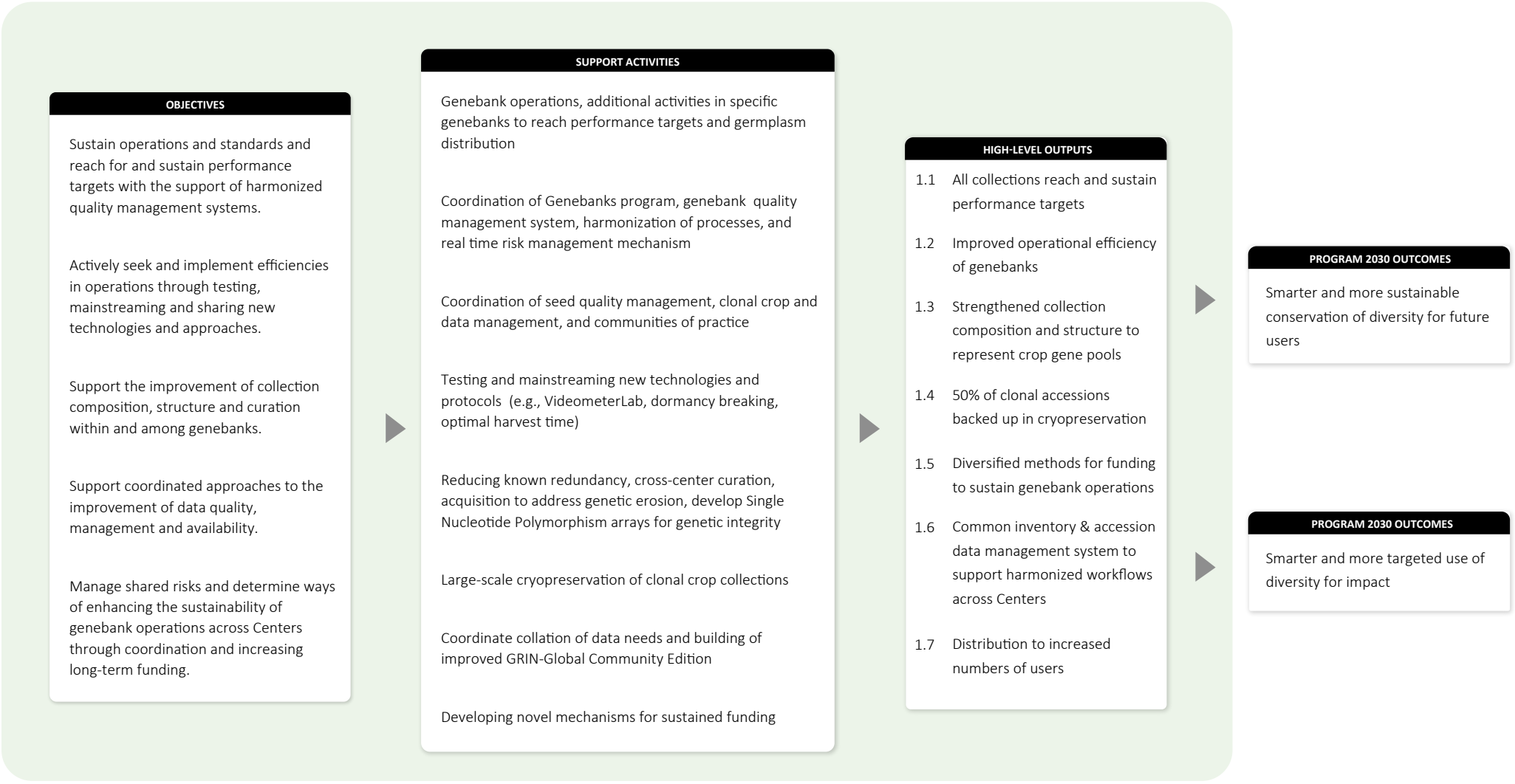
Output 1.4: 50% of clonal accessions backed up in cryopreservation. CIP, CIAT, IITA, and Bioversity International will continue activities to bring clonal crop collections into secure long-term conservation in the form of cryobanks. This involves amassing sufficient disease-free, genetically verified material, extracting the meristems or other growing tissue, and committing them to ultra-freezing conditions in liquid nitrogen to halt cell metabolism. This method requires tailoring for specific crops and genotypes and is not easily transferable or scalable. However, CIP and Bioversity International have successfully pioneered workflows to cryopreserve potatoes and bananas on a large-scale. Other Centers are following suit on cassava, yam, and sweet potato. By 2030, 50% of the collections of clonal crop species will be cryopreserved. In addition, cryotechnology will be tested and, if appropriate, implemented on further crop species with non-orthodox seed storage behavior, including crops managed by the World Vegetable Center and other partners (e.g., *Allium*, taro). This provides a more efficient and stable storage mechanism and eliminates the need to multiply the whole tissue culture collection annually for safety duplication in another location. It also potentially enables managers to reduce the level of active management of tissue culture and field collections.

Output 1.5: Diversified methods for funding to sustain genebank operations. The Crop Trust manages an endowment that currently funds CGIAR genebanks through long-term grants and partnership agreements at a level of approximately USD 5.5 million per year. The annual operations of Genebanks cost closer to USD 25 million per year. The CGIAR system Council and Centers have agreed since 2013 to protect the funding going to genebanks from budget cuts, which has enabled operations to be sustained at an adequate level. New ways will be sought to facilitate sustained operations and funding through matching specified costs to cost recovery mechanisms, sponsorship, levies, or other appropriate financing approaches, as well as developing a closer relationship with long-term supporters and funders of the genebanks to make and take opportunities to find and engage new funders.

Output 1.6: Common inventory and accession data management system to support harmonized workflows across Centers. Process teams and a data management community of practice will collaborate to harmonize workflows so that CGIAR and World Vegetable Center genebanks can adopt a common information technology infrastructure that is powerful enough to manage all data needs for inventory management across Centers and crops. Currently, CGIAR is collaborating with the Crop Trust to develop GRIN-Global Community Edition to fulfill this function. Genotypic data are being collated and managed to improve accession identification and management, monitor genetic integrity, assess diversity, and confirm redundancy in collections across Centers and beyond. These new data types need to be integrated into passport data and fully exploited in accession management.

Output 1.7: Distribution to increased numbers of users. Trends in germplasm requests are unpredictable. Reaching out to new users and promoting the use of the collections are the focus of Area of Work 2. However, facilitating the use of the collections is an essential genebank activity and needs to align with genebank operations. Any development of genebank products or heightened distribution needs to be matched by adequate levels of seed multiplication, health testing, and processing. The success of the strategy of AoW 2 to make the collections accessible to a wider range of users will become evident by increased germplasm distribution to increased users.

Figure 5. AoW 1: Biodiversity Conservation – ToC.



6.1.4. Partnerships

ToC element #	High-level outputs	Partners (including internal) and roles	Assumption (for outcomes only)	Indicator and target (for 2030 outcomes only)
OP 1.1	All collections reach and sustain performance targets	Crop Trust *(funds, reviews genebanks)*	Not required	Not required
OP 1.2	Improved operational efficiency of genebanks	Aarhus University *(leads community of practice)*	Not required	Not required
OP 1.3	Strengthened collection composition and structure to represent crop gene pools	National genebanks *(participates in diversity studies)*	Not required	Not required
OP 1.4	50% of clonal accessions backed up in cryopreservation	Hosts of cryopreserved safety duplicates	Not required	Not required
OP 1.5	Diversified methods for funding to sustain genebank operations	System Council, Crop Trust, Plant Treaty *(advice and financial support)*	Not required	Not required
OP 1.6	Common inventory and accession data management system to support harmonized workflows across Centers	Crop Trust *(software development),* other GGCE adopters	Not required	Not required
OP 1.7	Distribution to increased numbers of users	Users *(provide feedback and data)*	Not required	Not required
Program 2030-OC	Smarter and more sustainable conservation of diversity for future users	All the above	Enabling mechanisms in place at system and center levels to incentivize efficiency	Use of pooled funding per accession
Program 2030-OC	Smarter and more targeted use of diversity for impact	All the above	Clients have access to and interest in diversity and the capacity to use it	TBD

6.2. AoW 2: Strategic User Engagement

6.2.1. Planned outcomes

Genebanks will enable smarter and more targeted use of crop diversity to positively impact food and nutritional security, climate adaptation, environmental health, poverty alleviation, and gender and social inclusion. Genebanks users (universities, NARES, national genebanks, advanced research institutes, private companies, farmers, farmer organizations, schools, and NGOs) will improve their awareness and knowledge of CGIAR and World Vegetable Center genebanks, resulting in increased use of the genetic diversity available. The primary focus will be on improving the genebank user experience and ensuring well-characterized genetic material and genebank products are accessed by more users in a more targeted manner and more efficiently followed up through an iterative process. This will be achieved by enriching germplasm collections with value-added data, enhancing the intelligence behind accession selection, targeting information, products, and outreach to priority users and their needs, and establishing feedback systems to track germplasm use, allowing for continuous improvement of processes and information services.

6.2.2. Objectives

CGIAR and World Vegetable Center genebanks respond to wide-ranging requests from hundreds of users every year. The number of samples distributed may vary from 50,000 to more than 200,000 in any one year. Distributions are heavily skewed to a few countries, who are consistent requesters, while many countries are inconsistent or rare requestors. There has been little outreach to potential users, monitoring trends, or targeting of countries or user types who have expressed a need or are likely to want more access to crop diversity for research, breeding, or other purposes. There is no centralized website to explore existing data (i.e., beyond passport) that would facilitate outreach, data-driven selection of accessions, and germplasm ordering from one place.

Genebanks will implement a strategic approach to:

- Identify, prioritize, and characterize user typologies, analyze their needs, and proactively engage with user type representatives to determine how to improve the user experience in finding, selecting, and requesting germplasm from CGIAR and World Vegetable Center genebanks.
- Develop and deploy digital genebanking and AI-enabled analytics to create more agile and responsive mechanisms and products for exploring crop diversity in collections.
- Generate, integrate, and centralize data resources, tools, and products to cater to the specifications of target users.
- Develop a harmonized, efficient pipeline to manage germplasm requests from receipt to germplasm distribution.

6.2.3. Activities

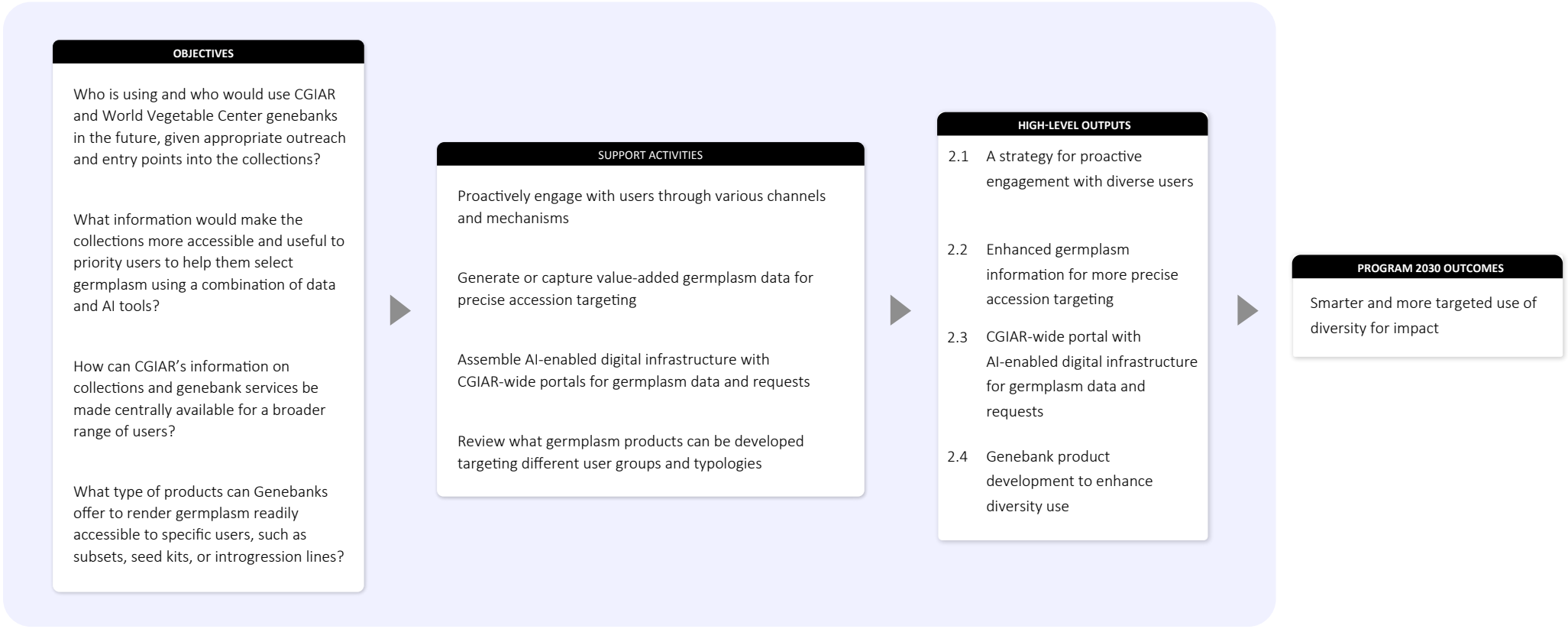
Output 2.1: A strategy for proactive engagement with diverse users. A strategy will be developed and implemented, in coordination with **Breeding for Tomorrow** and other partners, to assess needs for genebank services, including the most effective entry points (e.g., data, language, media) for prioritized user typologies, encompassing diverse crops, geographic regions, and uses of germplasm. Priority users will be based on past trends and include national breeding programs and researchers and students in universities in low- and middle-income countries who are working with or evaluating crop genetic diversity. User surveys and interactions with groups of users will help genebanks to assess satisfaction and identify unmet and future needs. **Genebanks** will create mechanisms to incentivize and facilitate information flow from users to genebanks to determine the usefulness of germplasm, data, and genebank services. More granular and standardized user and use data will be collected so that germplasm distribution and use trends can be accurately monitored to improve genebank services. Annual outreach and awareness raising of selected user groups and countries will broaden the user base in terms of the number and user types.

Output 2.2: Enhanced germplasm information for more precise accession targeting. Genebanks will enhance, enrich, and integrate the information base linked to genebank accessions (passport, characterization, evaluation, genotypic) and improve the quality and interoperability of individual genebank databases, ensuring that CGIAR genebank information resources are best-in-kind. Data-enhancement efforts will include preparing and validating AI-ready passport, taxonomic, and, where applicable, seed phenotypic data and images; generating high-density genotypic data to document genetic relationships among accessions; and identifying the allelic states of user-prioritized markers (where applicable). Genebanks will also compile (and generate where appropriate) user-prioritized climate, nutrition, or biotic-stress-related evaluation data in close collaboration with market intelligence in **Breeding for Tomorrow**. Evaluation data is important for enhancing use, as such data can support subsetting and targeting (including through predictive characterization). Thus, **Genebanks** will also devote efforts to making available accession-evaluation datasets generated by previous genebank users or through partnerships. FAIR data principles under the guidance of the **Digital Transformation Accelerator** will be adhered to wherever possible. The scope of this activity will largely depend on the funding envelope available to support the generation of value-added accession data. Frequently used and standardized protocols or analytical pipelines for data generation, curation, and analyses will be released to the broader genebank research and practice community. To guide this work, crop networks or communities will be convened to discuss and consolidate decisions on the composition and evaluation of crop collections.

Output 2.3: CGIAR-wide portal with AI-enabled digital infrastructure for germplasm data and requests. In the next six years, **Genebanks** will focus on improving the usability of subsetting and visualization tools, integrating data of different types, and leveraging AI for communication and analytics. Toward this aim, **Genebanks** will work with the **Digital Transformation Accelerator** to create a CGIAR-wide portal for comprehensive accession data access, enabling AI-guided germplasm searches and requests based on robust analytical workflows and human-in-the-loop approaches. The portal will enhance the information offered and user experience, enable more strategic engagement and better dialogue with users, and improve user services by reducing transaction costs when requesting germplasm. The CGIAR-wide portal will be fully interoperable with Genesys, offering access to all CGIAR collections and associated data at one entry point. **Genebanks** will manage all relevant genomic datasets describing CGIAR germplasm collections using the Genotype Investigator for Genome-Wide Analyses (GIGWA) database from where genomic data will be available both directly for genomic experts and indirectly via the CGIAR-wide portal for more general queries. We will also develop a tool for AI-enabled internet data harvesting to track the use of accessions by genebank users and analyze interactions between genebanks and their users to gain further insight into use and future needs. All technologies developed will be interoperable to ensure integration among the components of a growing suite of genebank-relevant, BrAPI-compliant databases (GGCE, GIGWA, Genesys, Enterprise Breeding System, and Breeding Management System).

Output 2.4: Genebank product development to enhance diversity use. As part of the User Engagement Strategy, **Genebanks** will review what germplasm products can be developed targeting different user groups and typologies. Subsetting is a key mechanism to help users narrow down the choice to identify accessions of interest. Subsets can be customized using the subsetting tool developed by the Genebanks Initiative and hosted on Genesys. **Genebanks** will create subsets representing genetic diversity and targeting frequently requested features (traits, allele combinations, geographic locations, climate conditions, etc.). Aside from subsets and mini cores, creating introgression lines of crop wild relatives and their cultigens represents a first step in making hidden gene expression visible for researchers and breeders. Responding to demand and market intelligence, individual genebanks will collaborate with **Breeding for Tomorrow,** research institutes, and universities to co-generate relevant products and knowledge for trait discovery. The World Vegetable Center has successful experience in developing and disseminating seed kits of mixed crops for on-farm evaluation and garden establishment (at home or school) for crop and cultivar testing, crop introduction, education, and disaster recovery. This is especially relevant for opportunity crops where investment in breeding is limited. **Genebanks** will partner with **Breeding for Tomorrow** to determine opportunities for developing and promoting mixed crop seed kits for specific target beneficiaries.

Figure 6. AoW 2: Strategic User Engagement – ToC.



6.2.4. Partnerships

ToC element #	Statement	Partners (including internal) and roles	Assumption (for outcomes only)	Indicator and target (for 2030 outcomes only)
OP 2.1	A strategy for proactive engagement with diverse users	NARES, **Breeding for Tomorrow** *(sharing market intelligence)*	Not required	Not required
OP 2.2	Enhanced germplasm information for more precise accession targeting	**Breeding for Tomorrow** Genotyping and sequencing services, phenotyping specialists, universities	Not required	Not required
OP 2.3	CGIAR-wide portal with AI-enabled digital infrastructure for germplasm data and requests	Crop Trust, **Breeding for Tomorrow** (sharing market intelligence and products), Digital and Data enabler	Not required	Not required
OP 2.4	Genebank product development to enhance diversity use	**Breeding for Tomorrow**, NARES (market intelligence)	Not required	
Program 2030-OC	Smarter and more targeted use of diversity for impact	All above	Continued and varied demand for genebank services	To be defined

6.3. AoW 3: Genetic Resources Policy

6.3.1. Planned outcomes

Genebanks will contribute to the adoption and implementation of harmonized access and benefit-sharing (ABS) policies at international, national, and organizational levels (including CGIAR). Those policies will provide a sound legal basis and incentives for conserving and exchanging genetic resources and associated information, including digital sequence information (DSI) and traditional knowledge, for use in agricultural research and development. They will also promote technology transfer, information sharing, capacity development, and income redistribution in low-income countries for those involved in conserving and sustainably using genetic diversity.

6.3.2. Objectives

CGIAR is an important actor in the global system of conservation and exchange of genetic resources for food and agriculture and related information, accounting for nearly 90% of germplasm transfers under the Plant Treaty's Multilateral System of Access and Benefit Sharing (ABS). CGIAR also has a well-established role in supporting national partners in developing policy frameworks, including through co-founding, together with the FAO Plant Treaty, the Joint Capacity Strengthening Program to Implement the Multilateral System of Access and Benefit Sharing.

Until recently, ABS laws regulated genetic resources but not the information derived from those resources. The management and availability of DSI is an emerging issue for policy development. In addition, there are increasing calls to engage in the rights of farmers, Indigenous Peoples, and local communities and consider policies that support dynamic interlinkages between organizations involved in on-farm and in situ conservation.

Building on the critical work of the Genebank Platform and Initiative and responding to these emerging needs, **Genebanks** will:

- Determine how international ABS policies applying to genetic resources, DSI, and traditional knowledge can be made more supportive of agricultural research for development and food system transformation and CGIAR's mission.
- Develop and futureproof policies to be relevant to rapidly evolving technologies (e.g., next generation sequencing, AI), areas of research (e.g., synthetic biology, metabolomics), and the expectations of stakeholders involved in conservation and sustainable use of agricultural biodiversity.
- Ensure CGIAR scientists, leaders, and Programs are aware of and able to comply with existing ABS obligations arising from national and international laws and CGIAR's own policies and guidelines.
- Assist NARES partners in developing national measures and SOPs to implement and operate under the ABS provisions of the Plant Treaty, Nagoya Protocol, and Kunming-Montreal Global Biodiversity Framework.

6.3.3. Activities

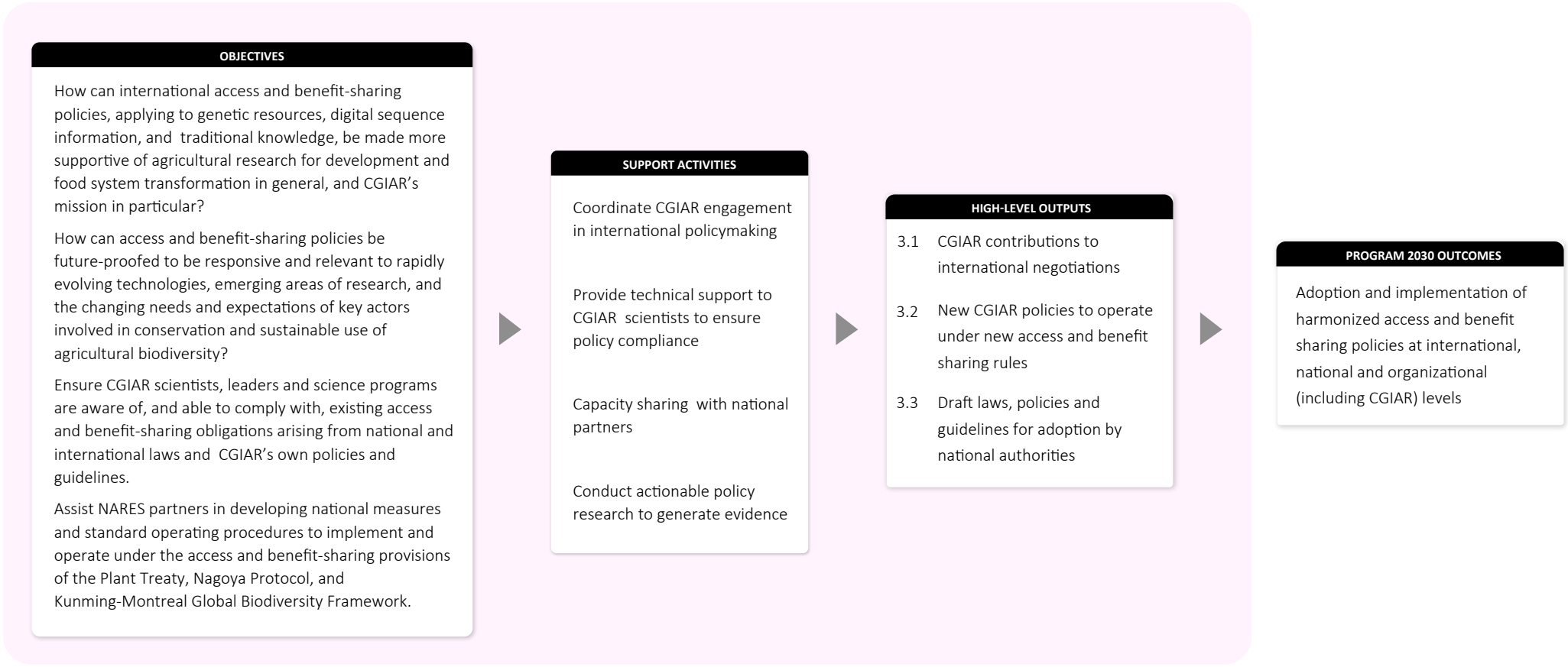
Output 3.1: CGIAR contributions to international negotiations. Genebanks' Policy Team will monitor developments and coordinate CGIAR engagement in relevant international negotiations, primarily under the frameworks of the Plant Treaty, UN Commission on Genetic Resources for Food and Agriculture (CGRFA), and Convention on Biological Diversity (CBD). The Team will liaise with Secretariats, delegations, and other stakeholders, draft submissions and oral statements, convene side events and follow up on published recommendations. To ensure that CGIAR is responsive to emerging trends and developments, a Multistakeholder Genetic Resources Policy Committee will be set up to feed into and inform CGIAR's international engagement, policies, and practices with respect to genetic resources, DSI, and farmers' rights.

Output 3.2: New CGIAR policies to operate under new access and benefit-sharing rules. Trends in the uses and flows of genetic resources will be studied in AoW 2 at the micro level. The Policy Team will study such flows at a macro level and the availability and use of DSI and traditional knowledge in response to global challenges, technological developments, shifting research and development priorities, industry practices, and evolving ethical expectations and policies. The research outputs will inform CGIAR interventions in international policymaking fora, CGIAR's policies and practices, and technical support for national partners.

CGIAR institutional policies, guidelines, and best practices related to managing and using genetic resources, DSI, and traditional knowledge will be developed in compliance with evolving international obligations and ethical standards. Centers' licensing and intellectual property protection practices will also be reviewed to ensure compliance with CGIAR's Guiding Principles for the Management of Intellectual Assets and shared with the Plant Treaty's Governing Body. In addition, the Policy Team will develop and run training courses for CGIAR and NARES scientists, provide one-on-one advice to CGIAR scientists through the Genetic Resources Policy Helpdesk, convene and support a community of practice to mainstream good practices, strengthen compliance with ABS rules and explore areas of uncertainty.

Output 3.3: Draft laws, policies, and guidelines for adoption by national authorities. National partners will develop measures and procedures through support from **Genebanks** to implement the Plant Treaty, Nagoya Protocol, and Kunming-Montreal Global Biodiversity Framework. Specifically, national partners in low- and middle-income countries will be supported to (a) undertake actionable policy research on the effects of access and benefit-sharing norms concerning genetic resources, traditional knowledge, digital sequence information, farmers' rights on conservation and sustainable use of genetic resources, (b) develop policies, laws, procedures, and guidelines to implement and operate under the Plant Treaty, Nagoya Protocol and the Global Biodiversity Framework, (c) identify genetic resources and related information they will make available to others through the multilateral system, and (d) access genetic resources and related information that they need through the multilateral system.

Figure 7. AoW 3: Genetic Resources Policy – ToC.



6.3.4. Partnerships

ToC element #	Statement	Partners (including internal) and roles	Assumption (for outcomes only)	Indicator and target (for 2030 outcomes only)
OP 3.1	CGIAR contributions to international negotiations	Plant Treaty, CBD, CGRFA *(Feedback on CGIAR engagement in negotiations).* Art 15 DGs and System Board *(Approve submissions to intergovernmental bodies).* Breeding for the Future *(cooperate in policy research).* CGIAR multistakeholder GR policy advisory group *(feedback re: CGIAR engagement in negotiations, policies and practices).* DSI Scientific Network (*coordinate advocacy approaches; co-author studies, journal articles).*	Not required	Not required
OP 3.2	New CGIAR policies to operate under new access and benefit-sharing rules	Plant Treaty*, CBD, CGRFA (*Feedback on draft CGIAR policies and practices).* Art 15 DGs and System Board *(Approve CGIAR policies and guidelines).* **Breeding for Tomorrow** *(develop licensing policy; feedback on compliance and capacity needs; user of guidelines, policies, training courses, help desk).* CGIAR System Office *(annual review of Centers' compliance, and licensing).* CGIAR CGIAR Legal and IP Network *(awareness raising and promotion).* UK Open University *(develop and host online training course).*	Not required	Not required
OP 3.3	Draft laws, policies, and guidelines for adoption by national authorities	Plant Treaty Secretariat, national focal points, ABS Capacity Development Initiative, regional networks, international genebanks (*resource persons, capacity sharing projects).*	Not required	Not required
2030-OC	Adoption and implementation of harmonized access and benefit-sharing policies at international, national, and organizational (including CGIAR) levels	All above	External factors or reputational impacts do not disable the successful development of policy and negotiations	Numbers of policies adopted

6.4. AoW 4: Germplasm Health

6.4.1. Planned outcomes

CGIAR and World Vegetable Center Germplasm Health Units (GHUs) will co-create and implement innovations and procedures to detect and eliminate pests and diseases, designing and improving context-specific phytosanitary services for germplasm health management and facilitating genebanks and breeding germplasm imports and exports to national, regional and international partners. Ensuring CGIAR's GHUs are functioning at optimal efficiency, mainstreaming improved technologies and protocols, facilitating their spread through capacity sharing and engaging national and international phytosanitary agencies will contribute to reducing pest and disease risks to agriculture worldwide.

6.4.2. Objectives

Effective GHUs are crucial to ensure CGIAR compliance with national quarantine measures established in accordance with the FAO International Plant Protection Convention (IPPC) framework and the International Sanitary and Phytosanitary Measures (ISPMs) to regulate germplasm movement to prevent the spread of pests and diseases. GHUs will enhance cross-cutting, network-level activities by crop and subregion to refine methodologies and respond to common phytosanitary challenges. GHUs will advocate for a systems approach to phytosanitary certification of germplasm, referred to as GreenPass, as an annex to the ISPM38 on the international movement of seeds for expedited delivery of health-assured germplasm to users globally.

The CGIAR and World Vegetable Center GHUs provide services to genebanks and breeding programs to process incoming and outgoing shipments of germplasm and to test and, in some cases, clean the germplasm of quarantinable pests and diseases. These services are mostly or partially covered through charges, cost recoveries, and institutional resources, leaving little possibility for investment in procedures, upgrading, joint development of diagnostics, adopting new technologies, or the opportunity to convene and coordinate as a group. Through **Genebanks**, GHUs will:

- Develop and improve phytosanitary interventions to meet current and emerging phytosanitary demands.
- Identify, develop, and mainstream effective, advanced diagnostics technologies (genomic-based molecular methods, multispectral imaging, AI/bioinformatics, etc.) for routine germplasm health monitoring.
- Share capacity with national partners and collaborate with international bodies and other stakeholders to overcome regulatory bottlenecks to germplasm distribution.

6.4.3. Activities

Output 4.1: Agile phytosanitary health delivery system. GHUs will harmonize processes and standards using a QMS approach, modernize facilities and procedures to enhance operational efficiency and develop a costing framework to facilitate improved funding for phytosanitary service delivery. A robust data management system will be developed to store and analyze germplasm health diagnostic data for actionable insights, support decision-making, monitor trends in pests and disease occurrence in germplasm, and assess pest risk.

Output 4.2: Improved diagnostics for efficient germplasm health testing. GHUs will adopt and integrate next-generation technologies, such as high-throughput sequencing methods, point-of-use quick diagnostics, AI-based multispectral imaging for non-invasive diagnostics, and others, to modernize germplasm health monitoring activities.

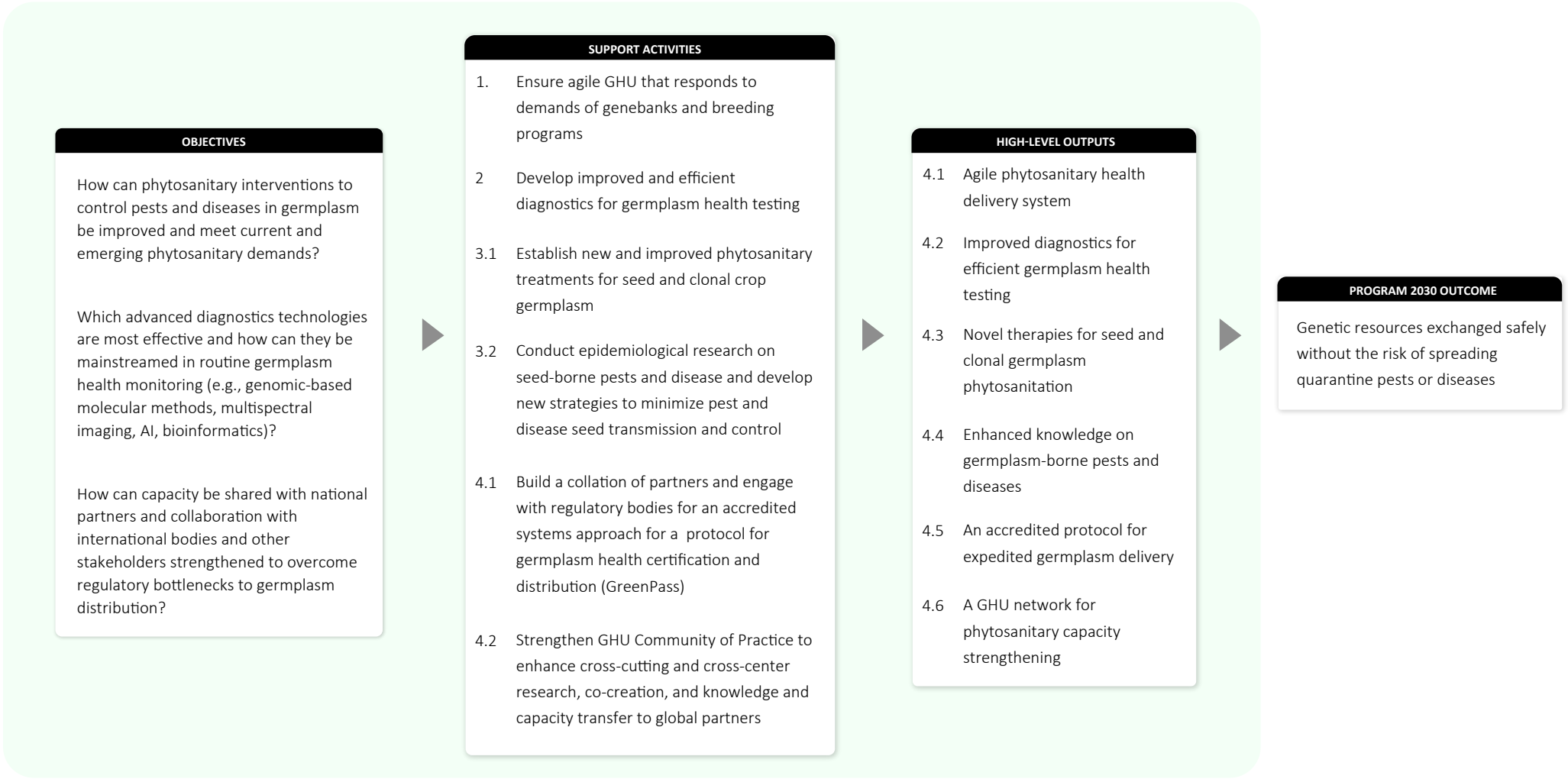
Output 4.3: Novel therapies for seed and clonal germplasm phytosanitation. GHUs will develop effective therapies for virus elimination in clonal crop germplasm and identify alternative seed treatment chemicals to comply with the UN SDG 2030 agenda on phasing out highly hazardous pesticides in use by 2035. GHUs will also explore data analytics and modeling to predict germplasm-borne pest and disease risks due to climate change and other factors to enhance preparedness for emerging phytosanitary scenarios.

Output 4.4: Enhanced knowledge of germplasm-borne pests and diseases. GHUs will improve the understanding of the epidemiology of pests and diseases across different germplasm collections, guiding identification, management, and mitigation of seed-borne infections, ultimately improving germplasm health management strategies and futureproofing collections from emerging risks due to climate change and other factors.

Output 4.5: An accredited protocol for expedited germplasm delivery. CGIAR has been developing a Greenpass system, whereby CGIAR GHUs' practices may be formally recognized by national and regional authorities so as to facilitate the movement of germplasm across borders. Delays in shipments at borders incur significant costs to CGIAR and expensive roundabout ways. At worst, unique materials from national partners for conservation at CGIAR genebanks can be destroyed. **Genebanks** will build on the gradual process of generating trust among the international community of plant health agencies and developing a unique form of accreditation to improve international germplasm movement to and from CGIAR genebanks.

Output 4.6: A GHU network for phytosanitary capacity strengthening. GHUs will strengthen collaboration with national plant protection organizations (NPPOs) and national genebanks to transfer technology, share knowledge, build capacity, and co-design solutions to control invasive pests and diseases that threaten biodiversity. Through these efforts, GHUs will ensure that CGIAR germplasm shipments comply with international and national phytosanitary regulations and contribute to Target 6 of the Biodiversity Plan of the CBD, which aims to reduce the introduction and spread of invasive alien species by 50% by 2030 and minimize their impact on biodiversity and ecosystem services.

Figure 8. AoW 4: Germplasm Health – ToC.



6.4.4. Partnerships

ToC element #	Statement	Partners (including internal) and roles	Assumption (for outcomes only)	Indicator and target (for 2030 outcomes only)
OP 4.1	Agile phytosanitary health delivery system	**Sustainable Farming** and **Breeding for Tomorrow**, FAO-International Plant Protection Convention (IPPC), National Plant Protection Organizations (NPPOs), EPPO, Universities, ARIs, and NARES institutions. *(Co-creation, knowledge sharing, and leverage 3rd party research outputs for building knowledge base)*	Not required	Not required
O.P 4.2	Improved diagnostics for efficient germplasm health testing	**Sustainable Farming**, FAO-IPPC, NPPOs, EPPO, Universities, ARIs, and NARES. *(Complementary research, knowledge sharing, and leverage 3rd party research outputs for development and validation of protocols).*	Not required	Not required
OP 4.3	Novel therapies for seed and clonal germplasm phytosanitation	**Sustainable Farming**, FAO-IPPC, NPPOs, EPPO, Universities, ARIs, and NARES. (*As above)*	Not required	Not required
OP 4.4	Enhanced knowledge of germplasm-borne pests and diseases in germplasm collections	**Sustainable Farming** and **Breeding for Tomorrow**, FAO-IPPC, NPPOs, EPPO, Universities, ARIs, World Vegetable Center, and NARES. (*As above)*	Not required	Not required
OP 4.5	An accredited protocol for expedited germplasm delivery	FAO-IPPC, NPPOs, EPPO, USDA-APHIS, ISF, APSA, AfSTA and Universities. (*Advocacy and awareness raising, knowledge sharing, and stakeholder consultation workshops)*	Not required	Not required
OP 4.6	A germplasm health unit network for phytosanitary capacity strengthening	**Sustainable Farming** and **Breeding for Tomorrow**, FAO-IPPC, NPPOs, EPPO, Universities, ARIs, and NARES. (*Co-creation, knowledge sharing, training, and knowledge transfer activities.)*	Not required	Not required
2030-OC	Genetic resources are exchanged safely without the risk of spreading quarantine pests or diseases	All above	Enabling phytosanitary policies for import and export	Ensured 100% compliance with phytosanitary regulations

6.5. AoW 5: Strengthening Capacity for In Situ and Ex Situ Conservation Globally

6.5.1. Planned outcomes

Genebanks, through partnerships and capacity sharing, aims to increase the crop diversity that is conserved and made available, free of quarantine pests and diseases, for use under the Plant Treaty framework on a global scale. A strengthened global system of more integrated in situ and ex situ efforts, from local to international, will respond to calls from the CBD and the UN to stem biodiversity loss and maintain and make available genetic diversity through soundly managed genebanks and in situ mechanisms. CGIAR and World Vegetable Center genebanks act as keystones, positioned to support this global system and strengthen mechanisms for collaboration and exchange between international, regional, national, and community levels. **Genebanks** will respond strategically to the specific needs of regions and, to some extent, countries and communities, using limited resources to the maximum effect and stimulating increased exchange of crop diversity and collaboration between actors worldwide.

6.5.2. Objectives

Under the auspices of FAO, contracting parties and stakeholders have repeatedly committed to developing a fully-fledged global system for the conservation and sustainable use of crop diversity. CGIAR and World Vegetable Center genebanks are counted on to share capacity. They have widespread outreach in crops and geographical regions and are well-positioned to facilitate capacity sharing globally, regionally, and in neighboring countries. Regional collaborations and networks effectively share capacity among many countries at one time.

Many national genebanks have achieved extraordinary resilience, frequently involving personal sacrifice, to keep collections of genetic diversity alive with little or no financial support over decades. Unfortunately, potential users in countries still lack access to genetic resources for research, breeding, and use. There are overwhelming needs for capacity sharing, international collaboration, and strengthened mechanisms to facilitate the sharing of information, expertise, and germplasm within and across borders; considerably more need than CGIAR and World Vegetable Center can address since every country has multiple genebanks and communities trying to conserve unique genetic diversity. Each one is under-resourced, under-equipped and under-staffed.

Genebanks will respond strategically to specific needs and priorities identified through the following plans and reports:

- State of the World Report on Plant Genetic Resources (3rd edition) and the Global Plan of Action for Plant Genetic Resources for Food and Agriculture (2nd edition) include country reports describing the number and status of collections worldwide and priority capacity needs.
- Compliance reports and other regular reports to the Plant Treaty submitted by Contracting Parties provide information on the priority capacity needs of individual countries.
- Crop Trust external genebank reviews undertaken in projects, Seeds4Resilience and Biodiversity for Opportunities, Livelihoods and Development, provide in-depth reports and expert recommendations on the infrastructure, equipment, and operational needs of more than 20 national genebanks.
- Reviews of national breeding capacity by the Accelerated Breeding Initiative report on the conservation needs of breeding programs in many countries in Sub-Saharan Africa.
- Global Conservation Strategies of more than 40 crop species have been developed by communities of crop experts and describe the status of ex situ conservation of specific crops and the priority needs to improve the overall conservation status of the crop gene pool according to expert knowledge.
- The African Vegetable Biodiversity Rescue Plan co-developed by 43 contributors from three African Plant Genetic Resources networks, validated by the African Union, and endorsed by the Crop Trust. It provides a road map for the next 10 years on the rescue, conservation, and use of vegetable genetic resources in Africa.
- Regional and other capacity sharing workshops convened by CGIAR, World Vegetable Center, and the Crop Trust provide updated information on priority needs and trends.
- Ad hoc or formal requests for assistance from individual countries to genebanks.

Specifically, **Genebanks** will:

- Convene regional networks and groups to agree and implement multi-country approaches to address priority needs expressed in relevant published reports.
- Support regional initiatives to jointly analyze crop diversity and secure at-risk clonal crops and other vulnerable crop types in long-term conservation, especially cryopreservation.
- Address the Plant Treaty's resolution requesting that CGIAR expand its efforts to share capacity in managing and using DSI.
- Strengthens in situ - ex situ linkages and addresses emerging risks to unique crop diversity.

6.5.3. Activities

Output 5.1: Regional hubs for increasing cryopreservation capacities and saving crop diversity at risk. A specific need exists in the conservation of trees and crops that are not propagated by seed since these are highly exposed in farmers' or genebanks' fields to climate change-related challenges. Community and national genebanks do not have the resources to maintain tissue culture collections in sterile conditions for indefinite periods. **Genebanks** will aim to build on a model approach for partnering with communities to rescue unique clonal crop diversity that is being developed through a UK Darwin-Initiative funded project. Farmers' varieties are gathered for disease cleaning in a regional phytosanitary hub. The clean material will be multiplied with national partners and returned to the farmers for planting, and a small number of samples will be sent for long-term conservation in cryopreservation in a cryohub.

Output 5.2: Diversity analyses of crops at a regional level for strategic conservation and use.
Building on a low-cost, joint initiative to genotype and share data on common bean diversity among national partners in Latin America, additional crops will be subject to similar analyses in centers of crop diversity to delineate overlapping or unique genetic diversity shared within and between collections and enhancing collaboration among national and international partners to share data and germplasm and ultimately to enable informed curation decisions and strategies and to ensure that unique diversity is safety duplicated adequately.

Output 5.3: Capacity strengthened at a regional level for diversity conservation and use. Regional workshops and initiatives enable multiple countries to participate and benefit from joint activities and training. Each international genebank acts as a regional hub for information, storing germplasm and safety duplicates, sources of expertise and genebank services, and collaborators collecting genetic diversity under threat. In turn, international genebanks should be able to rely on national genebanks as a channel to reach out to research and farming communities within countries.

Through regional entry points, **Genebanks** will nurture relationships with NARES by responding to specific needs and providing genebank services, technical support, and, where feasible, financial support and responding to calls from the Crop Trust and Plant Treaty to support projects to build the capacity of targeted national genebanks and countries. CGIAR and World Vegetable Center genebanks will coordinate with **Breeding for Tomorrow** to partner with target NARES partners to ensure national breeding programs are supported by effective conservation services from their respective national genebanks. In Sub-Saharan Africa, CGIAR and World Vegetable Center will work with Africa Union, Southern African Development Community, West and Central Africa Council for Agricultural Research and Development (CORAF), and Association for Strengthening Agricultural Research in Eastern and Central Africa communities to determine how to most strategically address the overwhelming needs for genebank services and capacity building. CGIAR, the Crop Trust, Plant Treaty, and other relevant organizations will build a strategic approach to support the regional networks' plans.

Output 5.4: Capacity strengthened of NARES for the management and use of digital sequence information. Low- and middle-income countries have expressed a specific need for the Plant Treaty Governing Body to have the capacity to harness the potential of crop diversity available to them by being able to generate, manage, and analyze associated data and specific genotypic data or digital sequence information. It is understood that DSI may hold as much potential for future crop improvement as the material seeds from which DSI comes. Areas of Work 2 and 3 will jointly develop training courses and provide opportunities for capacity sharing, specifically on DSI under Area of Work 5.

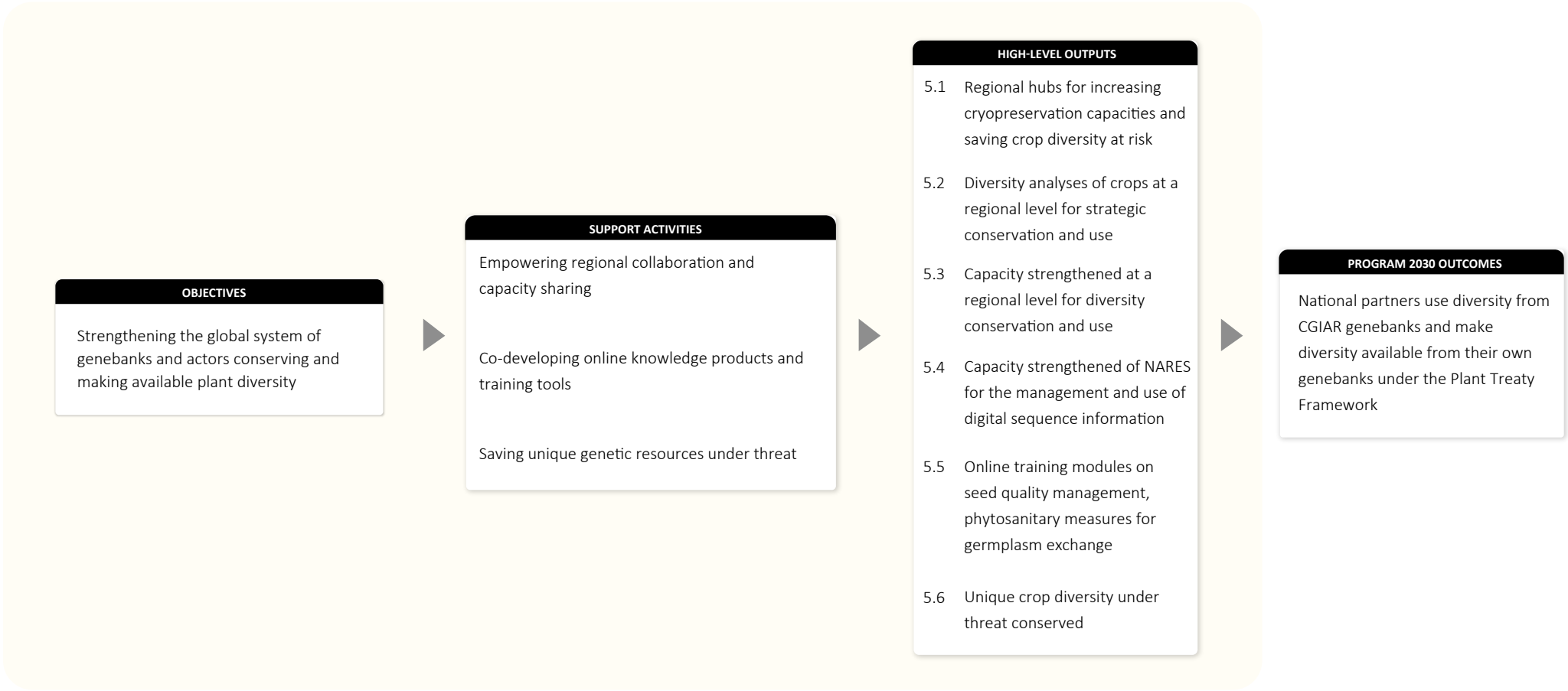
Output 5.5: Online training modules on seed quality management, phytosanitary measures for germplasm exchange. CGIAR and the World Vegetable Center, together with other genebanks, will pool their expertise in a range of thematic areas, including managing and analyzing genotypic data, analyzing diversity and gaps, cryopreservation, subsetting, data management systems, seed quality management, genebank operations, and QMS, to develop online knowledge products and training course modules, which will be made available on platforms such as GRIN-U developed by USDA. This will build on existing training courses, co-developed between CGIAR and the Open University, on PGRFA policy and, more recently, SQM.

In collaboration with the **Capacity Sharing Accelerator**, opportunities will be explored with organizations such as the Mastercard Foundation Scholars Program to support MSc and PhD studentships in genebank-related research. These programs will offer scholarships for courses and research opportunities, targeting students from low- and middle-income countries. Graduates will be equipped with advanced skills to contribute to national and international genebank work. In addition, genebanks will continue to support, where possible, the hosting by **Genebanks** of short-term internships (e.g., World Food Prize Foundation Internships).

Output 5.6: Unique crop diversity under threat conserved. All conservation approaches must take account of the essential actions undertaken by local communities to conserve plant diversity, especially in areas of crop origin and diversity richness. It is unquestionable whether in situ approaches are key to ensuring diversity is maintained. These approaches continue to have a role in farmers' livelihoods, especially for the many crops that are ill-suited to or not represented in ex situ conservation, including crop wild relatives and trees. International genebanks provide first-level safety duplication in complement to the Svalbard Global Seed Vault (which provides second-level duplication). CGIAR and the World Vegetable Center are uniquely positioned to provide reliable, long-term storage for crop diversity at risk of extinction and to repatriate genetic resources and diversity to national genebanks or communities when they are lost. The World Information Early Warning System is a global database that compiles information on accessions in national genebanks, which can be used to monitor the status of conservation at a country level. FAO and Crop Trust have developed an emergency mechanism to support national genebanks in trouble. However, there are no reliable methods for monitoring genetic erosion in the field or responding to risks or evidence of localized decline in crop diversity and knowledge. This is an area of international concern and one which may be assisted by new AI technologies. Given the vulnerability and aging of the rural communities that safeguard such natural and cultural heritage, CGIAR will seek opportunities to attain additional funding to respond directly to irretrievable loss of genetic diversity.

In addition, scientists working in **Multifunctional Landscapes** as well as in the CGIAR and World Vegetable Center genebanks have close ties to several NGOs, farmer communities, and associations that are actively conserving crop genetic richness. Partnering with actors targeting nature-positive solutions, CGIAR will augment its support role in a growing network of in situ conservation sites, providing sources of clean planting material, acting as a conservation backup, encouraging diversity studies, and providing low-resource solutions to medium-term conservation and characterization of plant diversity, as well as responding to requests for repatriation of crop diversity, as it has been doing for many years.

Figure 9. AoW 5: Strengthening Capacity for In Situ and Ex Situ Conservation Globally – ToC.



6.5.4. Partnerships

ToC element #	Statement	Partners (including internal) and roles	Assumption (for outcomes only)	Indicator and target (for 2030 outcomes only)
OP 5.1	Regional hubs for increasing cryopreservation capacities and saving crop diversity at risk	National genebanks *(capacity and germplasm sharing especially on clonal crops)*	Not required	Not required
OP 5.2	Diversity analysis of crops at a regional level for strategic conservation and use	National genebanks *(sharing germplasm and data for analyses)*	Not required	Not required
OP 5.3	Capacity strengthened at a regional level for diversity conservation and use	National genebanks, regional PGRFA networks, Plant Treaty, Crop Trust, Breeding for Tomorrow *(sharing capacity, data, and germplasm)*	Not required	Not required
OP 5.4	Capacity strengthened of NARES for the management and use of digital sequence information	National genebanks *(sharing germplasm, data, and capacity)*	Not required	Not required
OP 5.5	Online training modules on seed quality management, phytosanitary measures for germplasm exchange	Open University, NARES *(hosting training modules, participating in courses)*	Not required	Not required
OP 5.6	Unique crop diversity under threat conserved	NARES, NGOs, Civil Society Organizations *(sharing knowledge, germplasm, capacity)*	Not required	Not required
Program 2030-OC	National partners use diversity from CGIAR and World Vegetable Center genebanks and make diversity available from their own genebanks under the Plant Treaty Framework	All above	Support for NARES partner's genebanks from governments	Increased availability of crop diversity worldwide

7. Country integration

7.1. Example of integration in a country or set of countries

Genebanks work as a group and individual genebanks at every level, from global to local (see Table 2). CGIAR and World Vegetable Center genebanks play a role in conserving and making available crop diversity to all countries across continents, but also to support countries to more effectively conserve and make available their own crop diversity in support of their national breeding systems and research programs and for direct use by farmers. GHUs primarily facilitate relations between CGIAR Centers and national phytosanitary agencies to enable the effective flow of germplasm across international borders while ensuring the prevention of transboundary spread of pests and pathogens. GHUs frequently interact with more than 100 countries annually. Building on the work of the Genebanks Initiative, Area of Work 5 will strategically interact with regions, countries, and communities to address priority needs for capacity sharing. More details on specific activities are provided in Section 6.5.

Table 2. Genebanks' interactions as a group and as individual centers with different communities.

	Global	Regional	National	Subnational
Genebanks as a group	International Treaty on Plant Genetic Resources for Food and Agriculture, International Plant Protection Convention (IPPC), CGRFA, CBD standards, metrics, processes, and policy guidance Online training courses, resources, and tools	Regional networks capacity sharing in specific thematic areas (e.g., digital sequence information (DSI), quality management systems (QMS), germplasm health)	Collation of country reports, statistics, and submissions identify common priorities for capacity sharing	
Individual genebanks and genebank health units	Crop strategies and networks (e.g., International Potato Center leadership of potato strategy)	Collaborations with specific genebanks (e.g., cryohubs, diversity analyses of specific crops, seed phytosanitation, safety duplication)	Training and support for genebanks and national phytosanitary agencies, backstopping, hosting safety duplicates, and repatriation	Interaction with target communities in centers of crop diversity for two-way flow of germplasm and long-term conservation of unique diversity

Global level
The Plant Treaty, International Plant Protection Convention (IPPC), and FAO's Commission on Genetic Resources for Food and Agriculture convene regular international meetings at which policy and other guidance and feedback are provided from countries, regions, and the community as a whole to CGIAR Centers. This guidance influences CGIAR's policies and activities related to research, breeding, and the use of plant genetic resources, and it indicates key priorities for capacity building. For example, in 2023, the Governing Body of the Plant Treaty made a resolution to recommend that CGIAR Centers strengthen their technical assistance to reduce the gap in capacity regarding digital sequence information. CGIAR genebanks will respond to this request by developing capacity-sharing activities (See Section 6.5).

Regional levels
Most regions host networks specifically catering to the conservation and use of plant genetic resources (e.g., Mesoamerican and Andean Plant Genetic Resources Networks). In addition, regional meetings, consultations, and workshops are regularly organized by FAO, the Crop Trust, and CGIAR. There are regional genebanks acting in the Pacific (CePaCT), the Southern African Development Community region (SPGRC), and Central America (CATIE) with which CGIAR and World Vegetable Center genebanks collaborate. Several mechanisms, co-developed by CGIAR and the Crop Trust under the Genebank Platform, are now applied to regional and other genebanks that are signatories to Article 15 of the Plant Treaty. **Genebanks** will continue to lean on these regional mechanisms to reach out, exchange capacities, and develop deeper collaborations. Activities to develop cryohubs and carry out diversity analyses are implemented through regional mechanisms, and follow-up interactions with specific countries are mostly organized through regional entry points.

Country and local levels:
There is more demand for capacity support than can be met by current levels of international support. CGIAR's capacity-sharing role will be primarily directed at supporting as many countries as possible through regional or global level activities (e.g., regional workshops, online training courses, joint diversity analyses, cryohubs, crop strategies, germplasm health, and phytosanitation).

Countries in Sub-Saharan Africa will be targeted for individual support. Many countries have submitted compliance reports with prioritized needs to the Plant Treaty and have important unique collections of diversity (in situ or ex situ) under threat, under-utilized, or under-represented in ex situ conservation. CGIAR and World Vegetable Center genebanks have also developed close relationships with specific institutes, civil society organizations, and communities where farmers and activists are conserving unique crop diversity or are interested in adopting new varieties and crops in their local seed systems to enhance nutrition, create jobs, and increase climate resilience. Funding will be sought to expand partnerships to support in situ/on-farm conservation and to encourage the two-way flow of germplasm so that endangered crop diversity is backed up in ex situ conservation and legacy varieties or other varieties from similar climates are available to farmers for testing, evaluation or other uses.

Examples of these interactions at different levels are summarized in Table 2.

Table 3. Examples of interaction and integration with national partners.

Region	Country	System	Area of Work	Examples	Key partners
Sub-Saharan Africa	Country A	National genebank	**Venues to meet:** Plant Treaty and CGRFA Governing Body meetings **Mechanisms for identifying priorities:** Compliance reports, State of the World on PGRFA, country report to Global Plan of Action, Crop Trust genebank external review, capacity reviews of national breeding programs **Collaboration with CGIAR genebanks:** Support to participate in AGM or regional meeting, advice received on genebank operations, safety duplicates hosted at IITA, AfricaRice, ICRISAT or other Centers, recipient of capacity building on DSI, participant in online course in PGRFA policy, sharing best practices and standards, joint funding for genotyping/phenotyping, candidate to receive targeted help to collect or regenerate unique accessions	AfricaRice partnership with, Madagascar, Mali, IITA with Chad, Niger, ILRI with Rwanda and Zimbabwe, ICRAF with AOCC/ AFPBA, World Vegetable Center with the African Union PGR Working Group, the West and Central African PGR Network, SPGRC, and national collections in Benin, Tanzania, Madagascar, Eswatini, Nigeria, and Ghana to implement the Africa Vegetable Biodiversity Rescue Plan, and NGOs and local governments in the seed kit programs for home and school gardens	Plant Treaty, FAO CGRFA, Crop Trust, **Breeding for Tomorrow**, regional partners, NGOs, African Union
Latin America	Country B	NGO supporting on-farm conservation	**Venues to meet**: Plant Treaty and CGRFA Governing Body meetings, capacity building events, joint projects **Mechanisms for identifying priorities:** Gap analyses identifying centers of crop diversity, partnerships through national genebank **Collaboration with CGIAR genebanks:** Germplasm exchange, safety duplicates hosted at CIAT, CIMMYT, CIP and other Centers, technical assistance for community genebanks, joint funding for regeneration, genotyping, phenotyping, cryopreservation or other activities	Aguapan in Peru, Jala community in Mexico, banana farmers in the Solomon Islands	Plant Treaty, International and national NGOs, Svalbard Global Seed Vault
CWANA, Asia and Pacific	Country C	Public sector research and breeding	**Venues to meet:** Scientific conferences, international exchanges, online searching for germplasm **Mechanisms for identifying priorities**: National mechanisms **Collaboration with CGIAR genebanks:** Germplasm exchange, data exchange, sharing best practices and standards, joint funding for genotyping, phenotyping or other activities	Collaboration with the National Bureau of Plant Genetic Resources (India) and TNAU in India, Rural Development Administration in South Korea, Kasetsart University in Thailand, PRC in VietNam, and UPLB in the Philippines	Government, universities, funding agencies, seed companies
USA, Australia, NZ, and Europe	Country D	National research institute	**Venues to meet**: Plant Treaty and CGRFA Governing Body meetings, European or USDA PGRFA networks, and scientific conferences. **Mechanisms for identifying priorities:** National mechanisms **Collaboration with CGIAR genebanks:** Germplasm exchange, data exchange, sharing best practices and standards, joint funding for genotyping, phenotyping or other activities	Collaboration with IPK Germany, Centre for Genetic Resources, the Netherlands, Netherlands, NPGR USDA	Government, universities, funding agencies, seed companies

8. Boundaries and linkages with other components of the Portfolio

8.1. Boundaries with other components of the CGIAR Portfolio

The scope of **Genebanks** is relatively well-defined, with long-serving teams of trained staff with specific knowledge of the operations and collections they manage. CGIAR genebanks have collaborated as a group for several decades and were first formally established as a Program in 2012 when the Genebank CGIAR Research Program was initiated. **Genebanks'** Areas of Work focus on the conservation and use of crop diversity in the collections managed by CGIAR and World Vegetable Center genebanks and selected partners. There is little overlap with other CGIAR Programs. Any research relates to the optimization of conservation and diagnostic protocols or to the enrichment of knowledge and data resources relating to the collections with the goal of ensuring germplasm requesters are well served and satisfied and that the collections are and remain relevant for use.

CGIAR activities relating to trait discovery, pre-breeding, and breeding will be undertaken in the framework of **Breeding for Tomorrow**. In general, **Breeding for Tomorrow** will generate data related to genebank accessions, and **Genebanks** will harness the data to enrich genebank data resources and promote the use of the collections. There are plant species and product profiles that are not the focus of **Breeding for Tomorrow** but may be under the responsibility of **Genebanks.** These include small millets, traditional vegetables, Andean roots and tubers, soyabean, wild tree, and forage species. For these species, **Genebanks** may seek funding or partnership to further evaluate and use collections toward specific aims.

Genebanks contribute in small but consistent ways to strengthen their overall capacity to conserve and use indigenous crop diversity, individually playing a hub-like role in their respective agro-ecological or geographical regions and for crops for which they have expertise. **Multifunctional Landscapes** is developing nature-positive solutions to address specific development goals that may involve conservation and use of plant genetic resources in target communities and countries. **Genebanks** will provide a support role and genebank services as required in these cases.

8.2. Linkages across the Portfolio

As major service providers to **Breeding for Tomorrow, Multifunctional Landscapes,** and all CGIAR Programs working with plant genetic resources, **Genebanks** and gene health units (GHUs) will:

- Provide clean germplasm for research, breeding, training, conservation, and direct use;
- Provide clean source material for clonal crop seed systems;
- Provide phytosanitary services and diagnostics and liaise with national phytosanitary authorities to move germplasm across borders;
- Conserve, safely duplicate, multiply, clean, and distribute breeding or research materials on behalf of CGIAR Programs where agreed; and
- Promote awareness and provide guidance regarding compliance with international policy on plant genetic resources.

Genebanks will also:

- Adopt and strengthen quality management system (QMS) mechanisms (using harmonized approaches wherever possible) in coordination with **Breeding for Tomorrow,** including audit and validation mechanisms.
- Share market intelligence on trends in requests, germplasm distribution, and users' needs.
- Share and co-develop data standards, phenotyping and genotyping protocols, digital object identifiers, databases (e.g., GIGWA), and enhance interoperability of data systems (e.g., Enterprise Breeding System and GGCE).
- Share capacity in conservation, genebank, and GHU operations, including low-tech approaches (e.g., with **Multifunctional Landscapes**).
- Develop CGIAR policy in response to developments in international policy on plant genetic resources and report on behalf of CGIAR at meetings of the Plant Treaty, CBD, CGRFA, and other bodies.
- Co-develop areas of policy research to inform decision-making and activities to enhance farmers' rights and ABS and capacity sharing relating to DSI.
- Provide model approaches and help, where applicable, for the conservation of other living collections harbored in CGIAR Centers.

Genebanks does not undertake research for development, but **Genebanks** teams collaborate with **Breeding for Tomorrow** on projects to mine collections and crop diversity for traits of importance. This will involve **Genebanks** teams sourcing and selecting diverse genetic resources and potentially carrying out genotypic or phenotypic analyses on behalf of CGIAR Science Programs using co-developed protocols and approaches. These projects will be developed on a case-by-case basis. Key to the success of such activities is the adoption, co-development, and sharing of data standards, ontologies, and platforms for managing data across CGIAR Centers and Programs, which is a vital area requiring the support of the **Digital Transformation** Accelerator. **Genebanks** and **Breeding for Tomorrow** are seeking ways to integrate data and data management systems to improve the sharing of relevant data. Both have adopted GIGWA as database software for managing genotypic data. The **Digital Transformation** Accelerator will facilitate the collaboration of **Genebanks** and **Breeding for Tomorrow** to develop AI tools and an online portal for genetic resources to explore and order germplasm. Linkages are also relevant to climate action around vulnerability assessments for prioritizing adaptation mechanisms, where **Genebanks** data can be used to understand the range of potential environmental adaptations in collections.

Genebanks will also use the information from reviews of national breeding capacity undertaken in the past three years to target the Programs which have identified a lack of conservation services or access to genetic resources as a constraint. A strategy will be developed and implemented between CGIAR and national genebanks to build conservation support for targeted NARES breeding partners.

9. Monitoring, evaluation, learning, and impact assessment

9.1. Monitoring, evaluation, and learning

Genebanks will continue to use an online reporting tool (ORT), which was set up in 2014 to monitor the status of individual collections with respect to performance targets. The World Vegetable Center already uses the same reporting format and performance targets. Through the quality management system (QMS) adopted in the Biodiversity Conservation AoW, genebank operations, data, and accession numbers are audited internally and externally and are subject to regular review by the Crop Trust. The audits ensure that international standards are complied with and deviations and risks are documented and managed.

FAO's monitoring of UN SDG 2.5, State of the World of PGRFA, and the Global Plan of Action, the Crop Trust's oversight of long-term partnership agreements and grants and CBD's Global Biodiversity Framework all require annual, biannual, or periodic submissions from CGIAR and help monitor outcomes of CGIAR and World Vegetable Center genebanks in all five Areas of Work. In addition, individual accessions, their data, and the availability status of national and international genebanks are also recorded and regularly updated in the Crop Trust's online portal, Genesys.

Areas of Work and communities of practice for seed and clonal crops and data management will be coordinated by dedicated staff, who will be responsible for implementing workplans and collating information and feedback from each genebank and GHU. Progress on high-level outputs will be reported also in the Online Reporting Tool in a suitable format to comply with system-level annual reporting requirements. By nature, the Strategic User Engagement AoW will involve an iterative process of identifying target user typologies to engage and develop user entry points into genebank data resources. The success of this Area of Work will become evident in trends in the use of the online portal and germplasm requests monitored under AoW 1 (Biodiversity Conservation). Genebanks will adopt a robust feedback mechanism to monitor rates of response to users' requests and their satisfaction.

Bilateral work relates to research projects, which will not be monitored through **Genebanks**. However, the results of such work will provide new data and information to aid the selection of genebank materials, which will become evident in trends in germplasm requests and the use of materials.

9.2. Impact assessment

The impact of genebanks is notoriously challenging to assess given the lack of germplasm tracking, obscure pedigrees of improved materials, complex attribution patterns along a long impact pathway, and the wide range of users and purposes to which genebank materials are put. Much has been published on the economic impact of traits or diversity sourced from genebanks, and some cost-benefit analyses have concluded that the costs of long-term conservation will be minor compared to the scale of impact and returns on investment of just one disease-resistant trait coming from screening a genebank collection in a major crop. The most impressive impacts occur where "black swan" events (e.g., UG99 wheat stem rust, banana Fusarium tropical race 4) demand the screening and use of diversity found nowhere else but genebanks.

Opportunities will be taken to participate in large, rigorous studies undertaken by downstream partners and Science Programs to which genebanks contribute. For instance, **Genebanks** may benefit from adoption studies undertaken by **Breeding for Tomorrow** or other studied breeding programs. AoW 2 (Strategic User Engagement) will improve germplasm tracking, its use, and follow up with users to monitor potential outcomes of ordering genebank materials. The increasing use of common standard digital object identifiers by CGIAR and other breeders would considerably improve tracking the contribution of genebank materials to widely adopted improved varieties.

Impact stories have been written by postgraduate students and have highlighted the contributions of genebanks to varieties growing in farmers' fields. While these published studies are limited in depth and scope, they suit the scope of genebanks as service providers and the wide range of impacts that genebanks contribute to. The possibility of developing an *ex-ante* study of the option value of digital or AI-assisted genebanks will be explored.

10. Capacity sharing

The primary capacity-building objectives of **Genebanks** are to enable as many partners as possible to adopt simple but effective approaches to improving the conservation and availability of crop diversity in soundly managed genebanks, including through compliance with international policy and phytosanitary standards. Following the activities initiated under the Genebanks Initiative, **Genebanks** will work primarily through regional networks, convening groups of interested national partners to pursue priority themes and needs. The emphasis will be on securing diversity that may not already be well conserved or represented in genebanks and enabling national genebanks and other partners to make crop diversity and data available to users within their constituencies. A wide range of themes have been identified in published reports (Table 4), and CGIAR and World Vegetable Center genebanks can bring capacity and experience. Cryopreservation is an area of specific strength for CGIAR, and securing clonal crop diversity in cryopreservation fulfills the equivalent function of the Svalbard Global Seed Vault for seed. Building capacity to manage and make use of digital sequencing information (DSI) is also a special focus after a 2023 resolution directed specifically at CGIAR by the Plant Treaty Governing Body.

Table 4. Themes for capacity sharing and the expected outcomes for target partners.

Themes for capacity sharing	Description	Outcomes	Target partners
Germplasm collecting and acquisition	Gap analyses, technical preparation before collecting, sampling strategy, formalities for acquisition of germplasm, processing, and safety duplication.	Increased crop diversity conserved and available	Hotpots for crop diversity
Cryopreservation	Securing unique clonal crop diversity through cryopreserving. 2 options: CGIAR cryopreserves on behalf of countries or national partners are hosted and guided to cryopreserve accessions from their genebanks.	Clonal crop diversity better secured in conservation	Phase 1 focused on Latin America partners with some existing capacity. Additional countries where feasible
Diversity analysis	Sharing germplasm for joint genotyping and data analysis to determine genetic diversity across countries and collections.	Indication of complementarity between collections, identification of unique, novel diversity, and redundancy within and between collections	Latin American countries have already initiated activities. Moving to other regions
Seed Quality Management	Processes to maximize seed quality and longevity approaches from automation, improved viability testing, dormancy-breaking, and experiments to test alternative approaches where there are bottlenecks. Also, opportunities to build low-tech approaches to conserving seed in the field.	Increased efficiency in seed genebank processes and low-tech approaches for community genebanks	Aarhus University, national and community genebanks
Phytosanitary measures	Training in the incidence of pests and diseases, phytosanitary measures, diagnostics, and cleaning methods.	Disease-free and efficient international germplasm exchange	International Plant Protection Convention (IPPC) and National Plant Protection Organizations
Data management	Data management for workflow and collection management and promoting use. Crop Trust has developed GGCE software for general adoption by any genebank (including CGIAR). CGIAR genebanks may help countries to customize and adopt GGCE. Also includes the adoption of digital object identifiers, providing data to Genesys and Plant Treaty, managing and using genotypic and phenotypic data for analyses, and accession selection.	Improved availability of accessions through adding value	National partners
Digital Sequence Information (DSI)	Sharing capacity to carry out genotyping or sequencing, analyze, manage data, and make it available for the benefit of national partners.	Improved knowledge of collections and international collaboration	National partners
Implementation of international policy relating to PGRFA	Principles of Plant Treaty, Nagoya Protocol and other relevant policy, implications for national partners, use of the standard material transfer agreement, and related issues on direct use of farmers' landraces.	Improved collaboration and exchange of plant material and related information at national, regional, and global level	National partners especially in Sub-Saharan Africa
Genebank operations	Genebank basics: introduction to the genebank standards and the processes involved.	Improved conservation of crop diversity	National partners, especially in Sub-Saharan Africa
User engagement and germplasm distribution	Development of a strategy to engage users in a country to promote the use of the genebank and provide appropriate crop diversity, including through user groups, subsetting, and participatory evaluation.	Increased strategic use of crop diversity within countries	National partners globally
Quality Management System	Mapping processes, documenting standard operating procedures, checking compliance with standards, internal audit, and introducing other critical elements of QMS.	Improved efficiency of genebank	National partners globally

11. Gender and social inclusion

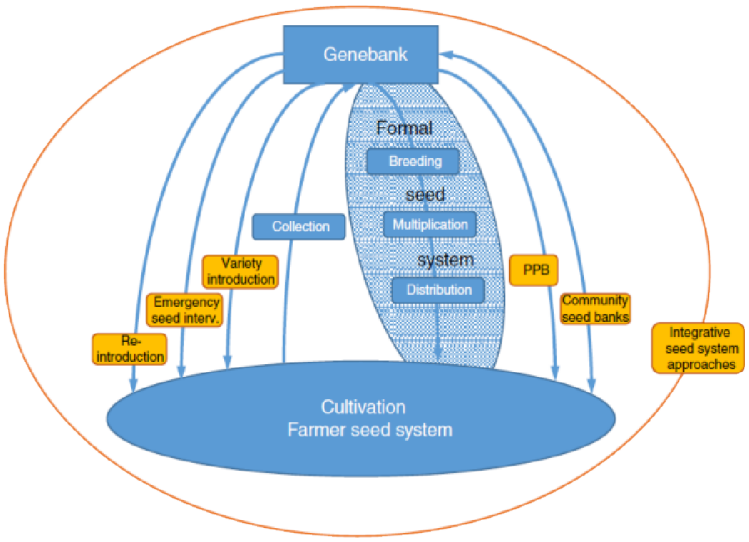
Genebanks are a rich source of crops, characteristics, and alleles that may be attractive to a wide range of users, including women, youth, underprivileged, and marginalized communities. Since genebanks represent an accumulation of farmers' varieties collected over a vast range of space and time, some of the material in genebanks is associated with relatively rare crops and varieties have a special application or local importance that may be relevant to specific groups and contexts. Offering such a choice can help to find solutions to complex and context-specific needs, but only if it is within reach of the communities in need. Without a doubt, the biggest hurdle the international genebanks face is ensuring that the diversity they manage is accessible to those who need it.

CGIAR and World Vegetable Center genebanks distribute materials directly to farmers, individuals, and communities on a small scale. CGIAR genebanks distribute a few thousand samples to farming communities, representing around 8% of their total annual germplasm distributions (although this figure appears to be increasing). Westengen et al.[5] depicted the pathways by which genebanks reach different users and communities within integrated seed systems (Figure 10). Certain crops, varieties, and traits (e.g., clonal crops such as potato and banana, forages, trees spp.) follow direct distribution routes more frequently than other crops depending also on the outreach of genebanks to different user typologies. For instance, CIFOR-ICRAF oversee numerous field stations and nurseries in multiple countries that connect with local farming communities. Also, providing mixed varieties and crops in the form of seed kits can help respond broadly to communities' aspirations to diversify their agricultural outputs and landscapes and integrate multiple food groups for system-based solutions and home gardens. It is acting upon trends in these direct germplasm distributions that **Genebanks** may be able to contribute directly to gender and social inclusion impact.

There are evidence gaps regarding the impact of genebank services and resources on women's livelihoods and empowerment, and limited understanding of which strategies will be effective in attracting women, youth, and minorities to explore genebanks for their benefit. There are few published studies on which to base immediate planning, although the Crop Trust carried out a desk study and has made general recommendations. AoW 2 (Strategic User Engagement). provides an opportunity to change this lack of information and promote approaches to specifically target the participation of women, youth, Indigenous People, and marginalized communities in accessing genetic resources and genebanks that are relevant to them. Such approaches will be based on the combined needs for (1) strategies to identify, prioritize, and engage target groups, including through capacity sharing, (2) ensuring that the tools, language, and mechanisms to explore genebanks can be developed to be attractive to target groups, (3) determining that the data, traits, and materials presented are relevant and of interest to target groups. In many cases, international genebanks are not best placed to directly engage target users, whereas national or local genebanks and seed systems, NGOs, projects, other CGIAR Programs have more direct involvement and capacity. It is critical that CGIAR and World Vegetable Center genebanks, as potential first ports of call online for users seeking good quality seed or new varieties, act not just as experts on the collections under their management but are knowledgeable of the wide range of relevant resources that may be more appropriate to users' needs and available from other sources.

In a more focused way, through AoW 5, individual genebanks will connect with communities on a small scale to encourage a two-way flow of germplasm and help to build capacity and provide safety backups to support in situ conservation of crops of mutual interest. Several genebanks nurture existing in situ – ex situ connections with communities where there remains a strong cultural connection to crop diversity and traditional knowledge. The custodians of such diversity are mostly from an older generation who have actively conserved their agricultural heritage against strong pressures to change. However, they struggle to interest younger generations to do the same. It is evident that without additional support these cultures, varieties and knowledge will follow a path to extinction that many other crops and cultures have previously trodden.
In countries where they have a strong presence, international genebanks may have the taxonomic expertise, legal status, and reliable conservation practices to work with such marginalized, diversity-rich communities to provide support in various ways and ensure that they access genebank resources and neither genetic diversity nor traditional knowledge are lost.

Figure 10. Distributions from genebanks to different constituents of the farmer seed system. Source: Westengen et al. 2017.



[5] Westengen, Ola T.; Hunduma, Theshome; Skarbø, Kristine (2017): From genebanks to farmers. A study of approaches to introduce genebank material to farmers' seed systems. Noragric Report No. 80 (March 2017). Aas: Norwegian University of Life Sciences (NMBU).

CGIAR and World Vegetable Center genebanks will also continue to lean on collaborators who are better positioned to actively address gender and social inclusion through research. In particular, genebanks collaborating with **Breeding for Tomorrow**, will carry out trait discovery to respond to specific gender-relevant market segments, building on the gender strategy of the Accelerated Breeding Initiative. **Genebanks** may be able to further expand the range of materials available with potential gender-relevant traits by developing subsets and expanding characterization data to include these traits. **Genebanks** will seek collaborations for project funding where possible. Initiatives such as HarvestPlus, illustrated that mass screening of genebank collections for relevant traits, in this case micronutrient content, can radically change the course of breeding toward new products that are highly relevant to women and children. A similar focus on specific traits relevant to marginalized groups will help identify additional ways genebanks can contribute to social inclusion goals.

12. Climate change

The changing climate puts increasingly homogeneous farming systems at risk of failure through extremes of abiotic stress and evolving pests and diseases. Rapidly unfolding climate-related disasters and an accelerating pace of climate change can only be addressed by keeping open as many options as possible. Agricultural biodiversity is expected to play a significant role in mitigating and adapting to the adverse effects of climate change. A key to achieving adaptation is broadening the range of crops and the genetic base of crops to diversify farming and food systems and building resilience. Simulation studies have demonstrated simple and feasible changes in farm practices can have significant positive impacts on crop productivity.[6] The continued availability and accessibility of both traditional and improved varieties of a portfolio of crops is key to future improvements in crop productivity. Genebanks are a rich source of adaptive traits and alleles in both landraces and wild relatives that can be made available through a range of projects, tools and approaches in adaptive breeding, developing new varieties of globally important crops under new challenges from climate change.

Specific crops have individual roles in climate change scenarios. They include species and landraces that can withstand extreme heat or drought (e.g., barnyard millet, sorghum, pearl millet, fonio), floods and submergence (e.g., submergence tolerant rice), or that have adaptations across a wide range of altitudes and temperatures (e.g., potato, maize) or resilience as famine foods (e.g., grass pea, millets, taro). By making these species available for use to breeders, research, or potentially mixed seed kits directly to users, genebanks can contribute widely to positive impacts on climate adaptation. With guidance from **Breeding for Tomorrow** and **Climate action**, accession data on relevant characteristics may be refined and ontologies for widely applicable climate-relevant traits may be developed and agreed upon so that genebank materials can be more easily searched and identified. CGIAR genebanks have been actively improving geographical reference data and proxies to add relevance to accession data. Subsets relating to climate-relevant traits and pest and disease resistance also continue to be developed to enable researchers to mine further into the genetic diversity of collections to assess the levels of variation that may exist in crop gene pools. Machine learning and AI may be used to determine environmental parameters relating to accession origin and onset data to refine sets of accessions that may have inherited environmental tolerances.

Ultimately, CGIAR and World Vegetable Center genebanks work as a backup precisely to deal with the many small-scale crises caused by extreme weather events that cause communities and countries to lose access to crop diversity. While the Svalbard Global Seed Vault acts as the last resort, countries, and communities regularly come to CGIAR and World Vegetable Center genebanks as a first port of call to replace or complete their crop collections and to repatriate varieties to farmers where they have been lost.

The management of genebank accessions and operations themselves has been impacted by climate change in multiple ways. The incidence of pests and diseases is impacting germplasm exchange as well as management of genebank accessions in the field. For clonal crops, this frequently leads to the destruction of incoming shipments at the point of entry. These fragile crops are proving costly to exchange. Investment in GHUs through **Genebanks** will help keep up with technologies and protocols and ensure germplasm exchange remains safe. In addition, the point at which conserved seeds are exposed to both pests and diseases, as well as weather events is when they are regenerated in the field. As accessions are planted in relatively low numbers, adverse conditions can destroy a harvest completely and require repeated plantings. Particularly vulnerable accessions with low seed numbers, such as crop wild relatives, demand more careful nurturing in screenhouses or controlled conditions. These challenges are shared with farmers in the field. Conserving crop diversity in situ and encouraging tighter linkages between in situ and ex situ will bring ever more benefits. In the meantime, more efficient operational capacity, seed quality management, and cryopreservation will help minimize the need to regenerate or rejuvenate accessions. Nearly all CGIAR genebanks are now fitted with solar panels and have reduced their electricity consumption, with Future Seeds in Colombia taking it a step further in achieving platinum-level LEED certification. Further opportunities to green genebank operations and facilities will be taken where presented.

13. Risk management

Note: Risks will be finalized and mitigation actions will be developed as part of the risk management plan during the Inception Phase.

All genebanks have conducted in-depth risk management as part of their quality management system (QMS). Furthermore, they have overcome extreme events while successfully managing severe risks to the collections. The achievements of the previous three programs of work, starting in 2012, have significantly improved the status of collections, infrastructure and genebank processes, including the safety duplication of the collections. CGIAR genebanks are much better placed to deal with existential risks than they were. In addition, **Genebanks** proposes to implement a real-time risk awareness mechanism that allows the group to share updates on emerging risks influencing activities in any one genebank, which will allow Program coordination to be informed of any potential escalation of risks that may require contingency planning or funding. Emerging risks relate to unrest in Western Asia, which may affect the operation of the ICARDA genebank and the ability of CGIAR Centers and System to manage the reform of the oversight, funding, and management of programs.

[6] Alimagham et al. (2024) Climate change impact and adaptation of rainfed cereal crops in Sub-Saharan Africa. *European Journal of Agronomy*, 155: 127137, https://doi.org/10.1016/j.eja.2024.127137

Table 5. Preliminary risks identified at early design stage.

Risk title (summarized statement)	Risk statement including potential event, sources, and consequences on objectives
Risk 1	CGIAR Centers fail to make information available relating to the use or users of genebanks or do not collaborate or share data to enable **Genebanks** to progress on the development of unified approaches for data management infrastructure, harmonized processes, and the development of a portal to facilitate users' access to genebank data and germplasm ordering.
Risk 2	The International community adopts policies that undermine the ability of **Genebanks** to partner with outside organizations in activities that involve exchanging germplasm and digital sequence information, resulting in the unavailability of biodiversity to address Program objectives and outcomes.
Risk 3	There is insufficient capacity, resources, or authority of management structures to facilitate the coordination of collective work under the Areas of Works or the technical and financial oversight of the Program, and pooled funding for the Program is not used for the intended purposes.
Risk 4	Changes in management mechanisms, coordination team, and budget cause disruptions in genebank operations, Program activities, or changes to the objectives of the Program.
Risk 5	Unrest or unpredictable events occur in countries hosting CGIAR and World Vegetable Center genebanks, including the emergence of new pests and diseases, that diminish the capacity of the group to achieve the intended outputs of the Program and demand an immediate reallocation of resources for recovery actions.

14. Funding sources

Genebanks will continue to be predominantly funded by pooled funding. Operations, as described in AoW 1, will be partially funded by the Crop Trust endowment fund, which is specifically targeted to fund international genebanks' essential operations in perpetuity. Long-term partnership agreements between the Crop Trust and specific CGIAR genebanks (IRRI, CIAT, and IITA seed collections) cover a large part of the costs of essential operations. All other CGIAR and WorldVeg genebanks have long-term grants, which range in size from USD 50,000 to USD 400,000 per year (see Table 6).

Due to CGIAR's legal obligation to provide germplasm and genebank services and to the recognized challenge of securing funding for conservation activities, Genebanks have been identified as a pooled funding priority by CGIAR funders since 2012. From 2018 to 2021, as per the CGIAR annual Financing Plan, the Genebanks Platform received the first cut out of the W1 funding. A ringfence mechanism was agreed by the System Council in 2022 and updated in 2023. This funding stability has been evaluated as highly beneficial by two external programmatic reviews (2017 and 2023) and should continue to apply to **Genebanks**.

The need for establishing mechanisms to ensure that CGIAR genebanks are adequately funded has been recognized since the 1990s. The origin and objective of the Crop Trust in 2004 was to fund CGIAR and other international genebanks. The endowment fund now stands at approximately USD 300 million, whereas an endowment of approximately USD 920 million is required to cover the current operating costs of 11 CGIAR and WorldVeg genebanks. The endowment mechanism has succeeded in that the income generated to support genebanks is greater than the donations that were originally made into the endowment mechanisms. However, there are reservations as to whether the Crop Trust can reach the needed fundraising target, which is why CGIAR cannot expect increased funding in the coming years. Consequently, additional mechanisms are needed to cover the costs of **Genebanks**. These mechanisms could involve levies, cost recoveries, sponsorship, fundraising, and mechanisms to boost funds going into the Crop Trust endowment. Dedicated time and expertise will be needed to explore the feasibility of these options in coordination with System Council members and the Crop Trust.

The introduction of costing in 2010, the genebank QMS, and the budgets of the Platform and Initiative have created incentives to control operating costs. Some success and evidence of improved cost efficiency have been reported (see IAES report). A Systemwide Genebanks Costs and Operations review report considered the future of the Genebank Platform and concluded that there may be a logical justification to centralizing long-term conservation capabilities across CGIAR.

Genebanks' Areas of Work are highly interconnected, depend on the same CGIAR and WorldVeg teams, and together form a coherent service package, responding to the recommendations of the IAES external review of the Genebank Platform. This allows funders to support **Genebanks** as an integrated and coordinated program. Scaling up activities and levels of funding would be beneficial, particularly for partnerships between genebanks and breeding to mine the collections for trait discovery using new technologies such as AI. It is also a priority to seek more funding for capacity sharing, especially to work with communities to ensure that endangered diversity is saved and available for use under the Area of work on Strengthening in situ and ex situ conservation globally.

Table 6 contains a list of bilateral projects mapped to **Genebanks**, representing roughly USD 30M USD.

Table 6. List of bilateral funded projects mapped to Genebanks

Project/ program title	Lead CGIAR Center	Funder	Duration	Expected 2025—30 funding (USDs)	Relevant Program Areas of Work, if known
Long-term conservation and sustainable use of plant genetic resources	CIAT	Global Crop Diversity Trust	2023-27	$4,139K	Genebanks, AoW 1
Screening, developing, and deploying anti-methanogenic feedstock into livestock systems in the Global South	Bioversity	Bezos Earth Fund	2023-28	$2,184K (CIAT genebank component)	Genebanks, AoW 2
Mining useful alleles for climate change adaptation from CGIAR gene banks	CIMMYT	BMGF	2022-26	$58K (CIAT genebank component)	Genebanks, AoW 2
Fast Tracking Climate Solutions from CGIAR Germplasm Banks	CIMMYT	FFAR	2022-26	$171K (CIAT genebank component)	Genebanks, AoW 2
Genebank genetic characterization and process optimization	CIMMYT	MasAgro-SADER- Mexican Government	2024	2.5M	Genebanks, AoW 2
Long Term Patnership Grant for conservation of the rice biodiversity at AfricaRice genebank	AfricaRice	Global Crop Diversity Trust	2024-2028	$ 780K	Genebanks AoW1
Genebank essential operations	ICRAF	Global Crop Diversity Trust	Jan 2023-Dec 2024	USD 500K	Genebanks AoW1
To provide sustainable solutions in global food production and nutrition security, to improve the livelihoods of many	ICRAF	ACIAR	June 2024-June 2025	AUD 1M	Genebanks AoW1
Genebank Essential operations	ICRAF	FAO-NORAD	Jul 2024-Jun 2025	USD650K	Genebanks AoW1
Long-term Grant (LTG)	ICRISAT	Global Crop Diversity Trust	2024	407K USD	Genebank, AoW 1
Conservation of ICRISAT genetic resources for food and nutrition security in the semi-arid tropics	ICRISAT	FAO-NORAD	2024-2025	750K USD	Genebank, AoW 1
Characterization of Chickpea Germplasm Resource to Accelerate Genomics-assisted Crop Improvement	ICRISAT	Department of Biotechnology, Ministry of Science and Technology, Government of India	2020-2025	1.09 million USD	Genebank, AoW 2
Bihar: Centre of Excellence for Millets and Value Chains	ICRISAT	Govt. of Bihar, India	2023-2028	1.6 million USD	Genebank, AoW 2
Sustainable intensification of millets for food and nutritional security in Asia and the Pacific	ICRISAT	FAO	2024-2025	10 K USD	Genebank, AoW 2
Development of Rain-fed Cereal Production in Saudi Arabia	ICRISAT	FAO	2023-2025	633K USD	Genebank, AoW 2
Long term funding of ex situ collections of germplasm	ILRI	The Crop Diversity Trust	2025-2030	$707K (assuming the current annual fund allocation)	Genebanks, AoW 1
Screening, developing, and deploying anti-methanogenic feedstock into livestock systems in the Global South	ILRI	Bezos Earth Fund	2023-2028	2,315K (ILRI share for 2025-2028)	Genebanks, AoW 2
Screening, developing, and deploying anti-methanogenic feedstock into livestock systems in the Global South	ILRI	BMGF	2023-2028	2,696K (ILRI share for 2025-2028)	Genebanks, AoW 2
Defining new phenotypes for forage and crop residue improvement based on rumen function and greenhouse gas emissions (UK-CGIAR)	ILRI	FCDO	2024-2026	500K (expected ILRI share for 2025-2026)	Genebanks, AoW 2
Implementation of a new Cryobank at the International Potato Center	CIP	GIZ	2022- 2025	USD1.2M	Genebanks AoW 4

Project/ program title	Lead CGIAR Center	Funder	Duration	Expected 2025—30 funding (USDs)	Relevant Program Areas of Work, if known
Long Term Partnership Grant	CIP	Crop Trust	2024		Genebanks AoW 1
Fortalecimiento de la conservación y uso sostenible de variedades locales de raíces y tubérculos andinos libres de enfermedades en la Zona de Agrobiodiversidad Andenes de Cuyocuyo- Puno	CIP	CGIAR/Peru	2023-2026	USD200K	Genebanks AoW 4
Estrategia de negocio para el mercado de alimentos funcionales, utilizando variedades locales de yacón de Pataz y del Centro Internacional de la Papa: un enfoque innovador.	CIP	Poderosa (Mining company)	2023-2026	USD800K	Genebanks AoW 4
Harvesting Resilience: Harnessing Andean Crop Diversity to Weather Climate Change	CIP	GCBC	2024-2026	USD700K	Genebanks AoW 4
VACS: Vision for Adapted Crops and Soil: Bambara Groundnut	IITA	US Dep. Of Agriculture	2024- 2027	USD1,4M	Genebanks AoW 2
BOLDER Project: Building Opportunities for Lesser-known Diversity in Edible Resources project (BOLDER)	IITA	Crop Trust	2024	USD100K	Genebanks AoW 4
Cowpea Allele mining project: Mining useful alleles for climate change adaptation in cowpea from CGIAR Genebanks (year 2022-26). Funding Source: BMGF	IITA	BMGF	2022-2026	USD2M	Genebanks AoW 2
Cassava Allele Mining Project: Mining useful alleles for climate change adaptation in the cassava from CGIAR Genebanks	IITA	BMGF	2022-2026	USD2M	Genebanks AoW 2
DANIDA project: Enhancing production of local underutilized food crops under climate change	Sub grantee IITA	Danish Government	2024-2028	USD67,000	Genebanks AoW 4
Long Term Partnership Project	IITA	Crop Trust	2023-2027	USD500K	Genebanks AoW 1
VACS: Vision for Adapted Crops and Soil: Taro	IITA	US Dep. Of Agriculture	2024- 2027	USD1,4 M	Genebanks AoW 2
LPA	IRRI	CropTrust	2024-2028	USD 7,778,192 (Total)	Genebanks AoW 1
Google AI Project	IRRI	Google	2023-2026	USD 2M (Total)	Genebanks AoW 2
eGWAS	IRRI	BMGF	2022-2026	USD 100k per year (Genebank component)	Genebanks AoW 2
Strengthening national capacities and regional integration for efficient conservation of plant genetic resources in post conflict countries	ICARDA	FAO	Nov 2020-2024	450,000 USD	Genebanks AoW 4
Support to upgrade Genebank in Baghdad and creation of a Genebank in Sulaymaniya Governorate, Kurdistan Region of Iraq	ICARDA	FAO	March 2024- June 2025	98,748 USD	Genebanks AoW 4
Revealing the Diversity of Barley Quality Traits through Synergies between On-farm Practices and Technological Innovations	ICARDA	FAO- ITPGRFA	2024- 2027	490,000 USD	Genebanks AoW 2
Screening, developing, and deploying anti-methanogenic feedstock into livestock systems in the Global South	ICARDA	Bezos Earth Fund	Sep 2023 – Aug 2028	570,193 USD	Genebanks AoW 2
Capacity and resource development of Lebanon's and Morocco national genebank	ICARDA	Crop Trust	Oct 2023-Dec 2024	380,000 USD	Genebanks AoW 4
LTG	ICARDA	Crop Trust	2020-2024	412,000 USD per year	Genebanks AoW 1

Table 7 provides an indicative allocation of funds per AoW based on the baseline budget approved by the CGIAR Global Leadership Team in November 2024. Funding to AoWs 1, 3, and 4 (Genebanks operations) cannot be reduced. To ensure sound operation of the Genebanks, GHUs, and policy work, and account for inflation, AoW 1's share of the total budget has increased compared to the 2022-2024 Portfolio. AoWs 2 and 5 fall short of their needs in terms of minimum viable required funding, which will have a significant impact on the team's ability to engage with NARES and other partners.

The baseline budget does not cover the full costs of the ICRISAT genebanks, nor the costs of the ICRAF and WorldVeg genebanks. Increased funding would allow implementation of the planned activities under AoWs 2 and 5 and the inclusion of ICRAF and WorldVeg genebanks.

Table 7. Breakdown of pooled funding by AoW in the baseline scenario (2025), in USD M

Area of Work	Pooled funding budget
Area of Work 1. **Biodiversity conservation**	22.0
Area of Work 2: **Strategic user engagement**	0.53
Area of Work 3: **Access and benefit sharing**	1.2
Area of Work 4: **Germplasm health**	2.21
Area of Work 5: **Strengthening in situ and ex situ conservation globally**	0.53
TOTAL	**26.47**

Annex - Pooled funding

All Areas of Work are targeted for pooled funding. The current proposal does not include additional sources. However, bilateral funding is particularly relevant for scaling up Areas of Work 2 and 5. The proposed budget follows closely the budget of the Genebank Initiative, but also includes budgets for CIFOR-ICRAF and World Vegetable Center genebanks in all Areas of Work except for AoW 3 (policy). AoW 1 combines parts of the Genebanks Initiative Work Packages 1 and 2. AoW 2 involves group work to strategically engage users instead of disparate budgets for Centers to work independently on a range of activities to promote the use of the collections. Policy and Germplasm health are budgeted separately as AoW 3 and 4 instead of being budgeted together with genebank activities, as was the case in Genebanks Initiative Work Package 2 and 4.

Funding from the Crop Trust endowment fund is not expected to increase unless there is a significant increase in the total value of the endowment. A USD 25 million increase in the endowment may trigger an increase in annual withdrawal of USD 1 million and, subsequently, a grant of similar size. All CGIAR genebanks will be eligible for funding since they will have reached performance targets by 2030. However, the size of the endowment fund will limit the amount of funding that the Crop Trust is prepared to make available.

Responding to recommendations from the IAES external review and comments from ISDC, **Genebanks** invests more in partnership and expands the work of the communities of practice to national partners and the Genebanks efforts to share capacity in conservation and use of genetic resources. If there is any increase in Crop Trust funding in the form of long-term partnership agreements, the savings made in pooled funding will be directed to AoW 5 and partnership and capacity building with national partners and communities.

CGIAR

Genebanks

Appendix

November 15, 2024

Appendix 1: Summary details of genebanks

1. AfricaRice		
Collections	Africa Rice represents an association of 28 African countries, on whose behalf it conserves and makes available a collection of rice originating mostly from African countries, including the world's largest collection of Oryza glaberrima. The genebank is in purpose-built facilities in Cote D'Ivoire. It has one of the largest indoor and outdoor facilities in Africa accessible for partners in the region for germplasm conservation, safety backup, regeneration/rejuvenation, and characterizations. The Rice Biodiversity Center for Africa has responsibilities to manage genebank operations in accordance with performance targets; (ii) characterize the collections; (iii) serve as a showcase and raise public awareness on rice biodiversity; (iv) share resources, knowledge, and expertise with the national genebanks in Africa to advance scientific research in the continent; and (v) encourage/promote knowledge transfer and access to information.	
Expertise and staff	• Genebank manager (more than 20 years of experience in rice R&D) • Rice genetics/genomics expert • 4 Senior Research Assistants, 5 research technicians and two lab junior assistants assisted by temporary workers • GHU has 3 staff (1 pathologist (10%), 1 GHU manager (full time), and a technician (full time)) assisted by temporary staff.	
Status	Accession numbers in 2023	20,681
	Crops	Rice, wild *Oryza*
	Performance targets	Reached performance targets in 2021
	Eligibility for Crop Trust funding	Awarded a long-term grant in 2024. Eligible for advanced funding under a Long-term partnership agreement (LPA) when Crop Trust has sufficient funding
	Genebank users	NARS, CGIAR, Advanced Research Institutes (ARI), farmers, universities, NGOs, Farmers Organizations,
Germplasm Health Unit	The GHU provides the following services for rice germplasm, including wild relatives and breeding lines: import/export procedures, active growth stage inspection, post-entry inspection, and clearance, GMO declaration, and health statement processing. The Unit is also engaged in research activities, including the development of diagnostic assays, seed treatment protocols, procedures for bulk sampling, epidemiology of seed-transmitted pests and diseases and, maintaining isolate banks for seed-borne microbes, guiding on risk assessments and preparedness procedures, data management and capacity development and sharing.	
Plans for improvement	• Fully implement molecular methods for duplicate identification • Adopt green measures to reduce the cost of electricity • Phenotypic and molecular characterization/evaluation to generate information to enhance conservation and use in collaboration with NARS • Acquire non-destructive near-infrared reflectance spectra from rice seeds to predict nutritional seed trait • GHU: adopt molecular methods for pathogen detection, improve microscopic detection, optimize seed treatments, improve seed-borne pathogen storage efficiency, improve data management, transmission, and waste disposal/incineration.	

2. Bioversity International		
Collections	Bioversity International Musa Germplasm Transit Centre (ITC) manages the world's largest collection of banana (70% cultivated banana, 15% wild relatives and 15% improved varieties). The collection is conserved in vitro and backed-up at IRD, France (in cryo) and at ULiège, Belgium (in vitro). The ITC is establishing a seed collection of Musa wild relatives in partnership with Meise Botanical Garden, Belgium. The ITC is hosted by the Katholieke Universiteit Leuven in Belgium. It conducts fieldwork through a network of NARS partner (under MusaNet) and at the CIAT lands in Palmyra.	
Expertise	• Cryopreservation specialist (> 30 years working on tropical crops, protocol development and training) • In vitro specialist (>30 years) • 3 research technicians, 1 IT staff and 5 specialized lab technicians • Expertise in Musa database, molecular characterization and bioinformatics in Montpellier	
Status	Accession numbers in 2023	1,705
	Crops	Banana, plantain, wild *Musa*
	Performance targets	To reach targets before 2030. Constraint presented in genome-integrated pathogen in B genome cultivars (e.g. plantain etc)
	Eligibility for Crop Trust funding	Has held a long-term grant since <2008. Not eligible for advanced funding.
	Genebank users	Universities, advanced research institutes, NARS, commercial companies
Germplasm Health Unit	GHU outsourced to University of Liege, provides the following services for Musa germplasm, including wild relatives: virus elimination, seed health certification, research activities, including the development of novel diagnostic assays, virus therapy protocols, quality assurance, data management and capacity development.	
Plans for improvement	• Increased health testing capacity and implementation of novel diagnostic assays which should increase the efficiency of the health testing and reduce costs. • Gain knowledge on somaclonal variation and epigenetics in banana to ensure the trueness-to-type of conserved germplasm. • Digitization of the cryopreservation processes and data.	
3. CIAT		
Collections	CIAT manages large and diverse collections of beans and tropical forages as seed and whole plants, and cassava in vitro and as 'bonsai' plants. Future Seeds, a new state-of-the art facility houses the collections and has Leadership in in Energy and Environmental Design (LEED) Platinum Level certification for its sustainable use of resources.	
Expertise	• Genebank Manager (24 years' experience, genetics/genomics, pre-breeding) • Senior staff: Operations Manager, Clonal Crop Coordinator, Genebank Genomics Coordinator • Seed Conservation and Regeneration team: 20 research coordinators, assistants and associates • Clonal Conservation team: 5 research coordinators, assistants and associates • GHU team: 9 research coordinators, assistants and associates • Genebank Genomics team: 4 research coordinators, assistants and associates • Information Management team: 6 system engineers, developers and data managers	
Status	Accession numbers in 2023	64,600 actively curated accessions
	Crops	Beans (*Phaseolus* spp.), cassava (*Manihot* spp.), more than 700 species of tropical forages
	Performance targets	Have reached performance targets for beans and forages; receiving LPA funds covering part of bean/forage routine-operation costs since 2023
	Eligibility for Crop Trust funding	Will reach performance targets for cassava in 2025
	Genebank users	NARS, universities, CGIAR breeding programs, NGOs, farmers
Germplasm Health Unit	The GHU provides several services to the genebank and the four crop programs: import/export health declarations, active growth stage inspection, post-entry inspection and clearance, capacity development and sharing, and research targeting the development of diagnostic assays, the improvement of methodologies and quarantinable pathogen surveillance, and the elucidation of the epidemiology of seed-borne pests and diseases. The Unit is registered with the Colombian National Plant Protection Agency and has implemented a QMS according to ISO/IEC 17025:2017 standards.	
Plans for improvement	• Move field stations for bean and forage regeneration out of areas with resurgent guerrilla activity to safer sites • Archiving cassava accessions • Migrate to RFID-enabled inventory management system • Acquire non-destructive near-infrared reflectance spectra from bean seeds to predict nutritional seed trait • GHU: update QMS under ISO 17025 standard and register all assays (including for rice) with the Colombian NPPO and implement several technical improvements in laboratory procedures, such as reference library creation, NGS-based pathogen detection in cassava collection, new molecular assays for seed health testing; also: integrate GHU data management with GrinGlobal Community Edition	

4. CIMMYT		
Collections	CIMMYT manages one of the world's most diverse maize and wheat collections, comprising over 28,000 maize and 124,000 wheat accessions, distributing up to 10,000 samples worldwide annually. The genebank has ISO 9001:2015 certification.	
Expertise	• Maize and Wheat Curators • Genebank Coordinator (22 years of experience) • 5 process leaders and an SQM manager.	
Status	Accession numbers in 2023	152,507
	Crops	Maize, Zea spp, Wheat, Triticum, Aegilops spp
	Performance targets	Reached performance targets in 2024.
	Eligibility for Crop Trust funding	Has a long-term grant since 2008 for wheat and 2010 for Maize. Eligible for advanced funding under a Long-term partnership agreement (LPA) when Crop Trust has sufficient funding
	Genebank users	NARS, CGIAR, ARIs, farmers, Universities, NGO, Farmers Organizations
Germplasm Health Unit	The GHU (Seed Health Lab) provides the following services for maize and wheat germplasm, including its wild relatives and breeding lines: import procedures, phytosanitary diagnosis to meet import/export requirements, active growth stage inspection in each different experimental cycles and stations, preparation of maize samples for shipment to a laboratory in the US for GMO analysis and GMO free declaration, and research activities, including the development of diagnostic assays, seed treatment protocols, procedures for bulk sampling, epidemiology of seed-transmitted pests and diseases, data management, QMS, capacity development and sharing.	
Plans for improvement	• Renovation plan to improve the infrastructure, aligning spaces with updated and efficient workflows, reducing the medium-term storage vault temperature from minus 4°C to minus 18°C • Hire a specialist for SQM and videometer characterization and data and informatics manager • Improve maize regeneration success rates working with partners in more suited agroecological conditions • Purchase equipment to automate seed selection and conditioning processes • GHU: PCR for virus detection, introduce electronic recording of results using tablets, acquisition of a sequencer for genotype-based pathogen identification	

5. CIP		
Collections	A highly complex collection of difficult-to-conserve roots and tuber crops and the largest in vitro and cryo collection in CGIAR. Field and screenhouse collections are managed in a high-altitude site as well as the Lima campus. The potato collection is 92% cryobanked. Many wild species are conserved. Andean Root and Tuber Crops (ARTC) comprise nine of non-Annex 1 crops, held in vitro, as seeds and in the field. Largest herbarium in the CGIAR. Operates at high-level ISO 17025 standards.	
Expertise	• Genebank Head (18 years' experience in different genebanks, biodiversity conservation, molecular characterization, in situ and ex situ approaches) • Senior scientists: genetic resources and phytopathologist scientist, genetic resources and pre-breeding scientist • Cryopreservation scientist with over a decade experience • Potato, sweet potato and ARTC curators (especially in situ and ex situ integration) • Data analysis team (5 people), including morphological, molecular, genomics data and AI • In vitro and phytosanitary coordinators • Complete herbarium collaborating with taxonomists globally • Data manager	
Status	Accession numbers in 2023	16,507
	Crops	Potato (Solanum spp.), sweet potato (Ipomea spp.), oca, olluco, yacon, arracacha, achira, maca, mashua, mauka, pachyrhizus
	Performance targets	Achieved for potato in 2024l sweet potato to reach in 2025-2026; ARTC 2030
	Eligibility for Crop Trust funding	Has had a long-term grant and is eligible for advanced funding under a Long-term partnership agreement for potato once Crop Trust has sufficient funding.
	Genebank users	Farmers Organizations, NARS, CGIAR, Advanced Research Institutes (ARI), Universities, NGO, Farmers
Germplasm Health Unit	The GHU (Health Quarantine Unit) provides the following services for root and tuber crops held in CIP genebank, including its wild relatives and breeding lines: diagnostic testing, import/export procedures, active growth stage inspection, post-entry inspection and clearance, GMO declaration, and research activities, including the development/validation of diagnostic assays, seed treatment protocols, data management, QMS, capacity development and sharing.	
Plans for improvement	• Conclude identification of duplicates and implement a rationalization plan for potato and sweet potato clonal collections • Trueness-to-type testing for seven ARTC conserved as in vitro, identification of duplicates, to optimize and increase efficiency in conservation • Improve sweet potato and ARTC cryopreservation protocols and move faster with the cryopreservation of cultivated sweet potato • Develop cryopreservation protocol for potato seeds and improve status of seed collection for of critical potato wild relatives • Rationalize the in vitro collection by maintaining at least 10% of the clonal collection just in cryo • Safety duplicate cryo copies • Phytosanitary protocols for virus elimination emphasizing cryptic viruses and begomoviruses • GHU: Develop, standardize, and validate new/improved diagnostic methods for testing pathogens in, but not limited to, CIP's mandate crops as a support to the local NPPO and producers. • Continue developing and updating the GHU-PLIMS to reflect current and new diagnostics, record results, and speed up the transfer of results from the GHU data management system to the GrinGlobal database.	

6. ICARDA		
Collections	ICARDA manages highly diverse collections of eight crop groups, characterized by traditional landraces and wild species from the Fertile Crescent. The genebanks are located in two sites: Morocco for the conservation of cultivated species of wheat, barley, chickpea and lentil; and Lebanon for crop wild relatives of cereals and legumes, forage and rangeland species and faba bean.	
Expertise	• Research team leader: Breeding, Population genetics, Focused Identification of Germplasm Strategy, Data management, Genomics • Genebank managers: Breeding, taxonomy and phylogenetics, collections and botanical surveys, in situ and ex situ conservation, crop wild relatives, herbaria collections • Senior Research Assistants, curators (Unique expertise in self-compatible cross-pollinated and self-incompatible cross-pollinated species; rescue regeneration of difficult species) • Data management • Herbarium management and curation	
Status	Accession numbers in 2023	151,937
	Crops	Wheat, barley, chickpea, lentil, faba bean, pea, grass pea, forages
	Performance targets	Barley: reached performance targets Wheat (currently at 89%) and Pea (currently at 86%): will reach by December 2024 Grass pea (currently at 86%): Plan to reach by 2026 Lentils (currently at 80%) Chickpea (currently at 72%): Plans to reach target by 2027 Faba bean and forages: reach by 2030
	Eligibility for Crop Trust funding	Has long-term grant from Crop Trust since 2008
	Genebank users	Breeders, Universities, NARS, Farmers, ARIs
Germplasm Health Unit	The GHUs (Seed Health Laboratories) in Lebanon and Morocco ensure the safety movement of the cereal and legume germplasm held in ICARDA, including its wild relatives and breeding lines through a strict quarantine monitoring system including: import/export procedures, active growth stage inspection, post-entry inspection and clearance, GMO declaration, and research activities, including the development of diagnostic assays, seed treatment protocols, procedures for bulk sampling, epidemiology of seed-transmitted pest and disease data management, QMS, capacity development and sharing. ICARDA's GHU is operating under a system which supports the use of well-standardized procedures and protocols aligned with NPPOs regulations and IPPC procedures, to keep an up to date, effective and reliable system which can accommodate any sudden or unexpected challenges/ threats, such as a change in plant pests dynamics.	
Plans for improvement	• Facilities fully powered by solar energy in Lebanon and Morocco • Equipped cytogenetics lab in Lebanon and Morocco • Renovation of additional spaces in Lebanon, to accommodate updated and optimized workflows and newly hired staff • Digitized Herbarium: vouchers digitized and all associated passport data available open source to the international community • Develop e-learning modules (in Arabic) including SOPs videos for all routine activities • Focus on communication and visibility: Develop strategy, enhance genebank environments for trainees, visitors, and school students through educational tours GHU: • Adopt and implement advanced molecular techniques (e.g., HTS) for more comprehensive pathogen detection. • Research and evaluate novel, eco-friendly seed treatment formulations. • Seek ISO accreditation for laboratory processes. • Streamline the phytosanitary certification process to reduce processing times.	

7. CIFOR-ICRAF			
Collections	CIFOR-ICRAF Genebank conserves domesticated, partially domesticated and wild tree species. These include tree species valued for their fruit, soil improvement, fodder, timber, medicinal properties or other products. In total, 193 species are held as seed and 67 species are held in the field at 37 sites in 17 countries, mostly in Africa but also in Peru, Bangladesh and Vietnam. Field sites have been established on partners land e.g. ICRISAT in Niger and Mali; the rest is held on national partners' land and managed in collaboration with ICRAF Genebank. Some regeneration stands established for orthodox seeded tree species are maintained as seed stands to be sources of seeds for bulk distribution established for orthodox seeded tree species are maintained as seed stands to be sources of seeds for bulk distribution. Most of the germplasm is made available locally or regionally.		
Expertise	• Head-Genetic Resources (over 20 years' experience in tree genetic resources conservation and use) • Seed conservation-seed physiologist, one technician and a nursery attendant; coordinator/curator and two technicians' to be recruited • Field conservation-one scientist and research assistant based at Headquarter coordinating field genebank activities with ICRAF focal persons in five regions-Africa (Sahel, Humid tropics, East and Southern Africa), Latin America and Asia • Information Management team-one data specialist and an assistant • GHU team: One technician; (A scientist to be recruited) • Genebank characterization team-one scientist and 2 technicians		
Status	Accessions numbers in 2023	Field collections-12,263	Seed collection –7,020
	Crops:	Fruit trees (field collection) and multi-purpose trees (seed collection)	
	Performance targets	Seed collection: Availability 76%; Security 25% Fruit collection: Availability100%; Security 9%	
	Eligibility for Crop Trust funding	Awarded a long-term grant in 2023	
	Genebank users	CIFOR-ICRAF projects, NARS, Universities, NGOs, farmers	
Germplasm Health Unit	The Germplasm Health Unit is a unit within the ICRAF Genebank, to offer phytosanitary and health monitoring services to the genebank as well as to the internal and external institutional users/projects. It ensures conservation, distribution, and exchange of disease and pest free high-quality plant material by undertaking routine and mandated disease and pest checkups of all the incoming and outgoing germplasm. It had developed standard guidelines for the genebank for preventive and prophylactic treatment of seeds as well as nursery plantlets for distribution. GHU also coordinates the monitoring and control of diseases and pests in the field genebanks. As a part of consultancy services, the unit helps in preparing guidelines for the projects on demand. GHU current staffing limits accomplishing of tree health tasks.		
Plans for improvement	• Progress on the performance targets-availability and security; collaborate with development projects in development of regional seed stands to ensure availability of priority species • Genebank operations-staffing needs (two seed testing technician and a curator). Due to budget constraints as a result of no funding under the Genebank Initiative, two seed laboratory technicians' contracts were not renewed. Expand storage facility • Seed quality management and longevity studies for priority species • Field genebanks- rehabilitation on most field sites urgently needed-some bilateral funds (ACIAR) received in 2024 is assisting in the rehabilitation of some field sites in Africa. Plans to develop complementary conservation methods • Database- finalize adoption of GGCE; Improve on Passport Data Completeness Index through approximation using available acquisition information details • GHU-database development, protocols, staffing needs (scientist and technician)		

8. ICRISAT		
Collections	ICRISAT Genebank at Hyderabad, India, serves as a world repository for 11 dryland cereals and grain legumes collected from 144 countries. Several of the landraces, now conserved in the ICRISAT genebanks, have disappeared from their natural habitats in Africa and Asia. The conserved germplasm has been well characterized for important morpho-agronomic characteristics. ICRISAT carries out conservation activities in regional stations in Niamey, Niger and Bulawayo, Zimbabwe, which represent portals for collecting and distributing germplasm regionally.	
Expertise	• Dr. Kuldeep Singh (>30 years of experience) specialist in plant breeding, plant genetic resources and molecular genetics and genomics • Senior scientist/manager (1 legumes, 1 cereals, and 1 seed laboratory at Hyderabad) • 1 QMS specialist and 1 IT specialist • Senior Scientist (Regional Genebank, Niamey) • Scientific officers, research technicians and other support staff trained in specific crop/genebank activities	
Status	Accession numbers in 2023	129954
	Crops	Pearl millet, finger millet, foxtail millet, little millet, kodo millet, proso millet, barnyard millet, sorghum, chickpea, groundnut and pigeon pea
	Performance targets	Reached in 2023
	Eligibility for Crop Trust funding	Has had a long-term grant since 2008. Eligible for a long-term partnership agreement. Under review
	Genebank users	NARS, universities, NGOs, farmer organizations
Germplasm Health Unit	GHU (Plant Quarantine Unit) Government of India recognized Export Certification Laboratory since 1978 and works in close collaboration with NPPO. Facilitated export of over 1.35 million seed samples to researchers and breeders in 175 countries and import of 0.2 million seed samples of its mandate crops since 1974. In the last 5 years, the GHU has health tested 31432 germplasm accessions for long-term conservation in genebank. In collaboration with ICAR-NBPGR, the GHU has developed effective seed health testing procedures to minimize inadvertent introduction of pests of quarantine significance.	
Plans for improvement	Add value to each accession by 2030 by sustaining performance targets, improving efficiency of genebank operations and promoting use of collection	

<table>
<tr><th colspan="3">9. IITA</th></tr>
<tr><td>Collections</td><td colspan="2">IITA manages a range of crops of importance to Africa namely seed crops (Cowpea, maize, soybean and 15 other underutilized legumes) Clonal crops (Cassava, Yam, Banana and Taro), requiring very different conservation methods (seedbank, field bank, in vitro and cryo preservation), and demanding particular attention to prevalent phytosanitary threats.</td></tr>
<tr><td>Expertise</td><td colspan="2">GRC:
• Head-Genetic Resources: Over thirty years' experience in genetics, breeding, genetic resources, climate change, underutilized crops, senior management Director of IITA West Africa
• Tissue culture specialist: one scientist
• Data manager: one scientist
• Molecular geneticist: one scientist
• Seed conservation specialist: one scientist
• Field bank manager: one senior staff
• In vitro conservation manager: one manager

GHU:
• GHU is managed by a scientist (Head of the Unit), a laboratory manager, a QMS supervisor, four full time national staff specialized in diagnostics and phytosanitation skills, an administration and data management assistant, and about ten short-term technical assistants trained in germplasm health testing. The GHU at HQ in Nigeria operates under the aegis of the Nigerian Agricultural Quarantine Service.</td></tr>
<tr><td rowspan="5">Status</td><td>Accession numbers in 2023</td><td>35,042</td></tr>
<tr><td>Crops</td><td>Cowpea, maize, soybean, Bambara groundnut, African yam bean, and 15 underutilized legume species, banana, cassava, yam, and taro</td></tr>
<tr><td>Performance targets</td><td>Reached for seeds, clonal crops in progress to reach targets before 2030</td></tr>
<tr><td>Eligibility for Crop Trust funding</td><td>LPA for seed crops signed in 2023</td></tr>
<tr><td>Genebank users</td><td>NARS, universities, NGOs, farmer organizations, Private sectors, Individuals</td></tr>
<tr><td>Germplasm Health Unit</td><td colspan="2">The GHU provides the following services for cassava, cowpea, maize, Musa, soybean, yam, African yam bean, Bambara groundnut, Taro, and wild Vigna germplasm, including wild relatives and breeding lines.: import/export procedures, active growth stage inspection, production of clean germplasm, and research activities, including the characterization of pathogens and pests, development of diagnostic assays, seed treatment protocols, procedures for bulk sampling, epidemiology of seed-transmitted pest and disease data management, QMS, capacity development, and sharing.</td></tr>
<tr><td>Plans for improvement</td><td colspan="2">GRC
• Digitalize seed files for accession seed lot verification for seed processing
• Utilization of multispectral imaging for identifying hard seed coats
• Replacement of the medium-term and long-term cold storage facilities and building of new Screen houses for seed regeneration
• Optimization of liquid nitrogen generation system to provide adequate service for the cryo genebank and NARs
• Expansion of facility for adequate duplication of clonal crops at Cotonou
• Develop unique genetic "barcode" for tracking and management of germplasm Genetic-ID testing and identifying duplicates to ensure collection integrity
• Allele mining for inherent tolerance for climate adaptation and stress tolerance
• Transform the GRC collection into a single 'virtual (DSI)' collection for more targeted use of diversity
• Multispectral imaging using drone for field characterization of GRC-crops for different canopy traits, including NDRE, NDVI, and chlorophyll content
GHUs
• Improve phytosanitary protocols for virus elimination in yams, cassava, and bananas with an emphasis on cryptic viruses
• Establish phytosanitary procedures for value-added crops (taro and others
• Develop biosafety level 2 (BSL2) facility for post-entry germplasm monitoring
• Establish alternative seed treatment procedures to replace synthetic seed treatment chemicals set to be phased out</td></tr>
</table>

10. ILRI		
Collections	ILRI manages a collection of diverse tropical forage (grasses, legumes and browses), and some species that are better known as crop wild relatives, in a modern genebank consisting of a mycology, virology, bacteriology, molecular diagnostics, and biosafety level II laboratory and greenhouse, supported by a Forage Seed Unit, which provides basic seeds and promotes the national seed systems, in Ethiopia. The collection is conserved as seeds in medium/long-term storage facilities with a component conserved as live plant in field genebanks in four locations with contrasting agroecologies. The extremely wide taxonomic diversity of the collection, and the fact that it is mainly composed of wild species, demands specific management.	
Expertise	• Genebank Manager (with support of the program leader and program management team) • Field regeneration research officer and 17 field staff • Seed science specialist • 2 documentation specialists • 20 trained laboratory staff and technicians • Forage Genomics: 2 science staff and an associate • GHU: Plant pathologist and 3 lab technicians	
Status	Accession numbers in 2023	18,664
	Crops	Forages
	Performance targets	Due to reach targets before 2030
	Eligibility for Crop Trust funding	Receives funding through a long-term grant since 2008. Not eligible for long-term partnership funding
	Genebank users	Agricultural Research institutions, universities, farmers, national genebanks, NGOs
Germplasm Health Unit	The GHU provides the following services for forage germplasm held in the genebank: import/export procedures, active growth stage inspection, production of clean germplasm, and research activities, including the characterization of pathogens and pests, development of diagnostic assays, seed treatment protocols, procedures for bulk sampling, epidemiology of seed-transmitted pests and diseases, monitoring and surveillance, data management, QMS, capacity development, and sharing.	
Plans for improvement	• Increased clean seed production through the establishment of irrigation facilities for off season production and screenhouses. • Rationalization of the collection following the recommendations of the 'Global Strategy for the Conservation and Utilization of Tropical and Subtropical Forage Genetic Resources'. • Improved seed dormancy breaking and longevity information and protocols for tropical forage species. • Safety duplicates at Svalbard Global Seed Vault. • Integrate and apply HTS technologies for disease identification and detection. • Pursue national accreditation of genebank and GHU facilities. • Improve the ageing greenhouse and screenhouses, replace -20°C freezers for long term storage.	

11. IRRI		
Collections	International Rice Genebank (IRG) managed by IRRI hosts the world's largest collection of rice germplasm. The collection includes both the cultivated species of rice, 23 related wild species and 7 related genera. IRG operates at high levels of efficiency and throughput using bespoke automated approaches.	
Expertise	• Head-Genetic Resources: Over twenty years of experience in plant breeding, genetics, pre-breeding, genetic resources; experience of working in South Asia, South-East Asia, West Africa and East and Southern Africa • Expert Teams to manage conservation of cultivated and wild species • Experienced Data management team • IRRI GHU is composed of 16 staff (15 national and 1 international). The unit conforms to ISO 9001:2015 and ISO/IEC 17025:2017 standards, and is a member of ISTA	
Status	Accession numbers in 2023	132,627
	Crops	Rice and Rice wild relatives
	Performance targets	Yes
	Eligibility for Crop Trust funding	Awarded long-term partnership agreement in 2018
	Genebank users	International Agricultural Research institutions, Advanced Research Institutes, National Agricultural Research Institutes and genebanks, universities, farmers, private companies, NGOs
Germplasm Health Unit	The GHU (Seed Health and Logistics Unit) provides the following services for rice germplasm, including wild relatives and breeding lines: import/export procedures including processing of MTAs, SPAs, and SMTAs, inventory preparation, crop health inspection, monitoring and surveillance, seed sampling and seed health testing, seed inspection, seed treatments and conditioning, and data management. Research activities include the characterization of pathogens and pests, development of diagnostic assays, new and improved seed treatment protocols, reference material and proficiency testing, bulk sampling methods, epidemiology of seed-transmitted pests and diseases, enhanced data management, QMS and continuous improvement, capacity development, plant health and quarantine awareness activities and knowledge sharing.	
Plans for improvement	• The genebank facilities have aged and the collection is also of a significant age, many accessions are approaching the upper limits of their expected lifetime in storage. If seed longevity drops dramatically, as predicted, this will trigger a major effort in seed rejuvenation. • Climate-proof the regeneration of the collection by moving regeneration to low-cost semi-permanent controlled facilities. • Continued application of AI in routine application including enhancing utilization of collection. • Improved seed dormancy-breaking protocols for wild relatives. • Increased adoption of automation to reduce cost and improve efficiency. • Genotypic characterization to generate information to enhance conservation and use. GHU: • Increase capacity for discovery, implementation, validation, and verification of new diagnostic methods. • Strengthen biosafety practices and update facilities to contain quarantine and regulated-non-quarantine organisms (wild rice, insects, etc).	

12. WorldVeg		
Collections	World Vegetable Center maintains a global collection of vegetable genetic resources. Most germplasm is conserved as seed, while a small Allium (garlic and shallot) collection is vegetatively propagated. The collection is maintained across two genebanks: the International Vegetable Genebank in Taiwan and Africa's Vegetable Genebank in Tanzania. The WorldVeg collection is one of the few collections of vegetable germplasm worldwide accessible under the Standard Material Transfer Agreement conditions.	
Expertise	• Seed conservation and regeneration of vegetable germplasm • Specialism on species from the Solanaceae (e.g. tomato, pepper, eggplant), Cucurbitaceae (e.g. pumpkin, bitter gourd), Fabaceae (e.g. Vigna and soybean), and Malvaceae (e.g. okra, jute mallow) families.	
Status	Accession numbers in 2023	63,905
	Crops	More than 400 species of vegetables, legume vegetables, and their wild relatives, esp *Glycine* (Soybean), *Vigna radiata* (mung bean), *Capsicum* (Pepper), *Solanum* (Tomato), Solanum (Eggplant), *Vigna angularis* (Azuki-bean), *Brassica* (Brassica complex), *Vigna unguiculata* (Cowpea, Yard-long bean), *Abelmoschus* (Okra), *Cucurbita* (Pumpkin, Squash), *Luffa* (Sponge gourd), *Amaranthus* (Amaranth), *Vigna mungo* (Black gram), *Phaseolus* (Lima bean, Snap bean), *Cucumis* (Cucumber, Melon), *Allium* (Onion, Garlic), Lablab (Hyacinth bean), *Hibiscus* (Roselle), *Vigna umbellata* (rice bean), and *Lagenaria* (Bottle gourd).
	Performance targets	The aim is to reach performance targets in 2027
	Eligibility for Crop Trust funding	Awarded a long-term grant in 2023
	Genebank users	The genebanks actively engage with seed users from the private, public, and societal sectors to enhance the use of vegetable germplasm to improve nutrition and livelihoods. Genebanks distribute seed kits directly to farmer groups together with training, on-farm evaluation, and seed system development.
Germplasm Health Unit	WorldVeg has a Seed Health and Quarantine Unit led by WorldVeg HQ that has extensive experience in seed health testing, especially for viroids and viruses of Solanaceae crops, to ensure safe seed distribution of tomato, pepper, and eggplant.	
Plans for improvement	• Assessing the seed viability of the complete collection. • Upgrading medium-term storage seed storage facilities to minus 18°C. • Optimize in vitro conservation of Allium germplasm. • Increase capacity to handle seed distribution requests and obtain user feedback. • Generate, compile, and manage genomic and phenotypic characterization information. • Strengthen Seed Health Facilities in Tanzania to support Africa's Vegetable Genebank.	

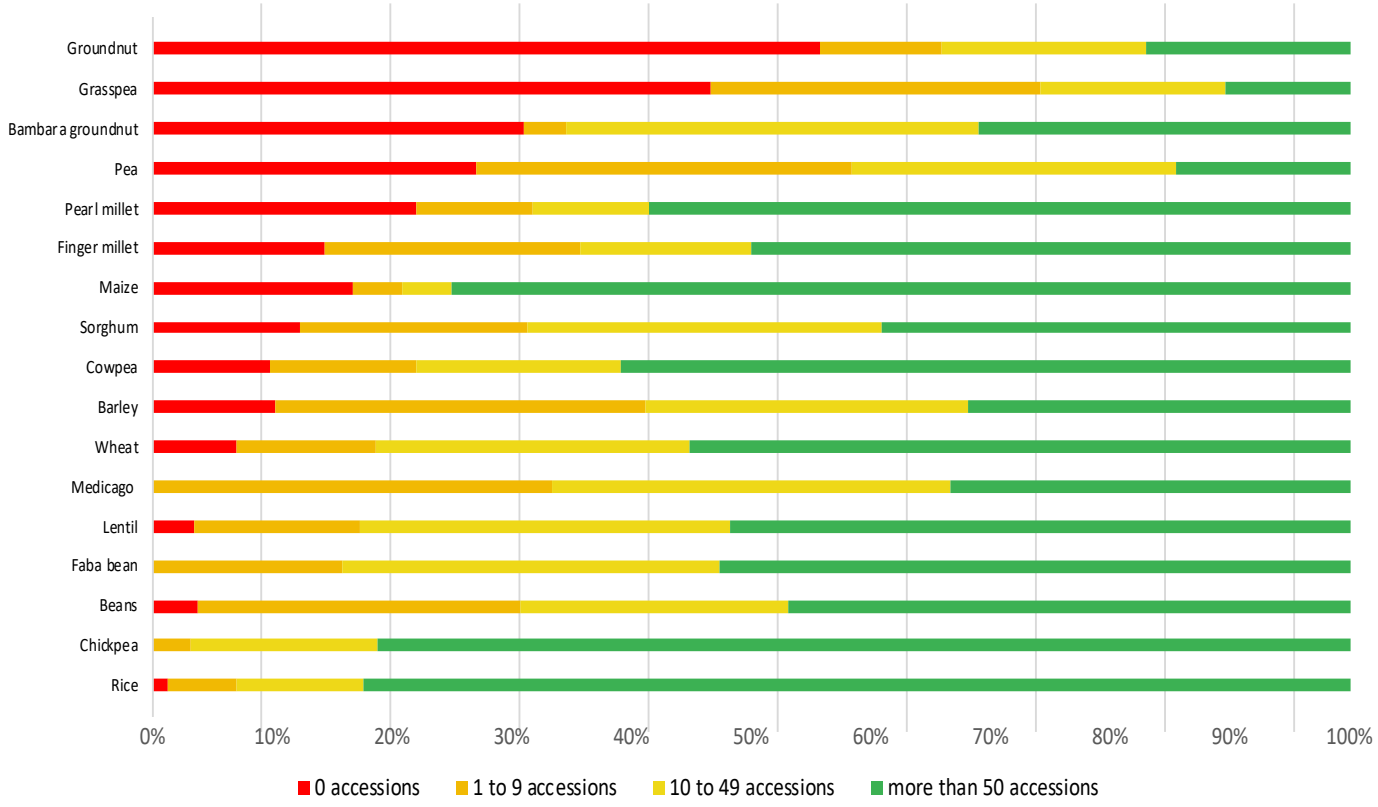
Appendix 2: Section 4 - Comparative advantage analysis

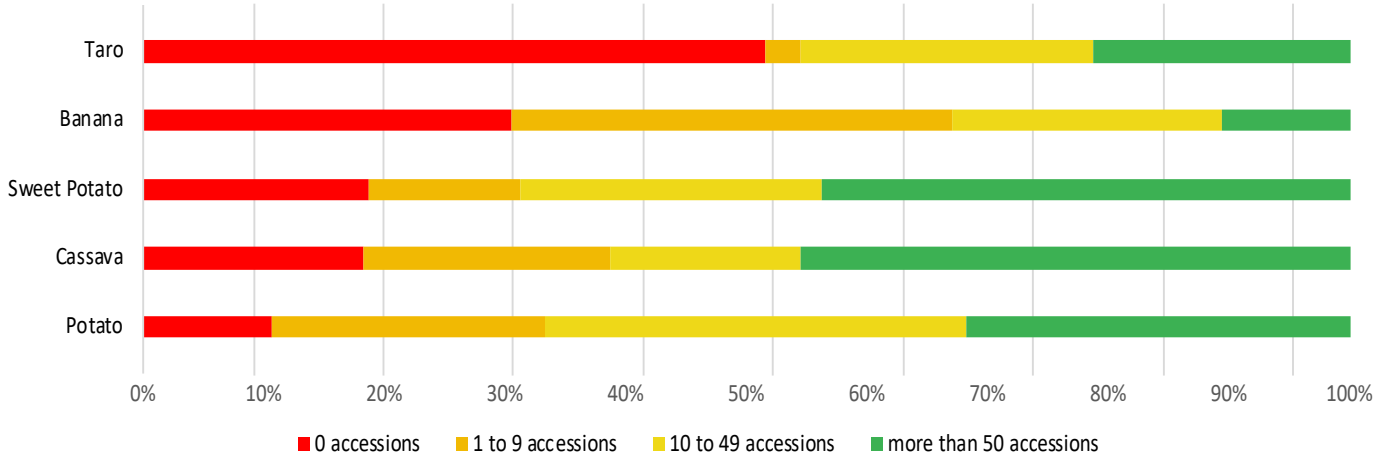
High-level output	Needed sources of Comparative Advantage required to deliver the high-level output	CGIAR's sources of Comparative Advantage in delivering the high-level output	Potential partner types (e.g., NARES, SMEs, private sector…)	Partners' sources of Comparative Advantage in delivering the high-level output	Analysis of the trade-offs between CGIAR and (potential) partners' sources of CA in delivering the high-level output, and indication of where the CA lies (i.e., with CGIAR or with the potential partner)
Conservation of collections of genetic diversity	Specialist skills (esp cryopreservation, and phytosanitary), unique collections and reliable facilities for long-term conservation.	CGIAR has CA and legal obligation to perform this role on behalf of global community. Collections are unique representing diversity from 50 years+. Located in areas of crop diversity. CGIAR has specialist skills and, by necessity, continues to pioneer on several themes (cryo, health, data, QMS, AI). Good benchmark with respect to costs per accession.	National genebanks, private sector, international genebanks (Article 15 genebanks are CGIAR, World Vegetable Center, CATIE, IAEA, ICBA, CePaCT, Cacao collection in Trinidad and Tobago, Coconut collections in 5 countries, Olive collection), Universities, farmers associations, NGOs	National genebanks cover range of species relevant to their country. Very few are well-resourced. Where they are, they prioritize use in country. International genebanks focus on alternative crops to CGIAR.	CGIAR has unique CA for long-term conservation and making available materials from unique international collections. National genebanks, where resourced, have CA to cover individual mandates and engage with users in their countries.
Improved operations, protocols, diagnostics, novel phytosanitation therapies	QMS, capacity to test, optimize, and research to generate new knowledge, technologies, methods, and therapies on crops/ collections relevant to CGIAR.	CGIAR have long experience and skills to improve processes, test new technologies and approaches, and QMS and communities of practice to mainstream new processes.	Universities, other genebanks or GHUs	While some partners will be researching conservation and phytosanitary technologies, developing and mainstreaming new processes is genebank-specific. Partners will optimize their own protocols and not CGIAR's.	Partners are not in a good position to optimize processes for CGIAR, although universities and other genebanks can research and share improvements that will guide optimization process in CGIAR
Diversified funding mechanisms	Fundraising skills	Relevant only to CGIAR	Global Crop Diversity Trust, Additional specialist help may be useful	Crop Trust fundraises for CGIAR already.	Crop Trust – CGIAR fundraising partnership already existing. This task requires augmenting.
Distribution of germplasm and data	Capability to respond to requests, good quality seed, phytosanitary controls, data, range of diversity.	CGIAR has major CA and legal obligation to perform this role on behalf of global community. Collections are unique with untapped potential. GHUs are recognized centers of excellence and offer tailored services, ensure compliance with national quarantine regulations and continuously adapt to evolving needs and phytosanitary rules.	National genebanks, private sector, international genebanks (Article 15 genebanks are CGIAR, WorldVeg, CATIE, IAEA, ICBA, CePaCT, Cacao collection in Trinidad and Tobago, Coconut collections in 5 countries, Olive collection)	National genebanks cover range of species and users that are relevant to their country. Few are well-resourced or have capacity to ensure phytosanitary compliance for international distribution. USDA has comparable international germplasm distribution rates for crops of relevance to USA.	There is no evidence to suggest that demand for crop genetic resources is limiting. There is enormous scope for increasing smarter use. A wide range of genebanks are needed to service different crops, environments, communities and users. CGIAR is best placed to provide a global role for responding widely to needs national genebanks
Selection tools, Artificial Intelligence - ready data	Data resources, software skills, web resources, marketing	CGIAR genebank has good capacity for data management by necessity. Added CA to collaborate closely with large breeding programs generating data.	National and international genebanks, Crop Trust, private sector (Google, Amazon)	Data resources relating to their own collections, and software skills	Area for collaboration to develop common tools, resources and standards to manage data resources relating to respective collections.

High-level output	Needed sources of Comparative Advantage required to deliver the high-level output	CGIAR's sources of Comparative Advantage in delivering the high-level output	Potential partner types (e.g., NARES, SMEs, private sector…)	Partners' sources of Comparative Advantage in delivering the high-level output	Analysis of the trade-offs between CGIAR and (potential) partners' sources of CA in delivering the high-level output, and indication of where the CA lies (i.e., with CGIAR or with the potential partner)
Contributions to international negotiations and draft laws and new CGIAR policies and guidelines	Policy and legal experience. Knowledge of international and national policies relevant to PGRFA (CBD, Nagoya Protocol, ITPGRFA)	CGIAR must be compliant by necessity	CGIAR can only represent itself – possibly external lobbying specialists could play a role	Outsourced specialists would need to be inducted and continuously updated with CGIAR-specific issues and idiosyncrasies. This is a specialist area, no obvious CA for other agency to play a role.	CGIAR is responsible for its own compliance with and influence on international policy developments. Unlikely that hiring external consultants – other than for discrete pieces of work - would be cost-effective.
Diversity analyses	Geographic, genetic, genomic, morphologic, taxonomic and environmental sciences, relevant stats and software skills	Access to data resources, collections, curators and other staff with knowledge of collections and in situ diversity.	Botanists, national partners.	Wide range of relevant expertise depends on crop species and geographical area.	Wide range of potential partnerships are relevant especially institutes with large collections of shared crops. CGIAR CA is for analyzing collections under their own management.
Cryohubs	Expertise in researching, optimizing and mainstreaming cryopreservation protocols	CGIAR has world-leading expertise in cryopreservation of clonal crops	USDA, RDA (South Korea), Japan, France, Germany and China, LAC NARS	Highly limited cryopreservation expertise in seed, dormant buds, potato and garlic.	CGIAR has clear CA for clonal crop cryopreservation and especially for large-scale application. CIP and Bioversity International expertise is unique.
Unique *In situ*/on-farm crop diversity under threat conserved	Low-tech conservation approaches, taxonomic skills	CGIAR taxonomic and conservation expertise in the crops it manages. Good understanding of seed longevity in storage and dormancy breaking	National genebanks, NGOs, universities, community experts	Wide ranging expertise on low-tech methods, traditional knowledge, taxonomy, socio-cultural expertise	National and local partners have a strong CA. CGIAR can contribute on specific themes especially for crops it has good knowledge of.
Capacity strengthening of NARS and Knowledge products and training courses	Range of knowledge, skills and experience relating to genebanking (seed conservation, cryopreservation and tissue culture) and germplasm health. Facilities and collections.	CGIAR's CA comes from direct experience of working to international standards in genebanking and managing large, diverse collections.	International and national genebanks, Crop Trust, Universities	Several national genebanks have excellent capacity to contribute to capacity sharing. Crop Trust has access to funds and range of consultants but no direct experience.	Important area for collaboration with Crop Trust and other genebanks who can offer capacity sharing especially for developing knowledge products and courses.
GHU network and GreenPass Protocol	Skills, labs, knowledge for detecting and controlling quarantine risk pests and diseases. Remit for international exchange.	CGIAR CA in dealing with high volume of germplasm exchange, familiar with national phytosanitary authorities, unique capacity and interest to distribute germplasm globally. Additionally, CGIAR locations enable support to networks especially in low- and middle-income countries.	International Seed Federation, FAO-IPPC, CABI, national/ regional phytosanitary agencies, universities, private sector phytosanitary testing in CGIAR host countries	No CA *sensu stricto.* Various organizations have an interest in collaboration but uniquely CGIAR interest to network globally and facilitate international germplasm exchange.	Alliance Bioversity banana genebank in Leuven, Belgium, has outsourced phytosanitary testing to a nearby university. Otherwise, there is little CA for other organizations to do or facilitate phytosanitary testing on behalf of CGIAR. Also, high-risk area in terms of consequences of CGIAR spreading pests and diseases.

Appendix 3: Representation of crop gene pools

These figures (seed and clonal crops) represent the results of studies undertaken under the Genebank Platform (2017-2021) to estimate representation of crop gene pools in CGIAR genebanks based on expert knowledge of distinct cultivar groupings.





Appendix 4: Genebank operations

OPERATION	DESCRIPTION	ACTIVITIES INCLUDED	ACTIVITIES EXCLUDED
Acquisition	Receiving and processing newly introduced accessions.	1. Communication with providers. Shipping. Unpacking 2. Obtaining plant import permits, risk analysis, entry into country and clearance process 3. Registration and passport data verification and entry 4. Data checking with data provider 5. Ensure legal procedures are covered	1. Gap identification 2. Collecting mission 3. Phenotypic and genotypic characterization, multiplication, seed processing and safety duplication for initial storage 4. Disease-indexing/ quarantine for initial storage 5. Disease-cleaning for initial storage
Administration and management	Administrative and supervisory tasks to ensure the effective management of the genebank as a whole	1. People management - Staff supervision and mentoring Planning HR and capacity development 2. Administration - Monitoring/analyzing/planning activities Donor reporting and performance indicators Budgeting and monitoring expenditure of genebank budget 3. Quality assurance - Monitoring and updating SOPS and risk management strategy 4. Networking – Providing feedback to the Treaty Secretariat and FAO Commission Representing the genebank or Genebank Platform in meetings, events or institutional processes Providing expertise and partnership in general	1. General staff meetings and gatherings 2. Training
Characterization	Recording the characteristics of each accession, often conducted during the regeneration process.	1. Selection of accessions and traits for characterization 2. Data collection 3. Observation and recording (including digital images) of morphological characteristics (including in electronic field book) 4. Routine measures to ensure identity and genetic integrity are maintained 5. Data entry into databases 6. All field and material preparation, planting, harvesting, etc. is included under REG unless characterization is carried out as a separate operation to regeneration with strong justification. 7. Travel to field sites	1. Identification of duplicates using molecular characterization except clonal and forages 2. Taxonomic studies 3. Maintenance of herbarium collection. Maintenance of seed herbaria collection. 4. Imaging and maintaining images 5. Molecular characterization 6. Analysis and formation of core collection and reference sets.
Cryopreservation	Long-term storage in liquid nitrogen of in vitro material (including seed material where applicable)	1. Germplasm maintenance in liquid nitrogen. Monitoring LN2 supply 2. Cryopreserved sample monitoring 3. Data entry	1. Costs associated with the introduction of new material into cryopreservation
Distribution	Sending accessions upon request (e.g., preparation, and shipment).	1. Selection of accessions 2. Communication with requestor (follow up, question answering, advice). SMTA acceptance, import permit receipt, etc. 3. Seed sorting and weighing/tissue culture preparation 4. Labeling and packing 5. Phytosanitary requirement follow-up 6. SMTAs issuance 7. Shipping/mailing 8. Data entry, inventory updates and filing fo SMTA/ paperwork 9. Follow up on receipt and satisfaction Including safety duplication	1. Multiplication/regeneration of samples 2. Disease-indexing

OPERATION	DESCRIPTION	ACTIVITIES INCLUDED	ACTIVITIES EXCLUDED
Germination testing (or viability testing)	Testing of germination rate of existing or newly multiplied accessions.	1. Selection of accessions, inventory check and preparation of lists 2. Germination test before storage including media preparation, removal of sample from storage, dormancy-breaking treatments. Germination counts, observations on abnormal seedlings and tolerance tests 3. Viability monitoring during storage. 4. Data entry	1. Seed processing
Germplasm health testing	Testing of germplasm health, often carried out upon acquisition during regeneration process and dissemination process.	1. Disease diagnostics (germplasm health assessment) at acquisition, seed increase, before conservation, dissemination (export), and safety duplication	1. Cleaning 2. In vitro costs
Information and data management	Data entering, processing and management (including catalogue preparation).	1. Management of hard copy documentation/field and lab books/collection sheets/MTAs/agreement 2. Database management and data backup including software and source code. Support for barcoding, electronic data capture, etc. 3. Data publication system for external users. Data enquiries. 4. Preliminary data analysis 5. Effective data validation, procedures for data quality assurance 6. Data transfer to other platforms (e.g. Genesys). Migration online of pdf files, digital images, etc. 7. Development for communication with information platforms 8. Online catalogs and ordering system. User surveys	1. Software applications and web development 2. Barcoding software development 3. Training 4. Data entry
Introduction of new accessions into cryopreservation	Process of cryoprocessing new accessions into the collection	1. Selection of clones to be introduced 2. Multiplication and processing of material for cryopreservation 3. Introduction of germplasm into LN2 4. Testing and analysis of success of accession cryopreservation 5. Data entry	1. Maintaining cryopreserved collection 2. Optimization of cryopreservation protocols
InVitro conservation	In vitro conservation, subculturing	1. Introduction into in vitro 2. In vitro seedling monitoring (viability/vigor check, elimination of old culture, contamination) 3. Germplasm subculturing for conservation 4. Germplasm maintenance using slow-growth methods 5. Multiplication of germplasm for distribution/safety duplication 6. Data entry including use of barcodes	1. Disease-cleaning 2. Disease-Indexing 3. Introduction into cryopreservation 4. Rejuvenation/regeneration 5. Research on in vitro protocols
Leaf DNA Herbarium	Maintenance of collections of lyophilized leaves or other materials for DNA extraction	1. Monitoring and storage of conserved non-reproductive materials	1. DNA extraction 2. Processing of materials into storage

OPERATION	DESCRIPTION	ACTIVITIES INCLUDED	ACTIVITIES EXCLUDED
Live Plants	Maintenance of essential collections that cannot be held other than as growing plants	1. Field management/irrigation/pruning 2. Selection of and preparation of material for field. Transfer to field site, planting and labeling (including barcoding) 3. Field inspection for diseases, insects and weeds 4. Processing for planting (cuttings, tubers, sanitation) and propagation 5. Germplasm harvesting (non-perennials) 6. Data entry	1. Activities covered by institutional land management services 2. Characterization 3. Any lab activities (e.g. health testing) 4. Regeneration/multiplication
Long-term storage	Conservation of seed accessions in the long-term storage facility. Cold room	1. Maintaining controlled environment access and security systems 2. Sample storage 3. Stock management including monitoring of collections; monitoring of conditions, security and access systems 4. Assigning locations and data entry	1. Items covered by institute service costs 2. Germination viability testing 3. DNA genebanks 4. Seed processing/preparation including packaging 5. Cryopreservation, in vitro conservation
Medium-term storage	Seed/tuber conservation of accessions in medium-term storage for ready dissemination upon request. Cold room.	1. Maintaining controlled environment, access and security systems 2. Sample storage 3. Stock management including monitoring of collections and conditions 4. Assigning locations and data entry	1. Items covered by institute service costs 2. Germination viability testing 3. DNA genebanks 4. Seed processing/preparation 5. Cryopreservation, in vitro conservation
Regeneration / Multiplication	Producing fresh seeds by planting out seeds for storage or dissemination. May include temporary holding of material in glasshouses and nursery	1. Monitoring/analyzing/planning need for regeneration. Selection of accessions and sites 2. Seed/planting material preparation including scarification. May include greenhouse stage prior to field. Transfer to field site. 3. Field/glasshouse preparation 4. Isolation cages for cross-pollinated species 5. Planting and field management. Inspection for diseases, pests, mixtures and weeds. Recording in central database. 6. Harvesting of seed/tuber/cuttings 7. Data entry 8. Travel to and from field sites (Includes regeneration for introduction of new accessions, multiplication for storage and multiplication for distribution)	1. Characterization data collection 2. Indexing/sanitation 3. Threshing, cleaning and processing 3. In vitro subculture
Seed processing	Packing, cleaning and drying of seeds – for storage or distribution	1. Processing, drying, packing, labeling (including barcoding). Fumigation 2. Threshing/mechanical cleaning 3. Seed extraction, washing and cleaning for 'wet' seed. Checking seed purity and quantity 4. Drying operations 5. Moisture content testing 6. Sample sorting 7. Seed packing and labeling 8. Data entry	1. Sample identity check, inc. grow-out 2. Germination test before storage 3. Disease diagnostics before storage 4. Viability monitoring during storage 5. Field health inspections 6. In vitro costs of any kind