



# 2021 ANNUAL REPORT

## CGIAR Genebank Platform



Genebank  
Platform



CROP  
TRUST



AfricaRice



Alliance



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### Acronyms

ABS	Access and Benefit Sharing	ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
AFS CRP	Agri-Food System CGIAR Research Program	IEA	Independent Evaluation Agreement
AfricaRice	Africa Rice Center	IITA	International Institute for Tropical Agriculture
AGM	Annual Genebanks Meeting	ILRI	International Livestock Research Institute
Alliance-CIAT	International Center for Tropical Agriculture	IPPC	International Plant Protection Convention
BMZ	Federal Ministry of Economic Cooperation and Development (Germany)	IRRI	International Rice Research Institute
CBD	Convention on Biological Diversity	ISI	Institute of Scientific Information
CGRFA	Commission on Genetic Resources for Food and Agriculture	ITC	International <i>Musa</i> Germplasm Transit Centre
CIMMYT	International Maize and Wheat Improvement Center	LPA	Long-Term Partnership Agreement
CIP	International Potato Center	MELIA	Monitoring, Evaluation, Impact Assessment and Learning
CoP	Community of practice	MLS	Multilateral system of access and benefit-sharing
Crop Trust	Global Crop Diversity Trust	NARES	National Agricultural Research Extension and Education System
CRP	CGIAR Research Program	NARS	National Agricultural Research System(s)
DArTseq	Diversity Arrays Technology Sequencing	NGO	Non-governmental organization
DOI	Digital Object Identifier	NPGS	USDA National Plant Germplasm System
EiB	Excellence in Breeding Platform	ORT	Online Reporting Tool
EMBRAPA	Brazilian Agricultural Research Corporation	PDCI	Passport Data Completeness Index
FAO	Food and Agriculture Organization of the United Nations	PGRFA	Plant Genetic Resources for Food and Agriculture
FTA	CGIAR Research Program on Forests, Trees and Agroforestry	Plant Treaty	International Treaty for Plant Genetic Resources for Food and Agriculture
GCO	Genebank Costs & Operations	QMS	Quality Management System
GHU	Germplasm Health Unit	RTB	CGIAR Research Program on Roots, Tubers and Bananas
GLDC	CGIAR Research Program on Grain Legumes and Dryland Cereals	SDG	Sustainable Development Goal
GLF	Global Landscapes Forum	S4R	Seeds4Resilience
GLIS	Global Information System	SGSV	Svalbard Global Seed Vault
GOAL	Genebank Operations and Advanced Learning	SMB	System Management Board
GPA	Global Plan of Action	SMO	System Management Office
GRIN	Germplasm Resources Information Network	SMTA	Standard Material Transfer Agreement
GWAS	Genome-Wide Association Study	SNP	Single Nucleotide Polymorphism
IA	Intellectual Assets	SOP	Standard Operating Procedures
ICARDA	International Center for Agricultural Research in the Dry Areas	SQM	Seed quality management
ICRAF	World Agroforestry (International Council for Research in Agroforestry)	USDA	United States Department of Agriculture
		W1/2	Windows 1 and 2



Studies to pilot new ways of breaking dormancy in *Oryza glaberrima* are under way in AfricaRice. Photo: AfricaRice

## Key Results

### 1.1 Highlight Global Progress and Achievements

The Genebank Platform supports the activities of the CGIAR genebanks and germplasm health units (GHUs) to conserve and make available crop, forage, and tree genetic resources, contributing to UN Sustainable Development Goals Target 2.5. The extraordinary lockdown measures required to control the COVID-19 pandemic continued to affect CGIAR genebank operations and activities. In 2021, the operations of the three CGIAR genebanks in Latin America and of IRRI were particularly constrained by lockdown measures and the other genebanks experienced restrictions in travel, meetings, procurement and staffing that prevented the completion of improvements and workplans.

Demand for germplasm and its distribution, however, returned to pre-pandemic levels in 2021. A total of 96,590 germplasm samples (63,788 accessions) were distributed by CGIAR genebanks to users (Figure 1). The majority of germplasm distributions (67%) were sent to recipients outside CGIAR in 91 countries. Lower-middle income countries received the largest proportion (64%) of germplasm shipments in 2021 (Figure 2). Annex Figures 1 to 3 provide more details of the distribution of germplasm to countries by Center and crop. Of the external distributions in 2021, 51% of samples were sent to universities or research institutes, 34% to National Agriculture Research Systems (NARS), the rest to the commercial sector, NGOs, farmers and individuals (Annex Figure 1). Most distributed samples (72%) were traditional cultivars or crop wild relatives (Annex Figure 2). Table 1 lists the top country recipients of germplasm from CGIAR genebanks (not including materials transferred within CGIAR).

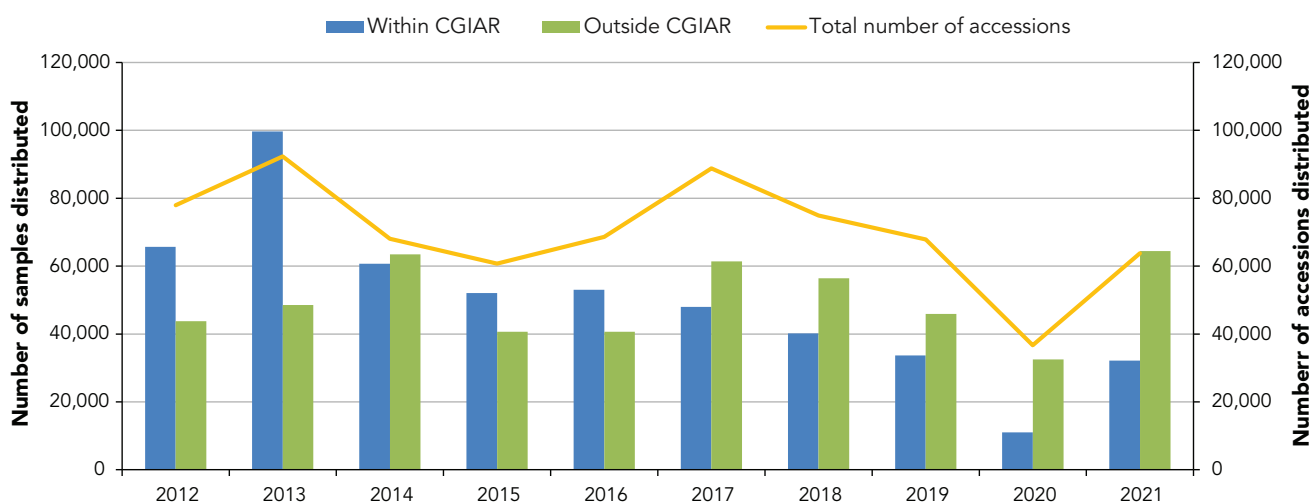
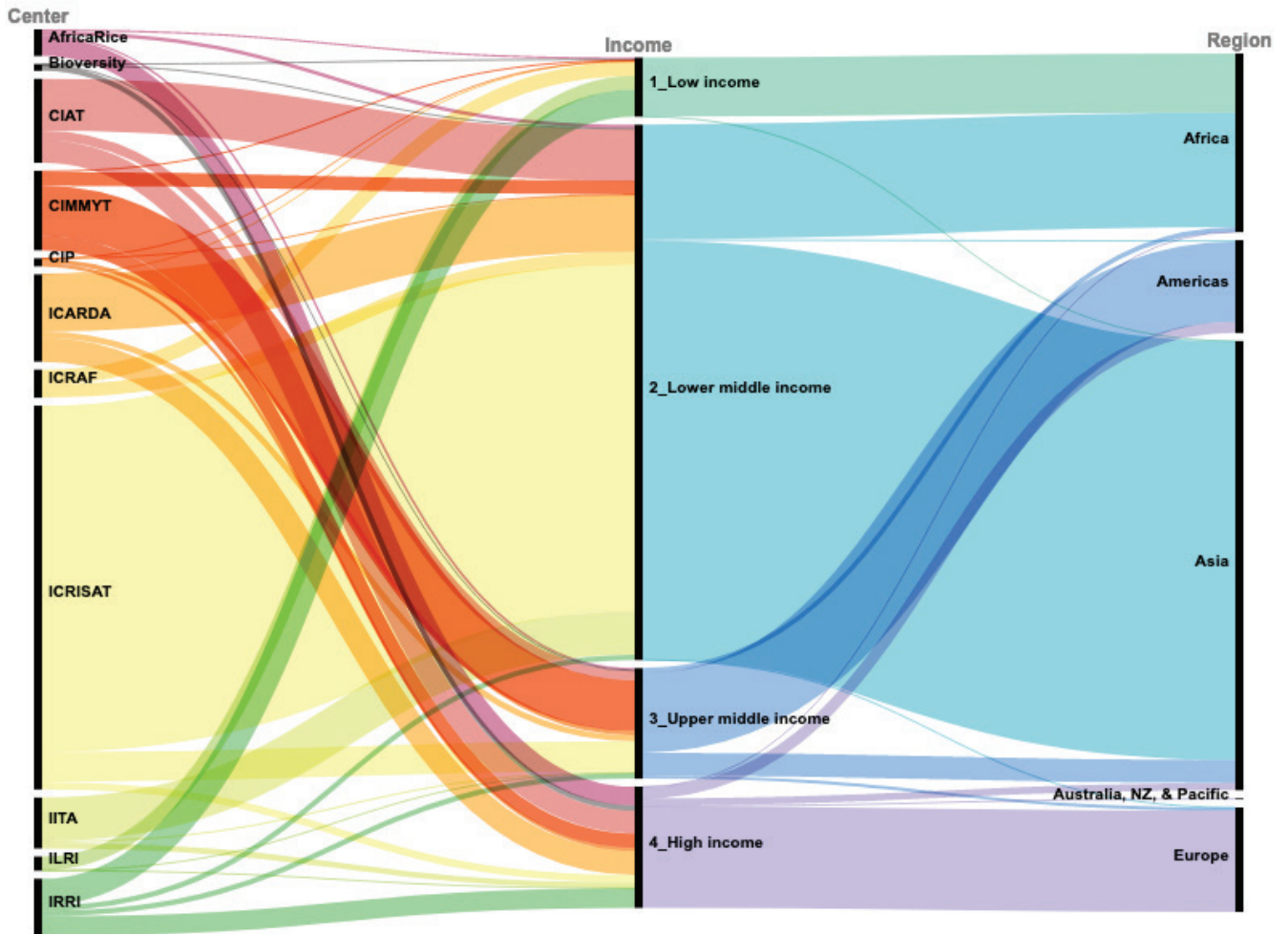
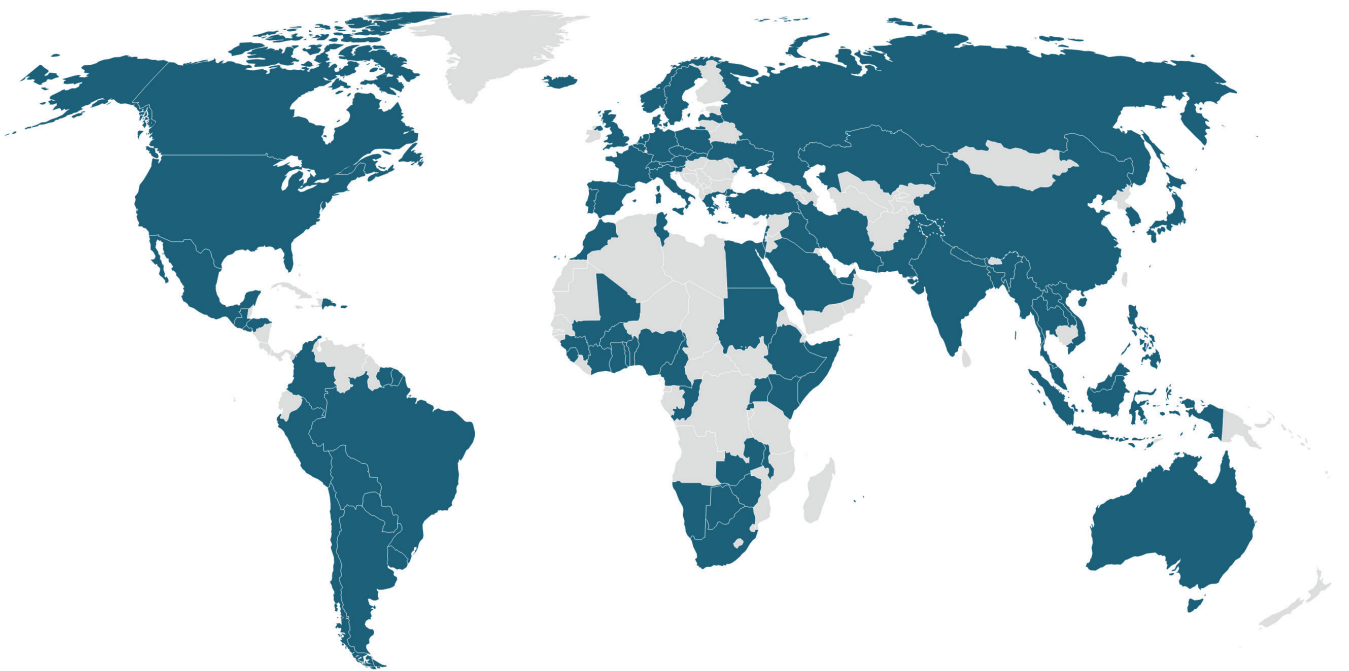


Figure 1. Samples and accessions distributed annually by CGIAR genebanks from 2012 to 2021



**Figure 2a.** Distribution of germplasm from CGIAR genebanks in 2021 (excluding distributions to CGIAR programs) Notes: Income and regional categories based on World Bank classification. See Annex Figure 1 for geographical distribution by Center.



**Figure 2b.** Countries (blue) receiving germplasm from CGIAR genebanks in 2021

## 1.2 Platform Progress towards Outputs and Outcomes

### 1.2.1 Overall Platform progress

By the end of 2021, CGIAR genebanks were managing a total collection of 739,653 crop, forage and tree accessions, including 26,329 *in vitro* accessions and 33,889 accessions held as trees or plants in the screenhouse or field. Approximately 83% of the total collection is acceptably viable, free of quarantinable diseases, with adequate stock, and legally available for international distribution (Figure 3).

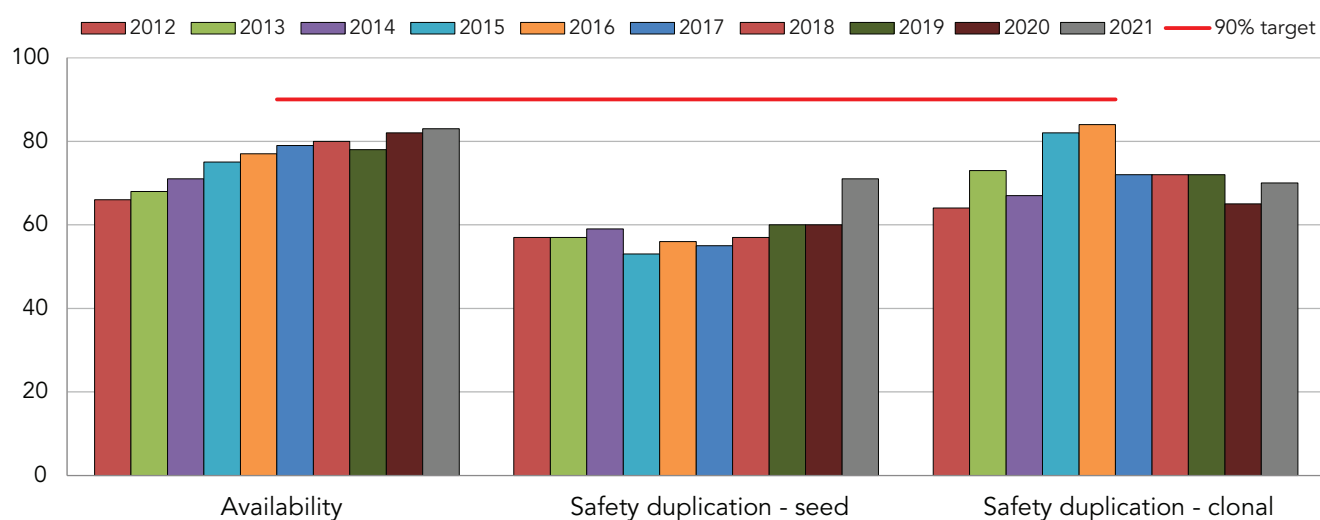
Of the seed accessions, 88% is duplicated at the Svalbard Global Seed Vault (SGSV) and 71% are safety duplicated in two locations. 70% of clonal crop collections is safety duplicated in the form of cryo-preserved or *in vitro* cultures (Figure 3).

The annual increase, since 2012, in total accession numbers, and numbers available and safety duplicated, are provided in Table 2. All genebanks are aiming for targets of 90% availability and safety duplication. Table 3 reports the achievement of milestones.

**Table 1.** Top 10 countries receiving germplasm from CGIAR Centers in 2021 (excluding distributions to CGIAR programs)

Rank	Lower-middle income & Low income economies			Upper-middle income & High income economies		
	Country	Number of Accessions	Number of Samples	Country	Number of Accessions	Number of Samples
1	India	7,209	26,972	Brazil	2,638	2,693
2	Morocco	4,506	4,506	Italy	2,656	2,659
3	Vietnam	719	4,309	United Kingdom	2,133	2,140
4	Nigeria	2,150	2,748	Mexico	1,706	2,052
5	Uganda	2,074	2,074	Germany	1,449	1,449
6	Ethiopia	903	1,114	China	894	894
7	Mali	78	1,065	Colombia	652	753
8	Lao, P.D.R.	72	685	United States	729	735
9	Ghana	482	486	Turkey	494	494
10	Kenya	203	431	Spain	482	482
	<b>Sub-total</b>	<b>18,396</b>	<b>44,390</b>		<b>13,833</b>	<b>14,351</b>
	<b>(% from total)</b>	<b>92%</b>	<b>96%</b>		<b>79%</b>	<b>79%</b>
	Others	1,658	1,904		3,718	3,815
	(% from total)	8%	4%		21%	21%
	<b>Total</b>	<b>20,054</b>	<b>46,294</b>		<b>17,551</b>	<b>18,166</b>

Notes: Ranking by number of samples. Income categories based on World Bank classification



**Figure 3.** Status (%) of availability and safety duplication of CGIAR genebanks from 2012 to 2021 (Target 90%)

**Table 2.** Key statistics of the aggregate CGIAR collection from 2012 to 2021

Indicator	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
1. Total number of accessions	710,001	725,244	738,215	750,604	757,767	768,576	773,112	760,467	736,210	739,653
2. Total number of accessions that are immediately available	465,358	492,654	525,410	559,053	580,706	608,751	621,915	592,118	601,811	632,384
3. Seed accessions held in long-term storage and safety duplicated at two levels	386,037	375,271	413,448	381,932	404,074	408,323	420,164	439,206	432,910	471,740
4. RTB accessions in cryopreservation or safety duplicated at one level	15,643	16,141	15,554	19,356	19,803	18,144	18,427	18,524	16,964	18,484



Barcoding rice at International Rice Research Institute. Photo: Shawn Landersz



Using a digital scale at AfricaRice. Photo: AfricaRice



Entering herbarium data at International Potato Center. Photo: Michael Major



Entering seed data at ICRAF. Photo: Michael Major

**Table 3.** Summary of status of Planned Outcomes and Milestones

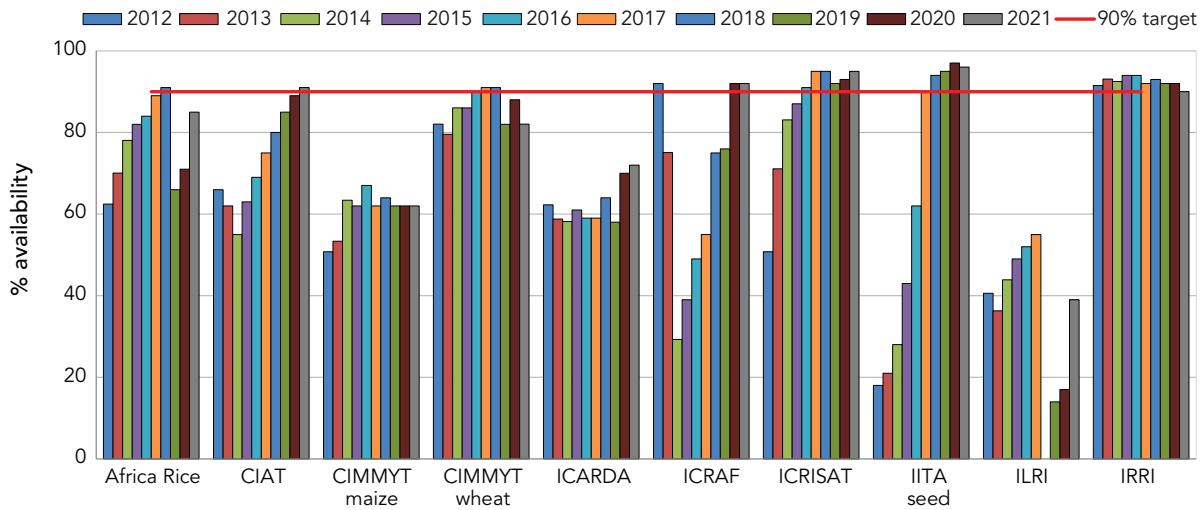
Milestone	2021 milestones status	Completed milestones or explanation for extended, canceled or changed
<b>Conservation Module</b>		
<b>Outcome 1.1: Disease-free, viable, documented germplasm made available</b>		
All genebanks and germplasm health units are working towards attaining or sustaining 90% targets of availability and safety duplication.		
1. 80% accessions available	83% (completed)	Despite the lockdowns' effect on operations, the numbers of available accessions increased in all genebanks in 2021.
2. 62% seed accessions safety duplicated	71% (extended)	Significant progress made in shipping safety duplicates to the Svalbard Global Seed Vault and to host institutes
3. 75% clonal accessions safety duplicated	70% (extended)	Duplication of clonal accessions improved from 2020 but still impacted by lockdown restrictions. The CIAT cassava collection was not able to be duplicated off the CIAT campus.
<b>Outcome 1.2: Crop diversity conserved in a rational and effective global system</b>		
All genebanks are working on improving quality management systems and assessing and improving the representation of crop gene pools within collections managed by the CGIAR.		
4. Storage periods redefined in at least 20 crops	(completed)	Documented in: Hay, F.R., et al. 2021. CGIAR genebank viability data reveal inconsistencies in seed collection management. <i>Global Food Security</i> Volume 30, 100557.
5. Gaps in at least eight crop genebanks addressed through CGIAR-NARS joint collecting missions	(completed)	Collections made of pearl millet, sorghum, groundnut, cowpea, sesame, rice, fonio, sorghum, maize, fodder spp., <i>Coleus dazo</i> , banana, breadfruit, traditional vegetables, crop wild relatives.
6. 5% reduction in average time taken to carry out phytosanitary controls	(extended)	The Germplasm Health Units (GHUs) drafted 172 Standard Operating Procedures (SOPs), mapped to the GHU Operational Framework to ensure the alignment of operations across Centers. The SOPs provide a framework for proper monitoring of efficiency in time and throughput. Audits are being implemented to ensure compliance to SOPs.
<b>Use Module</b>		
<b>Outcome 2.0: More effective access and use of germplasm enabled</b>		
All genebanks are working to promote the use of collections through improving data associated with accessions, data quality and its availability.		
7. Piloting of One CGIAR genebank database	(completed)	CGIAR genebanks decided to adopt a common genebank information management solution in 2019 and the Genebank Platform supported the development of the next generation of GRIN-Global database to improve its usability and functionality. GRIN-Global Community Edition (GGCE) was installed on cloud infrastructure, populated and made available for evaluation to CGIAR genebanks in early 2021.
8. Subsets promoted for phenotyping by users	(completed)	123 new subsets were added to Genesys by CGIAR genebanks in 2021. A total of 254 new subsets is now available to Genesys users.
9. Subsetting tool accessible via Genesys	(extended)	CIAT and ICARDA developed a subsetting tool that uses climate and soil data of georeferenced accessions. Integration of the tool into the Genesys website started in late 2021 and has not yet completed.
<b>Policy Module</b>		
<b>Outcome 3: Supportive policy environment developed</b>		
The Policy Module of the Genebank Platform continues to work to ensure that the activities, guidelines and reporting processes of the genebanks comply with legal requirements and the CGIAR engages in the development of international policy.		
10. Update 'white' papers on genetic resources policies and CGIAR compliance for DGs, System Office and System Board	(completed)	The Policy Module worked with the System Office to review Centers annual reports on compliance with the CGIAR Principles, with a particular focus on ensuring compliance the access and benefit sharing rules of the Plant Treaty and the Nagoya Protocol. The Policy Module also assisted some centers drafting their public disclosures concerning limited exclusivity agreements and intellectual property protection applications, again with a focus on making clear statements about compliance with Access and Benefit Sharing (ABS) laws and the CGIAR Intellectual Assets (IA) Principles.
11. Guidelines for Centers operations under the Plant Treaty and for integrating Access & Benefit Sharing considerations in R&D project life cycles	(completed)	Revised Guidelines for operating under the International Treaty for Plant Genetic Resources for Food and Agriculture (Plant Treaty) in harmony with the Nagoya Protocol were submitted to the Genetic Resources (GR) Policy Working Group, Global Director of Genetic Innovation and others for review.
12. Plant genetic resources policy sessions led by Platform scientists in national and regional workshops.t	(completed)	The Policy Module coordinated CGIAR participation in several meetings under the aegis of the Commission on Genetic Resources for Food and Agriculture (CRGFA), the Plant Treaty and the Commission on Biological Diversity (CBD). Further, in collaboration with the UK's Open University the Policy Module ran two editions of its online, training course entitled <i>Genetic Resources Policies for CGIAR Scientists</i> . 59 breeders, genebank managers and staff, and intellectual property focal points from across the CGIAR took the course in 2021.

### 1.2.2.a Progress by module Conservation Module

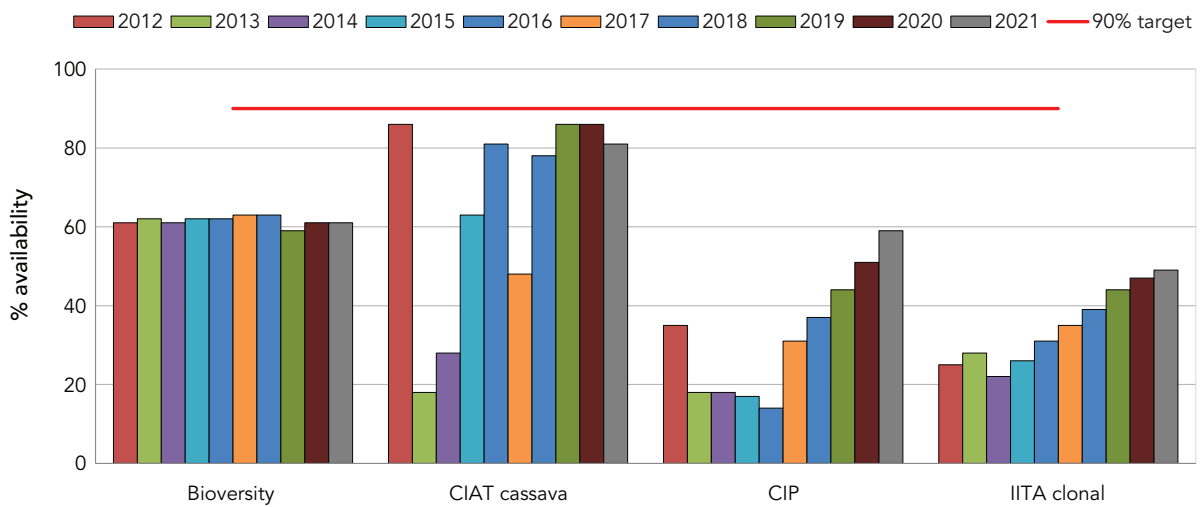
As collections grow and seed stocks are exhausted or lose viability, an optimal rate of operation must be achieved in order to reach and sustain performance targets. The German Federal Ministry of Economic Cooperation and Development (BMZ) supported the

Genebank Platform in 2021 to help bring collections up to performance targets. The progress of individual genebanks in reaching targets is presented in Figure 4 and Table 4. Despite the lockdowns' effect on operations, the numbers of available accessions increased in all genebanks in 2021. Five out of 10 seed collections have reached the 90% availability target.

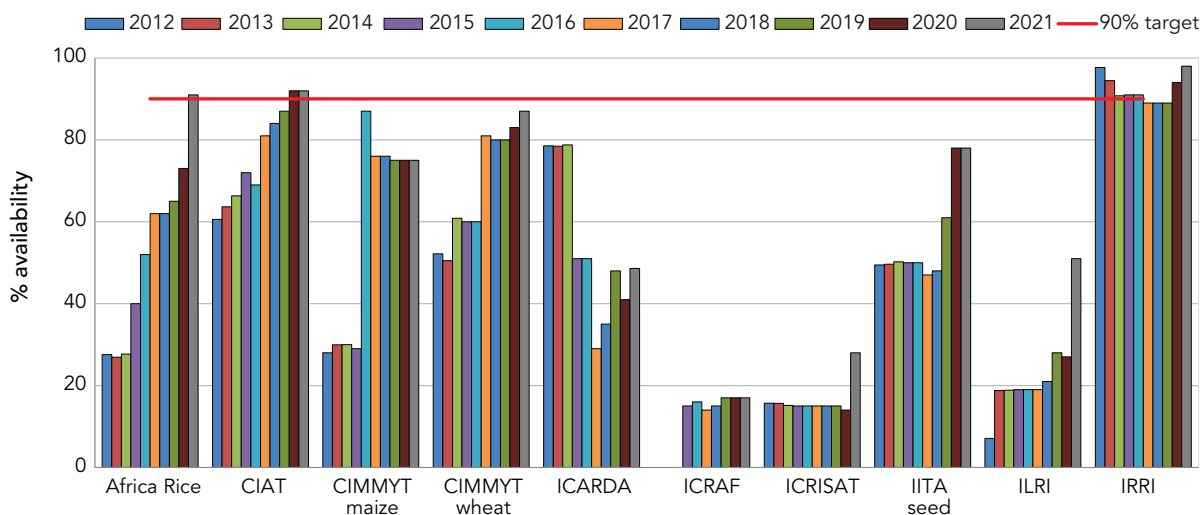
(a) % availability of seed collections



(b) % availability of clonal collections



(c) % safety duplication of seed collections



**Figure 4.** Trends in % availability and safety duplication of CGIAR collections



**Table 4.** Status of CGIAR genebanks with respect to performance targets in 2021

Center	% Availability 2021	% Increase from 2020	% Safety duplication 2021	% Increase from 2020	Comments
AfricaRice	85	20	91	25	An exercise to re-inventory nearly 30,000 undocumented seed lots has been completed. Seed increase and safety duplications in 2021 mean AfricaRice is close to performance targets.
Alliance-Bioversity	61	0	90	38	Shipments of both cryobanked and <i>in vitro</i> accessions in 2021 has improved the security of the collection.
Alliance-CIAT seed	91	2	92	0	Targets for availability and safety duplication have been met in 2021 and the seed collections are eligible for a long-term partnership agreement (LPA) with the Crop Trust.
Alliance-CIAT cassava	81	-6	0	-100	Safety duplication has been prevented by lockdown restrictions. However, there is a duplicate of the collection on site.
CIMMYT wheat	82	0	87	5	Figures concerning the wheat collection at CIMMYT will change after the completion of systematic re-inventorying and archiving in 2022.
CIMMYT maize	62	0	75	0	Re-inventorying of the maize collection. The data and status of the collection against performance targets are likely to change in 2022.
CIP	59	16	89	14	Stellar work on the potato collection (despite lockdown measures) means it is now at 84% availability and 81% of the clonal collection is in cryopreservation. The Andean Roots and Tuber collection, by contrast, remains unavailable due to absence of health testing and cleaning protocols.
ICARDA	72	3	48	17	Recalled accessions from Svalbard Global Seed Vault (SGSV) are now being replenished and the status of the ICARDA collections are improving gradually.
ICRAF seed	92	0	17	0	No change while long-term storage facilities and safety duplication processes are being improved.
ICRISAT	95	2	28	50	Obstacles to safety duplication have been removed and the first shipment of duplicates is now being made. ICRISAT should reach performance targets in 2022.
IITA seed	96	-1	78	0	Safety duplication shipments are due to take place in 2022 and the seed collections will be eligible for an LPA.
IITA clonal	49	4	65	63	Safety duplication is possible again after challenges during 2020 lockdown.
ILRI	39	129	51	89	Gradual increase in health testing, cleaning and safety duplication of the collection. There remains a serious political challenge in distributing germplasm.
IRRI	90	-2	98	4	Serious challenges in operating the genebank during severe lockdowns during 2021. IRRI continues to sustain performance targets.



Preparing banana meristems for cryopreservation at Bioversity. Photo: Shawn Landersz

All genebanks made progress towards performance targets, although there were setbacks. AfricaRice, ICRISAT and CIP potato collections are on course to reach performance targets in the coming months. The collections of clonal crops, which were highly vulnerable during lockdown because of reduced rates of subculturing and safety duplication caused by staff numbers in the relevant laboratories being restricted, are now mostly stabilized. CIAT has been unable to safety duplicate the cassava collection because of lockdown restrictions and continuing difficulty shipping duplicates to CIP through phytosanitary controls. An alternative to this challenging process needs to be pursued. Cryopreservation is the most secure form of both long-term conservation and safety duplication for the clonal crop collections (see *Cryopreservation*).

At least 18,800 accessions have been archived and 37,000 designated for partial curation thanks to recently published guidance on improving accession management. In addition, in response to recommendations from technical reviews, several genebank managers have substantially reduced surplus seed stocks that had built up over several decades and were kept as a precautionary measure, freeing up space and allowing resources and staff to be focussed solely on actively curated stock. Further accessions and seed lots are expected to be rationalized and the total size of the CGIAR collection may continue to show decreases as a result.

### **Cryopreservation**

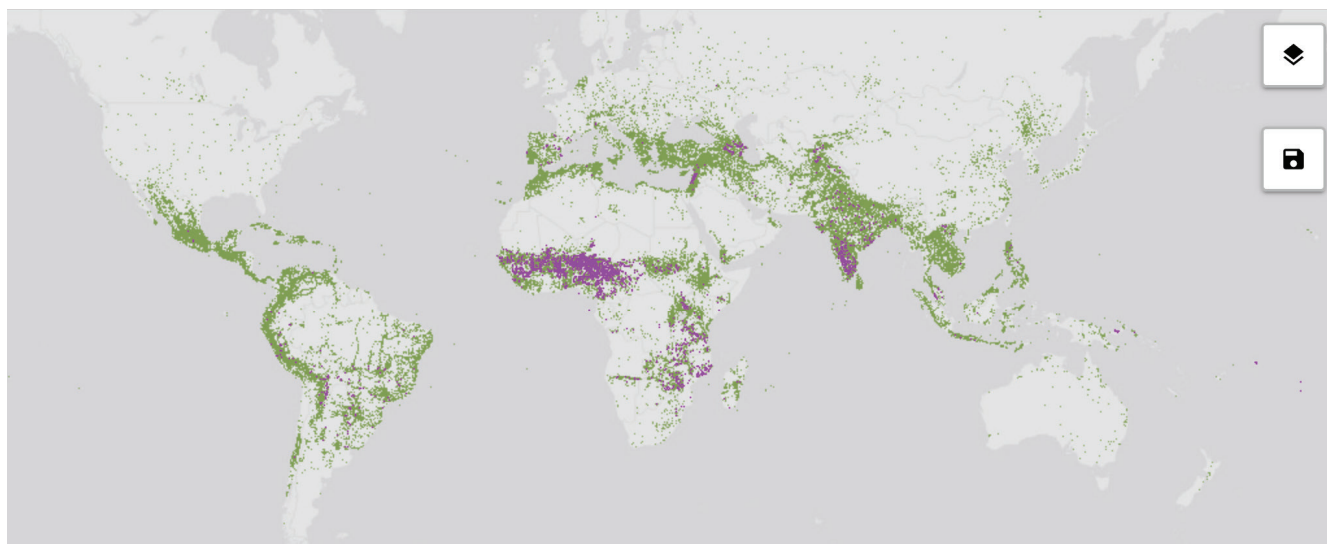
CGIAR has succeeded in cryobanking nearly 6,000 accessions of clonal crops, including 81% of the clonal potato collection and 73% of the banana collection. CIP, Bioversity, IITA and CIAT are collaborating with the Crop Trust to develop a Global Plant Cryopreservation Initiative to help national partners secure in cryopreservation the more than 100,000 accessions of clonal crops that are thought to be

conserved worldwide. The vulnerability of clonal crop collections conserved in the field or in tissue culture has been made evident during the pandemic with restrictions in movement causing a major challenge to genebank staff trying to keep accessions healthy. The Cryopreservation Initiative was given a boost in 2021 by the Plant Treaty, which hosted an Expert Panel on [“Cryopreservation: a long-term strategy for hard-to-conserve PGRFA collections in a post-COVID world”](#) as part of a series of online events for the International Year of Fruits and Vegetables. The event was sponsored by the Government of Belgium and involved an online roundtable and discussions attended by more than 200 participants.



### **Collecting and gap analysis**

Against the odds, collecting missions took place, mostly at the end of 2021, in Chad, Mauritania, Niger, Sudan, South Sudan, Togo, and Papua New Guinea, to fill gaps in collections identified by a comprehensive spatial analysis of passport data. The expeditions were undertaken by NARS partners in collaboration with Bioversity, ICRISAT, IITA and ICARDA and resulted in the collecting of a wide range of priority crops (approximately 4,000 accessions of more than 30 species) from more than 200 previously uncollected sites, including several crop species (such as breadfruit and traditional vegetables) that are not mandate species for CGIAR. All collected materials will be introduced into collections conserved at CGIAR genebanks or other relevant international genebanks, where they will be made available under the Plant Treaty. The projects involved providing training to NARS scientists, extension workers and farmers in collecting, documenting and conserving plant genetic resources, supplying



Accessions updated by CGIAR genebanks since 2021 (green) and accessions newly added by CGIAR genebanks since 2021 (purple).

essential equipment to national genebanks and highlighting the availability of germplasm from CGIAR genebanks. Nearly 500 accessions were repatriated from CGIAR genebanks to Chad, Niger and Sudan.

### Germplasm Health Units (GHUs)

In 2021, the GHUs health-tested 213,164 samples for over 100 different seed-borne pests and pathogens (Table 5), and just over half of these were for conservation in genebanks. Around 1,600 germplasm exchanges with 126 countries were facilitated, involving the removal of nearly 8% of imported or exported samples because of infection with pests or diseases.

### Use Module

#### Genesys ([www.genesys-pgr.org](http://www.genesys-pgr.org))

Genesys, the online portal for genebank accession data, is a key part of the Plant Treaty's Global Information System (GLIS). By the end of 2021, 4.2 million genebank accessions from 39 data providers

representing 502 genebanks are searchable from Genesys. In 2021 alone, 82% of these accessions were updated, heralding a new and promising era in which genebank data are dynamic, continuously improved and regularly shared. Considering the quality of accession data, the passport data completeness index (PDCI) continues to increase in CGIAR genebanks (Table 6). Six additional national partners signed data sharing agreements and made their data available on Genesys in 2021. Several new capabilities were also developed, including a tool that helps users identify similar accessions within or among genebanks. Genesys will be supported and developed by Crop Trust once the Genebank Platform has ended. CGIAR genebanks will continue to participate under the new Initiative by providing regular updates, uploading new datasets and tools and feeding into the growth of Genesys as the main online portal for users to access information on genebank accessions worldwide.

**Table 5.** Germplasm samples processed for conservation and distribution by GHUs in 2021

Center	Genebanks		AFS CRPs		Total	
	Samples analyzed	Diagnostic reactions	Samples analyzed	Diagnostic reactions	Samples analyzed	Diagnostic reactions
AfricaRice	3,191	7,404	7697	15,394	10,888	22,798
Alliance-Bioversity	250	1,391	0	0	250	1,391
Alliance-CIAT	3,379	27,374	5,918	45,731	9,297	73,105
CIMMYT	1,157	17,951	3,857	59,900	5,014	77,851
CIP	2,440	17,563	24	198	2,464	17,761
ICARDA	27,531	327,618	20,873	240,357	48,404	567,975
ICRAF	558	1674	12	36	570	1710
ICRISAT	12,598	23,883	2,032	3,318	14,630	27,201
IITA	64,846	83,057	30,980	12,195	95,826	95,252
ILRI	10,515	42,060	0	0	10,515	42,060
IRRI	5,417	7,428	9,889	23,400	15,306	30,828
<b>Total</b>	<b>131,882</b>	<b>557,403</b>	<b>81,282</b>	<b>400,529</b>	<b>213,164</b>	<b>957,932</b>



IITA have been working to disease-clean and conserve unique cassava diversity from East Africa. Photo: Michael Major

### Exploring cassava collections managed by CGIAR

The Genebank Platform supported the genotyping of more than 16,600 genebank accessions. The CGIAR cassava collection, comprised of collections from the center of diversity in Latin America conserved at CIAT and African landraces conserved at IITA, is now 98% genotyped. Initial results indicate that there is little overlap between the two collections in terms of genetic diversity (Figure 5). Cassava was introduced to Africa in the 16th century by Portuguese traders and has since developed into a major staple crop, with more than half the world’s harvest now coming from the continent. The diversification of the crop in and across Sub-Saharan Africa is evident in the collection at IITA. However, there is potential genetic redundancy within the two collections of up to 30%. Further investigation of passport data and phenotypic analysis will be needed to confirm whether accessions may be retired from the collections.

Preliminary results from association studies using six common traits have unearthed candidate markers linked to yield, dry matter content, number of roots and disease resistance. The full details and data visualizations will be available in 2022.

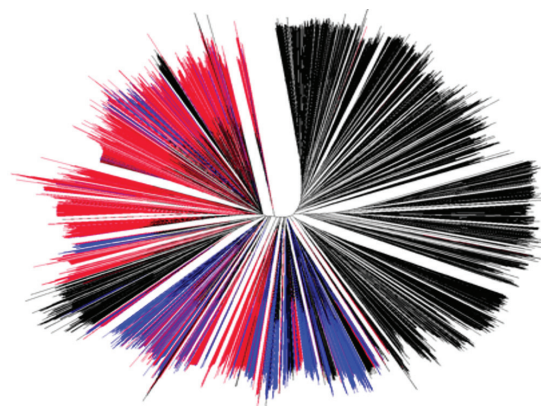


Figure 5. Preliminary diversity analysis of the CIAT and IITA collections using a neighbor-joining tree

Table 6. CGIAR germplasm data publicly available in 2021

Center	Number of accessions uploaded	% of DOIs	Passport Data Completeness Index (PDCI)				
			2017	2018	2019	2020	2021
AfricaRice	21,815	100%	5.60	5.89	7.67	8.07	8.34
Alliance-Bioversity	1,642	100%	5.57	5.94	6.22	6.25	6.35
Alliance-CIAT	66,599	100%	6.70	6.94	6.80	6.98	7.00
CIMMYT	179,254	100%	5.65	6.22	7.11	7.26	6.73
CIP	18,066	100%	5.61	7.53	7.39	7.41	7.56
ICARDA	151,858	100%	6.76	6.65	5.84	6.79	7.41
ICRAF	15,166	100%	6.69	6.68	6.33	6.77	6.93
ICRISAT	129,415	100%	6.89	6.95	7.27	7.27	7.46
IITA	35,708	100%	4.69	5.12	4.64	4.71	5.45
ILRI	18,625	100%	6.88	6.80	5.71	5.71	6.78
IRRI	132,290	96%	5.45	5.09	6.35	6.53	7.43
<b>All</b>	<b>770,438</b>	<b>99%</b>	<b>6.04</b>	<b>6.28</b>	<b>6.48</b>	<b>6.70</b>	<b>7.04</b>

Source: Genesys (<https://www.genesys-pgr.org/>)

## Policy Module

### Coordinating CGIAR engagement in international policy negotiations

The Policy Module of the Genebank Platform, led by Alliance-Bioversity, supports CGIAR in contributing to international fora dealing with genetic resources policy. In 2021, it coordinated CGIAR's engagement in the ongoing development of the Post-2020 Global Biodiversity Framework of the Convention on Biological Diversity (CBD), focusing on making sure conservation of PGRFA and access and benefit sharing (ABS), under the Plant Treaty, are explicitly included in the GBF and its monitoring framework. The Policy Module also participated on behalf of CGIAR in various meetings under the framework of the Plant Treaty, Convention on Biological Diversity and Commission on Genetic Resources for Food and Agriculture, many of which addressed the possible creation of new norms for benefit sharing derived from the use of digital sequence information (DSI). These latter discussions are likely to continue for a few more years in international fora, given how far apart low- and high-income countries are with respect to how the issue should be treated.

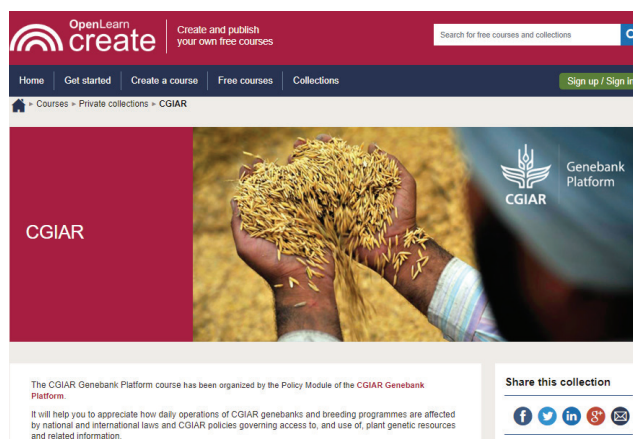
Once again, in 2021, the Policy Module worked with the System Office to review Centers' annual reports on compliance with the CGIAR Principles on the Management of Intellectual Assets (IA Principles), with a particular focus on ensuring compliance with the ABS rules of the Plant Treaty and the Nagoya Protocol. The Policy Module also assisted some centers in drafting their public disclosures concerning limited exclusivity agreements and intellectual property protection applications, again with a focus on making clear statements about compliance with ABS laws and the CGIAR IA Principles

#### Training in Genetic Resources Policies

In 2021, in collaboration with the UK's Open University, the Policy Module ran two editions of its online, 7 module, 40 hour, training course entitled 'Genetic Resources Policies for CGIAR Scientists'. Fifty-nine breeders, genebank managers and staff, and intellectual property focal points from across the CGIAR took the course in total in 2021.

#### 1.2.2.b. Relevance to COVID-19 by flagship

The demand for germplasm regained its previous levels in 2021 after dropping to half the normal rate in 2020. All genebanks and GHUs have been able to respond to requests and send out germplasm, although in some cases the help of other institute units was required. The focus of all genebanks, during lockdown, aside from keeping staff safe, was on sustaining sufficient staff in the laboratories, screenhouses and fields to carry out critical opera-



Online courses are now available on plant genetic resources policy developed in partnership with UK's Open University

tions to avoid the loss of accessions. These included monitoring cold rooms, subculturing *in vitro* accessions and processing seed from harvest to cold room. Several Centers invested in automated irrigation equipment in 2021 to ensure that harvests were not jeopardized by restrictions on workers going into the fields.

Unrest in Colombia, Ethiopia and Lebanon in 2021 led to roads being blockaded and restricted access to the respective genebanks and field sites. Genebank staff responded by staying on or near campus or finding alternative routes to work through the fields. Restrictions also prevented CIMMYT from using certain field sites for regeneration. Seven Centers reported that operations had been limited (some by up to 80%), while all Centers experience restricted physical events and travel. Collaboration with national partners and travel for workshops were particularly affected. Germplasm collecting and research work on seed quality management, cryopreservation, gap analysis and subsetting were set back. While virtual events have become the norm, the limitations of such meetings are evident in the quality of collaboration and progress in collaborative work, as well as in the level of innovation, consultation and general decision-making.

However, the most important lessons of lockdown have been learned for the conservation of large tissue culture collections (>5000 accessions), which were the most vulnerable to lockdown measures since they require continuous monitoring and subculturing by trained staff working in relatively small spaces. Only a small number of accessions have perished and most were replaced from safety duplicates. Without the motivation and stamina of genebank staff and the highly effective coping strategies of the Centers, the situation would have undoubtedly been catastrophic. From the perspective of the Crop Trust, CGIAR Centers need to be congratulated on the dedication of their staff.

**Table 7.** New germplasm subsets made publicly available from genebanks in 2021

<b>Alliance-Bioversity</b>	International Durum Yield Trial (IDYN) trait diversity reference set
Assessing variations in host resistance to <i>Fusarium oxysporum</i> f. sp. <i>cubense</i> Race 4 in <i>Musa</i> species, with a focus on the Subtropical Race 4	Iron (Fe) toxicity, tolerance
Effect of seasonal drought on the agronomic performance of four banana genotypes ( <i>Musa</i> spp.) in the East African Highlands	IWIN Yield Trial standard check varieties
Evaluation of Mchare and Matooke Bananas for resistance to <i>Fusarium oxysporum</i> f. sp. <i>cubense</i> Race 1	Karnal Bunt tolerance in synthetic hexaploid wheat
Filling the gaps in genebanks: Collecting, characterizing and phenotyping wild banana relatives of Papua New Guinea	Leaf glaucousness or waxiness
Guidelines for the evaluation of resistance to <i>Pseudocercospora</i> Leaf Spot diseases of banana	Leaf pubescence
Phenotyping <i>Musa</i> spp. for host reaction to <i>Fusarium oxysporum</i> f. sp. <i>cubense</i> , under greenhouse and field conditions	Loose smut ( <i>Ustilago tritici</i> ) differential
	Lr19 & Sr25 without yellow colored flour
	Lr34 & Yr18, germplasm
	Manganese (Mn) toxicity
	MasAgro SeeD, End-Use Quality
	MasAgro SeeD, Gluten Quality
	MasAgro SeeD, Grain Yield
	MasAgro SeeD, Heat tolerance
	MasAgro SeeD, High Grain Protein Concentration
	MasAgro SeeD, Large Grain Size
	MasAgro SeeD, Wheat Rusts Tolerance
	MasAgro SeeD, Yellow Endosperm
	MasAgro Seeds of Discovery (SeeD), high grain zinc (Zn) concentration
	MasAgro Seeds of Discovery parental materials used to develop "linked topcross panels" (LTP) of fixed lines
	Mexican wheat landrace diversity reference set
	Milling & baking quality, differential
	Multiple-ovary bread wheat germplasm
	Orange wheat blossom midge ( <i>Sitodiplosis mosellana</i> )
	Phosphorus (P) deficiency
	Physiological traits of wheat
	Powdery mildew differentials
	Pratylenchus neglectus nematode
	Pratylenchus thornei nematode
	Reduced plant height
	Rust ( <i>Puccinia</i> spp.), universal susceptibility
	Rye chromosome translocations in durum wheat
	Salinity (salt) toxicity
	Septoria nodorum blotch, Tox1
	Septoria nodorum blotch, Tox3
	Septoria nodorum blotch, ToxA
	Septoria nodorum, adult
	Septoria nodorum, glume
	Septoria nodorum, leaf
	Septoria nodorum, seedling
	Septoria tritici ( <i>Mycosphaerella graminicola</i> ) differentials
	Septoria tritici blotch
	Septoria tritici blotch differentials for wheat
	Stem rust ( <i>Puccinia graminis</i> ), Ug99 tolerance
	Stem rust, adult
	Stripe rust ( <i>Puccinia striiformis</i> ), differential
	Stripe rust, adult
	Sukumaran (2018) durum wheat (DARtseq) diversity reference set
	The Iranian Wheat Landrace Collection, DARtseq reference set
	The Iranian Wheat Landrace Collection, elite selections
	The Iranian Wheat Landrace Collection, Ug99 wheat stem rust tolerance
	Unique phenotypes
	Waterlogging, tolerance
	Waxy, high amylopectin wheat flour
	Wheat ( <i>Triticum</i> spp.) vernalization (Vrn) & photoperiod (ppd) differentials
	Wheat Association Mapping Initiative (WAMI) panel
	Wheat Grain Pericarp Color, Differential
	Wheat leaf rust differentials, Thatcher isolines
	Wheat manganese (Mn) efficiency
	Wheat stem rust ( <i>Puccinia graminis</i> ), differentials
	Wheat stem rust differentials, USA & Canada 1988
	Wheat Stem Rust, Sr2
	Wheat stripe rust differentials, Avocet isolines
	Wheat vernalization (Vrn), differentials
	Wheat with tolerance to wire worms
	Wheat zinc (Zn) efficiency
	Winter durum wheat
	Winter synthetic hexaploid bread wheat
	xTriticosecale, primary
	Yellow Alkaline Noodles
	Yellow spot, adult plant resistance
	Yellow spot, seedling resistance
<b>ICRISAT</b>	
Chickpea fusarium wilt resistance	
Chickpea heat stress tolerant	
Combined resistance to rust and late leaf spot in groundnut germplasm subset	
Groundnut multi-traits specific diverse mini-core germplasm resources	
Pigeonpea fusarium wilt resistance	
Pigeonpea photoperiod insensitive sources	
Pigeonpea salinity tolerance	
<b>ILRI</b>	
Rhodes grass subset	
IRRI	
Pigmented rice accessions	
<b>ICRAF</b>	
Big marula fruits	
Dryland fruit tree species	
Fast growing timber species	
High fruit yield	
Marula provenance evaluation	
<b>CIMMYT</b>	
Acid soils (Aluminum toxicity)	
Boron tolerance	
Bread and durum wheat with plump grain (high 1000 kernel weight)	
Bread wheat with high flour protein concentration	
Bread wheat, drought tolerance	
Buffelgrass core collection	
Cereal cyst nematode tolerance in wheat	
CIMMYT Wheat Physiology Core Germplasm Collection (CIMCOG1)	
Common bunt differentials	
Common Bunt resistance in durum wheat	
Copper (Cu), efficiency	
Crown rot ( <i>Fusarium pseudograminearum</i> ) tolerance	
Drought stressed wheat (Manes et al.)	
Durum wheat semolina yellow endosperm color	
Early & high yield	
Ergot ( <i>Claviceps purpurea</i> )	
Generation Challenge Program, Spring Bread Wheat ( <i>Triticum aestivum</i> ) Reference Set	
Generation Challenge Program, Winter Bread Wheat ( <i>Triticum aestivum</i> ) Reference Set	
Global Adaptation Wheat Yield Trial (GAWYT)	
Gluten, differentials	
Glutenin, differentials	
Grain hardness & PIN alleles	
Greenbug ( <i>Schizaphis graminum</i> ), tolerance	
Healthy wheat food products containing high amounts of dietary fiber	
Heat tolerance	
Heirloom wheat varieties	
Helminthosporium spot blight, tolerance	
High crossability between wheat, rye and other Triticeae	
International Adaptation Trial (IAT) indicators	
International Durum Yield Trial (IDYN) DARtseq diversity reference set	



Accessions of maize being processed at CIMMYT. Photo: Shawn Landersz

### 1.2.3 Variance from Planned Program for this year

Genebank Platform activities follow a relatively fixed program of work focused on the essential operations of the genebanks and GHUs. The variance due to COVID-19 has been described in detail above.

### 1.2.4 Altmetric and Publication highlights

The Genebank Platform website ([www.genebanks.org](http://www.genebanks.org)) provides links to research papers, policy briefs, conservation protocols, training materials, and submissions to international policy fora in conformity with CGIAR Open Access and Data Management Policy. In 2021, the genebanks reported a total of 122 publications by genebank staff in journals, conference proceedings, books, and book chapters, covering a wide range of topics. Out of 71 peer-reviewed journal articles, 85% are publicly available in open-access publications and 87% are published in ISI journals (Table 8).

## 1.3 Cross-cutting dimensions

### 1.3.1 Capacity Development

CGIAR genebanks and GHUs carry out services to CRPs and national partners to conserve, test, clean and distribute germplasm. They also serve as knowl-

edge hubs, responding to requests for data or advice on taxonomy, genebank operations, phytosanitary controls or other issues. They act as hosts for safety duplicated materials for NARS partners and each other. In 2021, genebanks reported 64 different genebank services were provided to national partners in 22 countries. In addition, the Policy Module provided a helpdesk on genetic resources policy issues and CIMMYT a helpdesk to assist in the evaluation, adoption and use of the GRIN-Global accession management software.

In 2021, individual genebanks reported fewer capacity building events than normal due to continued COVID-19 restrictions, but still more than 190 events took place across the Platform. The activities involved more than 3,400 participants (22% female) from 48 countries (Tables 9 and Annex 2), including 112 genebank tours to promote the importance of crop diversity and the work of CGIAR.

**Table 8.** Number of peer-reviewed publications in 2021

	Number	Percent
Peer-reviewed publications	71	100%
Open Access	60	85%
ISI	62	87%

**Table 9.** Participants in capacity development activities in 2021

Event category	Number of events	Number of participants
1: Genebank-organized training/workshop	19	229
2: Genebank staff as resource person in a capacity development event	22	1,937
3: Hosting a scholar/student in the genebank for educational purpose	32	43
4: Genebank tours	112	1,199
5: Visit from partners for research/scientific work	8	30
6: Farmers' open day	5	221
<b>Grand Total</b>	<b>193</b>	<b>3,438</b>



The Crop Trust organized 12 “GROW” webinars with the aim of provoking debate on topical issues affecting genetic resources

### The Value of Genebanks on Farms in Developing Agriculture



This thematic series will publish in [\*CABI Agriculture and Bioscience\*](#).



Genebank Impact Fellows published a set of case studies in a special issue of *CABI Agriculture and Bioscience*, “The Value of Genebanks on Farms in Developing Agriculture.”



IITA is participating in face-to-face workshops and staff exchanges for national genebanks participating in the S4R project. Photo: IITA

Twelve “GROW” webinars (Genebank Resources on the Web) were organized by the Crop Trust with speakers from a broad range of institutes presenting with the aim of provoking debate on topical issues affecting genetic resources today, such as the impact of CRISPR technology on genebanks (Table 10). More than 1,200 participants joined the sessions, most from outside CGIAR. The 2020 cohort of Genebank Impact Fellows published a set of case studies highlighting the impacts of genebanks and GHUs in a special issue of *CABI Agriculture and Bioscience*, “The Value of Genebanks on Farms in Developing Agriculture.”

Through their partnership with the Crop Trust, CGIAR

genebanks have also provided technical support to national genebanks in Sub-Saharan Africa under the National Seeds Collections for Climate-Resilient Agriculture in Africa (Seeds4Resilience – S4R) Project, funded by the Federal Government of Germany through the German Development Bank (KfW). The S4R Project is working with the national genebanks of Nigeria, Zambia, Kenya, Ethiopia, and Ghana. Bioversity and CIAT shared their expertise on international policy for use of plant genetic resources through a virtual meeting. CIP provided expert advice on the safety duplication of sweetpotato accessions collected in Zambia and IITA is participating in face-to-face workshops and staff exchanges for the national genebanks.



**Table 10.** Platform and Module level capacity building events in 2021

Event	Date	Host organization	Location	Audience (close CG/open to public/by invitation)	Links as evidence
GROW Webinar: Rethinking Genebank Management—some critical thoughts and new approaches	21 Jan 21	Crop Trust	Virtual	Open to public	<a href="#">Link</a>
GROW Webinar: CRISPR Crops—Plant Genome Editing Made Easy	18 Feb 21	Crop Trust	Virtual	Open to public	<a href="#">Link</a>
GROW Webinar: The Critical Role of International Collaborations to Improve Conservation and Utilization of Crop Collections	18 Mar 21	Crop Trust	Virtual	Open to public	<a href="#">Link</a>
GROW Webinar: Seed survival in storage: A deep dive into the factors that influence seed longevity	15 Apr 21	Crop Trust	Virtual	Open to public	<a href="#">Link</a>
GROW Webinar: Who Needs Seeds? New Genetic Technologies and Old Seed Morgues	20 May 21	Crop Trust	Virtual	Open to public	<a href="#">Link</a>
1st Policy Module training course: “Genetic resources policies for CGIAR Scientists”	24 May–9 Jul 21	Genebank Platform	Virtual	Closed CG and by invitation	<a href="#">Link</a>
GLF Africa Digital Conference: “Biodiversity for Resilience: Harnessing crops’ potential for drylands restoration and climate change adaptation”	2 Jun 21	Crop Trust and Genebank Platform	Virtual	Open to public	<a href="#">Link</a>
GROW Webinar: Future of Genebanks	17 Jun 21	Crop Trust	Virtual	Open to public	<a href="#">Link</a>
Unlocking the Value of Germplasm Collections’ workshop	8–9 Jul 21	Crop Trust, Genebank Platform	Virtual	By invitation	<a href="#">Link</a>
GROW Webinar: Are Genebanks Serving Farmers?	15 Jul 21	Crop Trust	Virtual	Open to public	<a href="#">Link</a>
16th Congress of the European Association of Agricultural Economists	20–23 Jul 21	Crop Trust, Genebank Impacts CoP	Virtual	Open to public	<a href="#">Link</a>
GROW Webinar: Digital Sequence Information: A Looming Disaster or Hidden Opportunity for Positive Change?	26 Aug 21	Crop Trust	Virtual	Open to public	<a href="#">Link</a>
GROW Webinar: Squeezing the Good Stuff Out of the Vaults: Fields, Genomics, or Genebankomics?	16 Sep 21	Crop Trust	Virtual	Open to public	<a href="#">Link</a>
GROW Webinar: Crop genetic erosion: a review of 100 years of evidence, thoughts on future research, and an outline of steps needed to mitigate, stem, and reverse further losses	21 Oct 21	Crop Trust	Virtual	Open to public	<a href="#">Link</a>
CIMMYT, CIP, ICRAF and ILRI deposit seeds in Svalbard	24 Oct 21	Crop Trust and NordGen	Svalbard, Norway	By invitation	
2nd Policy Module training course: “Genetic resources policies for CGIAR Scientists”	3 Nov–17 Dec 21	Genebank Platform	Virtual	Closed CG and by invitation	<a href="#">Link</a>
Parallel sessions 2.1 & 2.2 of the Global Conference on Green Development of Seed Industries	4–5 Nov 21	FAO, Crop Trust, Genebank Platform	Virtual	Open to public	<a href="#">Link</a>
Side event at the 2nd International Agrobiodiversity Congress	15–18 Nov 21	Crop Trust, Genebank Impacts CoP	Virtual	Open to public	<a href="#">Link</a>
GROW Webinar: SoyKB and KBCommons	18 Nov 21	Crop Trust	Virtual	Open to public	<a href="#">Link</a>
Annual Genebanks Meeting	23–25, 30 Nov; 1–2 Dec 2021	Crop Trust, Genebank Impacts CoP	Virtual	Closed CG and by invitation (19 participants)	
Annual Meeting of the West and Central Africa Plants Genetic Resources (PGR) Network	13–15 Dec 21	Crop Trust, Genebank Platform	Lome, Togo	By invitation	<a href="#">Link</a>
GROW Webinar: How Much Genetic Diversity is Really Still Missing from Genebanks?	16 Dec 21	Crop Trust, Italian Government, the Alliance of Bioersity International and CIAT	Virtual	Open to public	<a href="#">Link</a>

# Effectiveness and Efficiency

## 2.1 Management and governance

There have been no changes to governance arrangements.

## 2.2 Partnerships

### 2.2.1. Highlights of External Partnerships

The primary partners of CGIAR genebanks and GHUs are the wide range of users from 93 countries who requested germplasm, advice, and information in 2021 (Table 11). The exchange of germplasm takes place within a policy framework that demands close partnership with the Plant Treaty, the Commission on Genetic Resources for Food and Agriculture (CGRFA) and the International Plant Protection Convention (IPPC). The Svalbard Global Seed Vault is an essential partner in long-term conservation, as well as in communicating to the wider world the importance of crop diversity and the organizations that conserve it. CGIAR genebanks provide more than germplasm to users, however. Individual genebanks also provide a range of services and support to national partners, including information, data, training, as well as hosting safety duplicates.

### 2.2.2. Cross-CGIAR Partnerships

The most significant cross-CGIAR exchange occurring within the framework of the Genebank Platform concerns the movement of germplasm and associated data: the acquisition of materials from CGIAR breeding programs by genebanks, the distribution of germplasm from genebanks to research and breeding programs, and the phytosanitary testing of materials by GHUs. In 2021, 2,810 samples were acquired from CGIAR breed-

ing programs and 32,130 samples were sent to breeding programs. In addition, many exchanges occurred between genebanks and Platforms or CRPs, some of which are captured in Table 12.

## 2.3 Intellectual Assets

All All CGIAR genebanks have agreements with the Plant Treaty, placing their germplasm collections under its Multilateral System of Access and Benefit Sharing. The collections, and the germplasm contained within them, remain publicly available and no patents or plant variety protection rights are sought on the germplasm. In 2021, 99% of samples externally distributed by the Centers were transferred under Standard Material Transfer Agreements (SMTA). The remaining 1% of transfers were sent by ICRAF and IITA directly to farmers, for which an SMTA is not required.

## 2.4 Monitoring, Evaluation, Impact Assessment and Learning (MELIA)

The outputs from the Genebank Platform are monitored through the Crop Trust online reporting tool (ORT) using agreed performance targets (Table 13).

### Technical and financial reviews

Genebanks and GHUs have documented 347 Standard Operating Procedures (SOPs) as part of their quality management systems (QMS). 118 genebank SOPs have been audited and were verified through external technical reviews.

A total of 137 actionable “findings” were reported as part of technical reviews that took place between 2018 and 2020. In 2021, as a response to the recom-

**Table 11.** Key external partnerships of the Genebank Platform in 2021

Module	Description	Name of partner	Main area of partnership
Conservation	Ultimate safety duplication of CGIAR germplasm	Svalbard Global Seed Vault	Risk management
	Research collaboration, partnership for germplasm distribution, safeguarding of genetic resources, recipient of capacity building and other genebank services	National genebanks	Capacity development and risk management
	Collaboration in the delivery of the Global Plan of Action	Commission on Genetic Resources for Food and Agriculture (CGRFA)	International policy
	Collaboration in safe exchange of germplasm	International Plant Protection Convention (IPPC) & national plant protection agencies	Phytosanitary and international policy
	Provision of germplasm, clean planting materials, information and advice.	93 countries	Delivery
Use	Global information system (GLIS) on plant genetic resources for food and agriculture	International Treaty on Plant Genetic Resources for Food and Agriculture (Plant Treaty)	Delivery and policy
Policy	International PGRFA policy development and compliance, capacity building for policy implementation at national level	Plant Treaty & Convention on Biological Diversity (CBD) Secretariats	International policy

**Table 12.** Cross-CGIAR Collaborations (beyond the exchange of germplasm) in 2021

Collaborating CRPs, Platforms, Centers	Brief description of the collaboration
Forests, Trees & Agroforestry (FTA)	Genebank supported FTA and bilateral projects on restoration/regreening, including the collection of evaluation data. (ICRAF)
Grain Legumes and Dryland Cereals (GLDC)	Work with the Bean Program to characterize the <i>Phaseolus acutifolius</i> collection for a range of traits related to heat and drought tolerance. (Alliance - CIAT)
Livestock	Genebank has continued to collaborate with Livestock CRP researchers, in assessment of diversity as well nutritional quality analysis of the forage collections. Forage species assessed include <i>Cenchrus purpureus</i> , <i>Lablab purpureus</i> , <i>Urochloa brizantha</i> . (ILRI)
Wheat	Evaluation and characterization of wheat subsets of landrace accessions. (ICARDA, CIMMYT) Pre-breeding activities. (ICARDA)
Rice	Project development on Expression Genome-Wide Association Study (eGWAS). (IRRI) Development and application of improved cryopreservation techniques for cassava. (Alliance - Bioversity)
Roots, Tubers & Bananas (RTB)	Collaboration with Grupo Yannapi and the potato conservationist association "Aguapan" from indigenous communities of Pasco and Sierra de Lima to work on monitoring diversity of potato in Peru both in situ and ex situ. Over 1,134 tuber samples were received, photographed, and tuber skin was used to extract DNA. Genotyping analysis demonstrated that 88 were unique and they were processed for introduction into the CIP genebank. Of these, 72 have been successfully added to the CIP genebank <i>in vitro</i> collection till now. (CIP)
Excellence in Breeding (EiB)	Collaborated with breeders, grain and nutritional experts and other scientists within the center on different aspects, including seed health testing, seed quality, phenotypic of more than 2000 African rice accessions for their grain and nutritional values. (AfricaRice) Participation in the BrAPI hackathon and in Module 5 Polyploid Meetings. (Alliance-Bioversity)
Big Data	Discussions regarding the extension of the DSI concept towards Digital Genetic Objects (DGOs). (Alliance - CIAT)
Germplasm Health Units (GHUs)	The GHU-CIAT provided assistance to GHU-ILRI in the context of identifying fungal pathogens affecting ILRI's forage accessions. (Alliance-CIAT)
Crop Trust	Several initiatives involving multiple centers on Seed Quality Management (SQM), GRIN-Global Community Edition (GGCE), and Seeds for Resilience (S4R) Project. SQM project conducted a training on "Good practices for management and processing of seeds". GGCE is being tested and implemented across Center genebanks. Several Centers delivered capacity development and extension in Kenya and Zambia on genebank infrastructure and processes under S4R.

**Table 13.** Monitoring, Evaluation, Learning and Impact Assessment (MELIA) in 2021

Studies/learning exercises planned for this year	Status	Type of study or activity	Comments	Links to evidence
Document audits	Ongoing	Audit	A total of 347 Standard Operating Procedures (SOPs) have been drafted by genebanks (175) and GHUs (172). To date, 118 genebank SOPs (67%) have been subject to document audits.	<a href="https://genebanks.org/resources/genebank-documentation-audits/">genebanks.org/resources/genebank-documentation-audits/</a>
Genebank Impacts Fellowship	Complete	Outcome study	The impacts of the CGIAR genebanks were documented as part of the Genebank Impacts Fellowship program launched in 2018. Five new fellows were recruited in 2020, and a series of case studies were published in 2021, in a special issue of the journal <i>CABI Agriculture &amp; Bioscience</i> , titled "The Value of Genebanks on Farms in Developing Agriculture."	<a href="http://www.biomedcentral.com/collections/genebanks-agriculture">www.biomedcentral.com/collections/genebanks-agriculture</a>

recommendations of the reviews and to bolster the resilience of the genebanks against lockdown measures, Recommendation Action Plans (RAPS) were launched in each genebank. These RAPS included efforts to improve data management, test dormancy breaking techniques in crop wild relatives, improve long-term conservation facilities, reduce redundancy in seed samples and streamline viability monitoring.

The impacts of the CGIAR genebanks were further documented as part of the Genebank Impacts Fellowship program launched in 2018 and overseen by the Crop Trust and Michigan State University. Five fellows, from Cameroon, Côte d'Ivoire, the Philippines, USA, and Germany, were recruited in 2020, and a series of impact case studies was published in 2021–22 in a special issue of the journal *CABI Agriculture & Bioscience*, titled “The Value of Genebanks on Farms in Developing Agriculture.”

## 2.5 Efficiency

Drives towards efficiency and improvement across all CGIAR genebanks occur through the development and auditing of standard operating procedures (SOPs) under the genebank quality management system, and through technical reviews and the responses to individual recommendations. Several genebanks have

undertaken changes in processes and systematic re-inventorying of collections as a result of review recommendations. This has led to the archiving or elimination of both accessions and seed lots.

Testing and adoption of technologies and innovations is occurring through communities of practice (CoP) (Table 14). The seed quality management and germplasm health CoPs are currently piloting automated seed imaging as a means to gather details on seed identity, viability and health on a large scale. In collaboration with small specialist companies, IRRI has been testing customised robotics for seed phenotype sorting and germination testing. As a result, the suitability and limitations of such technologies for genebank operations is becoming much better understood. The opening of CIAT’s Future Seeds facility in 2022 has also served as an opportunity to pilot smart labelling or radio-frequency identification (RFID), which uses electromagnetic coupling to identify large numbers of samples at one time.

## 2.6 Management of Risks to your Platform

**Programmatic risks:** The Crop Diversity Endowment Fund managed by the Crop Trust currently stands at USD 339 million, excluding a EUR 50 million loan. This is short of the initial planned target of USD

**Table 14.** Building efficiencies in the Genebank Platform

Level of entry	Methods	Expected outputs
Individual genebanks	<ul style="list-style-type: none"> <li>Quality management systems (QMS)</li> <li>Annual improvement reports</li> <li>External technical reviews (5-year)</li> <li>Costing reviews (10-year)</li> <li>Testing of new technologies</li> <li>Protocol optimization</li> </ul>	<ul style="list-style-type: none"> <li>Documented standard operating procedures (SOPs) and system for auditing, review and improvement</li> <li>Improvements triggered by recommendations from expert reviews</li> <li>Compiled costs per activity/accession</li> <li>Annual assessments of efficiency aims and progress</li> <li>Piloting of imaging, automated seed sorting, automated germination testing, cryopreservation protocols</li> </ul>
Thematic areas	Communities of practice and specialization: <ul style="list-style-type: none"> <li>Data management</li> <li>Clonal crops</li> <li>Seed quality management</li> <li>Quality management systems</li> <li>Germplasm health units</li> <li>Impact fellows</li> <li>Genetic resources policy</li> </ul>	Workplans, strategies, research projects, revised procedures or SOPs, etc.
Platform level	<ul style="list-style-type: none"> <li>Shared performance targets/standards/QMS</li> <li>Genebank Operations &amp; Advanced Learning (GOAL) workshops</li> <li>Platform level recommendations from technical and costing reviews</li> <li>Benchmark studies</li> <li>2020 System Level Review of Genebank Costs and Operations</li> </ul>	<ul style="list-style-type: none"> <li>Progress to “steady-state” operations</li> <li>Aligned SOPs, templates and, in some cases, procedures (e.g. for same crops)</li> <li>Adoption of good practices across Centers</li> <li>System level actions to address recommendations</li> <li>Shared policy and technical framework for strategic curation of collections (including archiving)</li> <li>Consolidation &amp; rationalization of roles, activities and collections</li> </ul>



Bioversity worked with the National Agriculture Research Institute in Papua New Guinea to collect landraces



IITA teamed up with the Ministry of Agriculture and Food Security in South Sudan to collect local landraces



Partners at the National Centre for Agronomic Research and Agricultural Development in Mauritania work with ICARDA to collect sorghum diversity in farmers' fields



ICRISAT sent 140 accessions of pearl millet, sorghum and groundnut to the Institute of Agriculture Research for Development in Chad for repatriation. The accessions were planted for a farmers' field day.

500 million for long-term funding of international genebanks. In 2021, the Crop Trust withdrew 2.9% from the Endowment Fund and raised a further USD 1.1 million in bilateral funds from the European Commission. In addition, the German Federal Ministry for Economic Cooperation and Development (BMZ) provided USD 4 million through Window 2 to support the activities of the genebanks to reach performance targets. Together with the funding from EC and BMZ, the Crop Trust met its commitment of USD 15 million to the Genebank Platform in 2021.

**Contextual risks:** Unrest in Colombia, Ethiopia and Lebanon has focussed attention on the resilience of the systems for safety duplicating collection. Thanks to years of multiplying up samples for shipping to the Svalbard Global Seed Vault and other host institutes, safety duplication has substantially improved the security of collections. However, tissue culture collections depend on a conveyor belt system of safety duplication, with samples being multiplied continuously to ensure the whole collection remains duplicated at any one time. That system is at serious risk of collapse if the lockdown is extended and staff capacity is reduced. The only answer, at present, is cryopreservation, which enables a one-time, long-term duplication process. Once accessions are cryopreserved and safety duplicated, they will remain viable for decades without the need for replenishing unless the sample is used. The Clonal Crop Commu-

nity of Practice has therefore developed a Global Cryopreservation Initiative to take the existing work on cryopreservation to a new level and provide support to national genebanks to cryopreserve their collections too. The Crop Trust is assisting the group to raise funds with support from BMZ.

**Institutional risks:** The reform of the CGIAR and the associated development of proposals for new initiatives has been a highly intensive occupation for many staff in 2021. Of particular note for the genebanks has been the status of those Centers that decided not to participate in the reform. The coherence of the group of genebanks is well appreciated by the global community, especially in the forum of the Plant Treaty. The communication to this community of the change in configuration of the group and the status of all the collections needs to be carefully considered. Throughout reform discussions in 2021, it was re-iterated that CGIAR remains committed to its obligations under Article 15 of the Plant Treaty, both those Centers that are now part of One CGIAR and those that are not. The effects on governance of the reform are also being reviewed with the consideration that the legal entities must continue to have a governance role of the genebanks. The group will work in 2022 towards clarity on the finer details of these issues in order to be able to communicate clearly to the wider community at the Plant Treaty Governing Body meeting in India in September 2022.



First batch of 20,000 accessions of ICRISAT's sorghum and pearl millet germplasm shipped to the IITA genebank as a first-level safety duplicate. Photo: ICRISAT



CIAT's new genebank, Future Seeds, neared completion in 2021. Photo: CIAT



Regeneration of genebank accessions at ICARDA's station in Terbol. Photo: ICARDA



Seed viability testing at ILRI's genebank. Photo: Shawn Landersz

## Financial Summary

The budget is fixed and closely follows the original proposal, which was based on costed routine operations and actions. In 2021, approximately one third of the Genebank Platform costs was covered by the Crop Trust. This contribution includes funds raised by the Crop Trust from the European Commission and is primarily used to support essential routine opera-

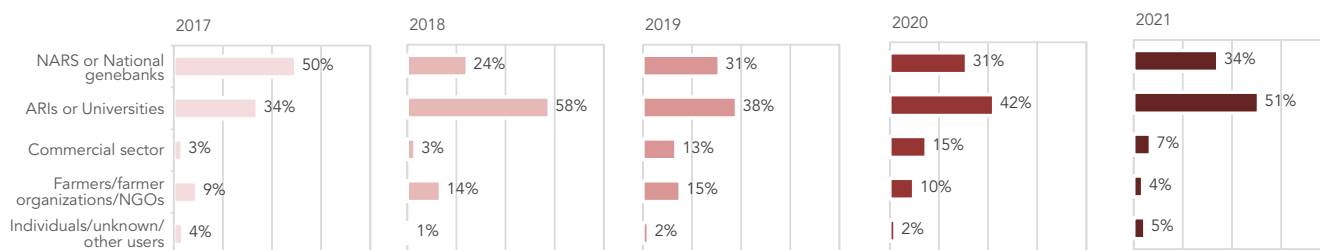
tions in nine of the 11 genebanks through long-term grants and a long-term partnership agreement. BMZ supported W2 in 2021 with the aim of funding upgrading actions to bring genebanks up to performance targets so that they become eligible for the Crop Trust long-term partnership agreements (LPAs). The UK Government also provided W2 funding 2021.

**Table 15.** Financial Summary

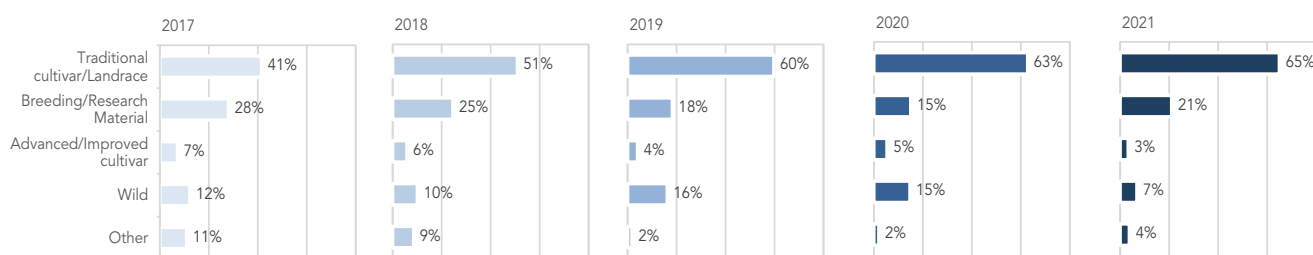
	Planned budget 2021			Actual expenditure 2021			Difference		
	W1/2	W3/ bilateral	Total	W1/2	W3/ bilateral	Total	W1/2	W3/ bilateral	Total
Module 1	18.12	9.07	18.12	18.34	27.19	27.27	-0.22	0.14	-0.08
Module 2	0.73	0.54	0.73	0.66	1.27	1.22	0.07	-0.02	0.05
Module 3	0.74	0.00	0.74	0.60	0.74	0.60	0.14	0.00	0.14
Management & Support Costs	0.75	0.00	0.75	0.75	0.75	0.77	0.00	-0.02	-0.02
<b>Platform Total</b>	<b>20.34</b>	<b>9.61</b>	<b>20.34</b>	<b>20.35</b>	<b>29.95</b>	<b>29.86</b>	<b>0.01</b>	<b>0.00</b>	<b>0.09</b>

Note: Values in USD millions. Some numbers do not add up due to rounding.

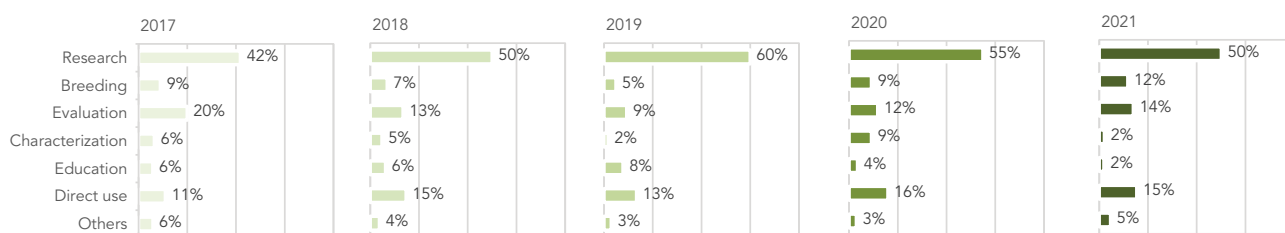
# Annex



**Annex Figure 1.** Recipients of germplasm distributed by CGIAR genebanks, 2017 to 2021



**Annex Figure 2.** Types of materials requested, 2017 to 2021



**Annex Figure 3.** Purpose of requests, 2017 to 2021

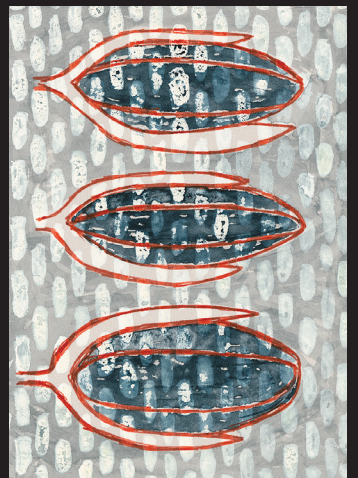
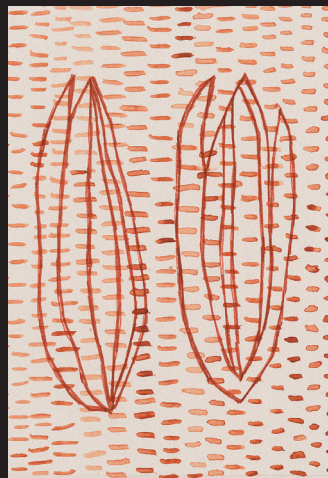
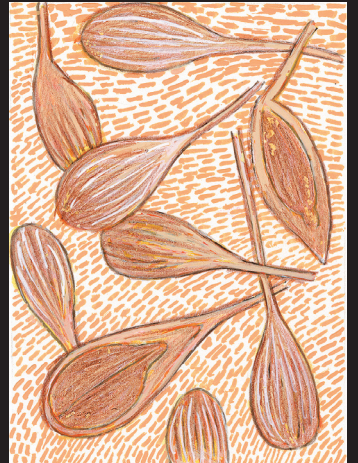
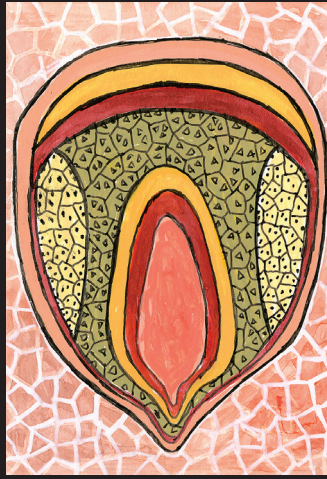
**Annex Table 1.** Participants in capacity development activities in 2020

Number of trainees	Female	Male
In short-term programs facilitated by the Platform	791	2,868
In long-term programs facilitated by Platform	0	0
PhDs	0	0

**Annex Table 2.** Update on actions taken in response to the IEA evaluation of the CGIAR research support program for Managing and Sustaining Crop Collections: Genebanks CRP

Status of response to this recommendation	Concrete actions taken for this recommendation	By whom	When	Comments	Link to evidence
<i>Revisit the Parity Study to establish realistic and transparent budget for each Center genebank</i>					
Ongoing	Costing reviews	Platform management	Visits per Center planned in 2018-2020	2017: IRRI 2018: Alliance-CIAT, CIMMYT, CIP, ICARDA 2019: ICRISAT, ILRI, ICRAF, Alliance-Bioversity 2020: AfricaRice, IITA	<a href="https://bit.ly/2QSU0lv">https://bit.ly/2QSU0lv</a>
<i>Promote the Genebank Platform communications</i>					
Ongoing	Genebank Platform website actively maintained and promoted. Facebook and Flickr pages were launched in mid-2018	Science communications specialist	Annual	2019: The website received 19,637 users during 2019 who accounted for 40,037 page views. The Facebook page has more than 900 followers and monthly reaches nearly 7,500 people. The Flickr page offers 814 images. Two email newsletters were sent out in 2019. 2020: The website received 18,070 users during 2020 who accounted for 39,299 page views. The Facebook page has more than 1,120 followers and monthly reaches nearly 10,500 people. The Flickr page offers 814 images. The Vimeo page has 31 videos. 1 email newsletter was sent out in 2020 to 713 subscribers. 2021: The Genebank Platform Facebook page had 100 posts in 2021 and 1,450 followers. It reached 47,500 people. We shared 15 GROW webinar videos (including intro videos) on Vimeo and all the full videos on YouTube (12 in total). We also shared 22 genebank trailers and two webinar workshop videos for "Unlocking the Value of Germplasm Connections". The website received 24,035 users and 51,374 page views. The Platform newsletter had 972 subscribers and five newsletters were sent out. The GROW webinar newsletter had 988 subscribers with 27 newsletters sent out.	<a href="http://www.genebanks.org">www.genebanks.org</a> <a href="https://www.facebook.com/GenebanksCGIAR/">www.facebook.com/GenebanksCGIAR/</a> <a href="https://www.flickr.com/photos/genebankplatform/">www.flickr.com/photos/genebankplatform/</a>
<i>External validation of QMS</i>					
Ongoing	Technical reviews	External reviewers	Visits per Center planned in 2019-2020	2019: Alliance-CIAT, CIMMYT, CIP, ICARDA, IITA, IRRI 2020: AfricaRice, Alliance-Bioversity, ICRAF, ICRISAT, ILRI	<a href="http://www.genebanks.org/resources/genebank-reviews/">www.genebanks.org/resources/genebank-reviews/</a>
<i>Enhance linkages between genebank characterization and breeders' evaluation and pedigree data</i>					
	Minting of DOIs			2019: 98% of accessions with DOIs 2020: 99% of accessions with DOIs 2021: 99% of accessions with DOIs	
Ongoing	Enriching data on collections through focal subsets	Use module	Annual	2019: Genesys has 113 subsets published and 345 characterization and evaluation datasets uploaded from CGIAR genebanks. 2020: Genesys has 135 subsets published and 433 characterization and evaluation datasets uploaded from CGIAR genebanks. 2021: Genesys has 254 subsets published and 433 characterization and evaluation datasets uploaded from CGIAR genebanks.	<a href="http://www.genesys-pgr.org/">www.genesys-pgr.org/</a>





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