2018 ANNUAL REPORT

CGIAR Genebank Platform

CGIAR Genebank Platform

CROP TRUST

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Acronyms

3K	3,000 Rice Genomes Project
ACIAR	Australian Center for International Agricultural Research
AFS CRP	Agri-Food System CGIAR Research Program
AGM	Annual Genebanks Meeting
AOCC	African Orphan Crop Consortium
ARI	Advanced Research Institute
B4R	Breeding for Rice
BBTV	Banana Bunchy Top Virus
BLE	Federal Office for Agriculture and Food
BMGF	Bill & Melinda Gates Foundation
BrAPI	Breeding Application Programming Interface
INIA	Agricultural Research Institute, Chile
CATIE	Tropical Agricultural Research and Higher Education Center
CBD	Convention on Biological Diversity
CGRFA	Commission on Genetic Resources for Food and Agriculture
CIAT	International Center for Tropical Agriculture
CIMMYT	International Maize and Wheat Improvement Center
CIP	International Potato Center
Crop Trust	Global Crop Diversity Trust
CRP	CGIAR Research Program
DArTSeq	Diversity Arrays Technology Sequencing
DG	Director General
DGDC	Directorate-General for Development Cooperation, Belgium
DOI	Digital Object Identifier
DSI	Digital Sequencing Information
EiB	Excellence in Breeding
ELISA	Enzyme-Linked Immunosorbent Assay
EMBRAPA	Brazilian Agricultural Research Corporation
FAO	Food and Agriculture Organization of the United Nations
FIGS	Focused Identification of Germplasm Strategy
FTA	CGIAR Research Program on Forests, Trees and Agroforestry
GHU	Germplasm Health Unit
GIGWA	Genotype Investigator for Genome-Wide Analyses
GLDC	CGIAR Research Program on Grain Legumes and Dryland Cereals
GLIS	Global Information System
GOAL	Genebank Operations and Advance Learning
GPA	Global Plan of Action
GRIN	Germplasm Resources Information Network
ICARDA	International Center for Agricultural Research in the Dry Areas
ICRAF	World Agroforestry Center (International Council for Research in Agroforestry)
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IEA	Independent Evaluation Agreement
IITA	International Institute for Tropical Agriculture
ILRI	International Livestock Research Institute
IPPC	International Plant Protection Convention
IRRI	International Rice Research Institute
ISI	Institute of Scientific Information
ISPM	International Standards for Phytosanitary Measures
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
LPA	Long-Term Partnership Agreement
MELIA	Monitoring, Evaluation, Impact Assessment and Learning
NARES	National Agricultural Research Extension and Education System
NARS	National Agricultural Research System(s)
NGS	Next Generation Sequencing
ODAP	Oxalyldiaminopropionic acid
ORT	On-line Reporting Tool
PATSPO	Provision of Adequate Tree Seeds Portfolio
PDCI	Passport Data Completeness Index
PGRFA	Plant Genetic Resources for Food and Agriculture
POWB	Plan of Work and Budget
QMS	Quality Management System
RTB	CGIAR Research Program on Roots, Tubers and Bananas
SGSV	Svalbard Global Seed Vault
SMB	System Management Board
SMO	System Management Office
SMTA	Standard Material Transfer Agreement
SNP	Single Nucleotide Polymorphism
SOP	Standard Operating Procedures
SPC-CePaCT	Secretariat of Pacific Community-Center for Pacific Crops and Trees
USDA	United States Department of Agriculture
WG-EFMLS	Open-Ended Working Group to Enhance the Functioning of the Multilateral System of Access and Benefit-Sharing

1. Key Results

1.1 Highlight Platform achievements

CGIAR Germplasm distribution

The activities of the Genebank Platform are targeted specifically to bring about increased conservation and use of genetic resources with the aim of achieving CGIAR System Level Outcomes (Sub-IDO 1.4) and UN Sustainable Development Goals (Target 2.5). The annual distribution of genetic resources from CGIAR genebanks provides a rough indicator for their use, although it should be recognized that numbers distributed only correspond to the level of demand in any one year rather than the general scale of use of these resources. In 2018, a total of 96,566 germplasm samples (66,930 accessions) were distributed by the CGIAR genebanks to users (Figure 1). Of these, 40,173 samples (42%) were provided to CGIAR Research Programs (CRPs) and 56,393 (58%) were distributed to recipients outside the CGIAR in 87 countries; the majority of samples being distributed to developing countries (Figures 2 and 3). For the second year in a row, germplasm distribution outside the CGIAR has exceeded that inside the CGIAR. Developing countries also received a larger proportion of germplasm in 2018 (77%) compared to 2017 (67%).

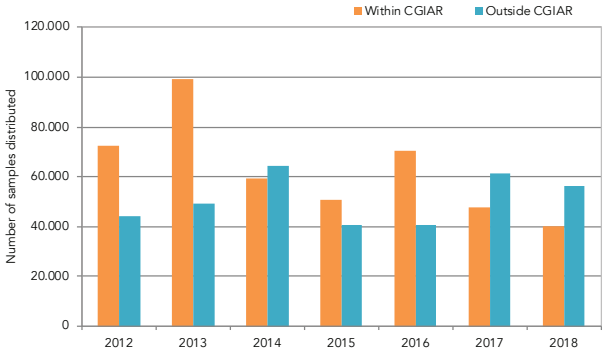


Figure 1. Annual total samples distributed by CGIAR genebanks from 2012 to 2018

Of the external distributions in 2018, most samples were sent to universities or research institutes (Figure 4). 61% of the samples distributed represented traditional cultivars and crop wild relatives (Figure 5). Table 1 lists the top country recipients of germplasm from CGIAR genebanks

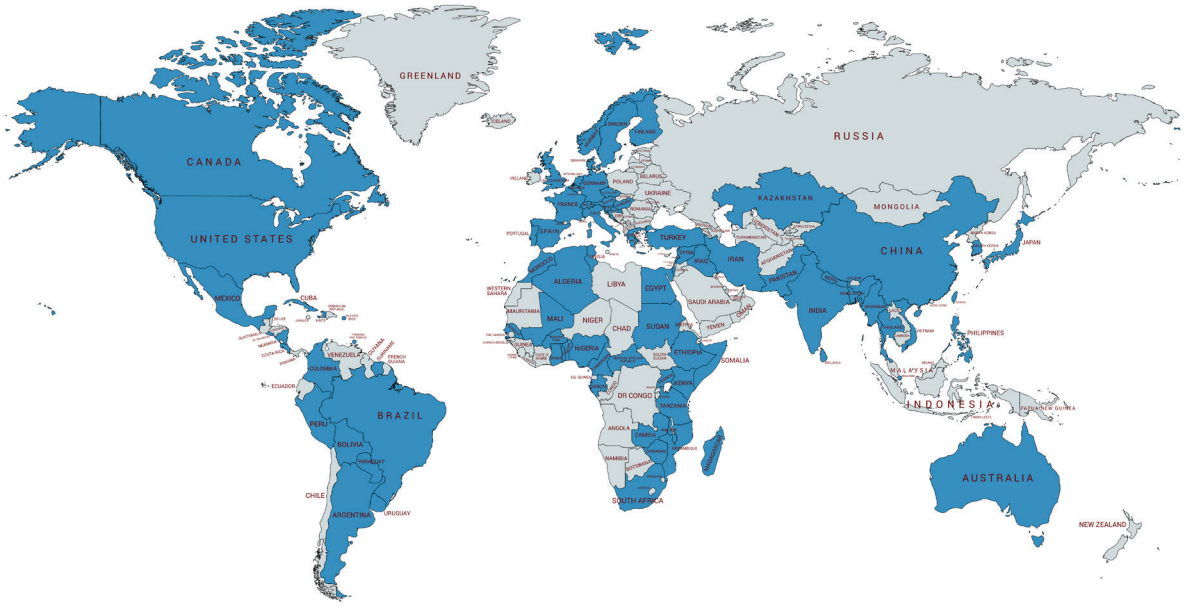


Figure 2. Map of countries receiving CGIAR germplasm in 2018

(not including materials transferred within or between CGIAR Centers). Most of these countries (14) featured also in 2017 as recipients of the highest number of samples of germplasm from the CGIAR. Of the top 10 developing countries, eight host CGIAR Centers. Only 16% of samples go to developing countries outside the top 10, suggesting that there is substantial scope for the CGIAR to scale up external distributions in the developing world. Annex 1 provides more details of the distribution of germplasm to countries from individual Centers and by crop.

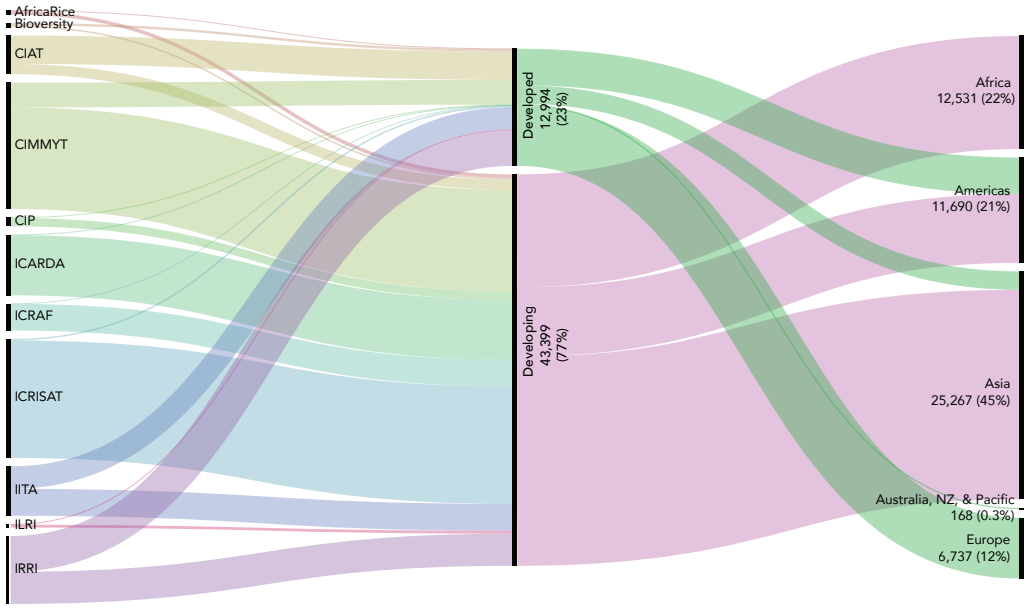


Figure 3. Samples distributed by each Center to users outside the CGIAR and geographical region of recipient in 2018

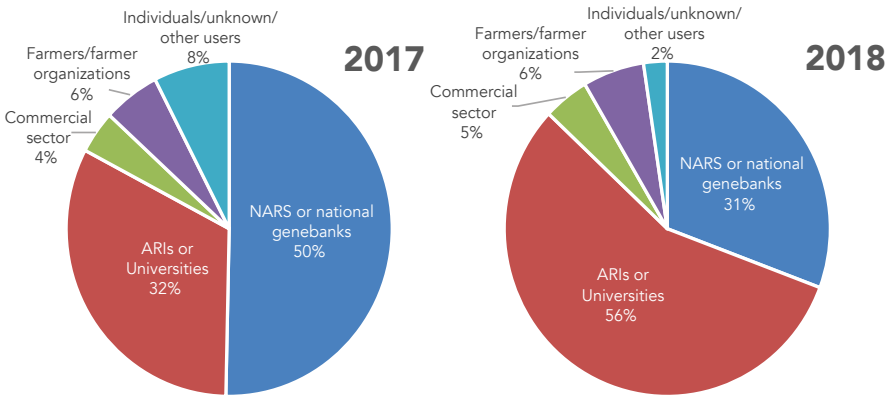


Figure 4. Recipients of germplasm distributed by CGIAR genebanks in 2017 and 2018

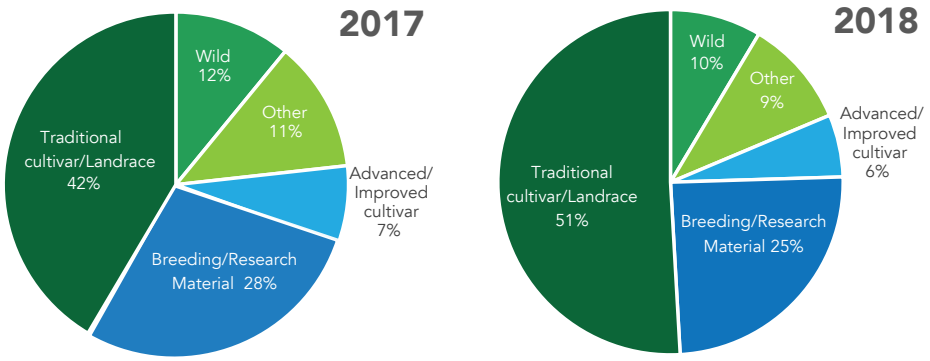


Figure 5. Types of materials distributed by CGIAR genebanks in 2017 and 2018

Progress on key performance indicators

By the end of 2018, CGIAR genebanks were managing 773,112 accessions, including 25,576 *in vitro* accessions and 32,212 accessions held as plants or trees in screenhouses or fields. Approximately 80% of total accessions are immediately available for international distribution (Figure 6). Of the seed accessions, 57% is secured in safety duplication at two levels and 78% is duplicated at the Svalbard Global Seed Vault (SGSV). 72% of clonal crop collections is safety duplicated in the form of cryopreserved or *in vitro* cultures.

An update of the current accession numbers of the aggregate collection under CGIAR management is provided in Table 2. Five seed genebanks have reached 90% targets for availability and one clonal collection is approaching the target. The individual status of the genebanks is provided in Figure 7 and Table 3.

Table 1. Top 10 developing and developed countries receiving germplasm from CGIAR Centers in 2018

	Developing			Developed		
Rank*	**Country**	**Number of Accessions**	**Number of Samples**	**Country**	**Number of Accessions**	**Number of Samples**
1	India	8,009	15,154	United States	3,654	3,727
2	China	4,002	4,311	**Belgium**	2,722	2,742
3	Morocco	3,780	3,780	Japan	1,874	1,874
4	Mexico	3,701	3,701	United Kingdom	1,695	1,839
5	Nigeria	1,650	2,471	Germany	1,011	1,011
6	**Lebanon**	2,071	2,071	Italy	424	424
7	Mali	356	1,679	Canada	322	322
8	Ethiopia	778	1,134	Sweden	178	178
9	**Colombia**	879	1,117	**Spain**	169	169
10	**Kenya**	328	984	Australia	152	168
	Sub-total (% from total)	25,554 (81%)	36,402 (84%)	Sub-total (% from total)	12,201 (96%)	12,454 (96%)
	Other countries (% from total)	6,082 (19%)	6,997 (16%)	Other countries (% from total)	528 (4%)	540 (4%)
	Total	**31,636**	**43,399**	**Total**	**12,729**	**12,994**

Notes: *Ranking by number of samples. Excludes distributions to CGIAR programs. Countries in bold were not in Top 10 in 2017.

Table 2. Key statistics of the aggregate CGIAR collection between 2012 and 2018

Indicator	Description	2012	2013	2014	2015	2016	2017	2018
1. Total number of accessions	Base number of accessions in the collections (excluding barley at CIMMYT, rice at CIAT, *Rhizobium* and mycorrhiza at CIAT and ICARDA, and regional collections of ICRISAT).	710,001	725,244	738,215	750,604	757,767	768,576	773,112
2. Total number of accessions that are currently available	Numbers of accessions that are viability tested, disease-free and with sufficient seed number for immediate distribution.	465,358	492,654	525,410	559,053	580,706	608,751	621,915
3. Number of seed accessions held in long-term storage and safety duplicated at 2 levels	Numbers of accessions in seed collections held in long-term storage and safety duplicated in a major genebank and in SGSV.	386,037	375,271	413,448	381,932	404,074	408,323	420,164
4. Number of RTB accessions in cryopreservation or safety duplicated	Number of vegetative-propagated accessions in cryopreservation or safety duplicated as *in vitro* samples.	15,643	16,141	15,554	19,356	19,803	18,144	18,427

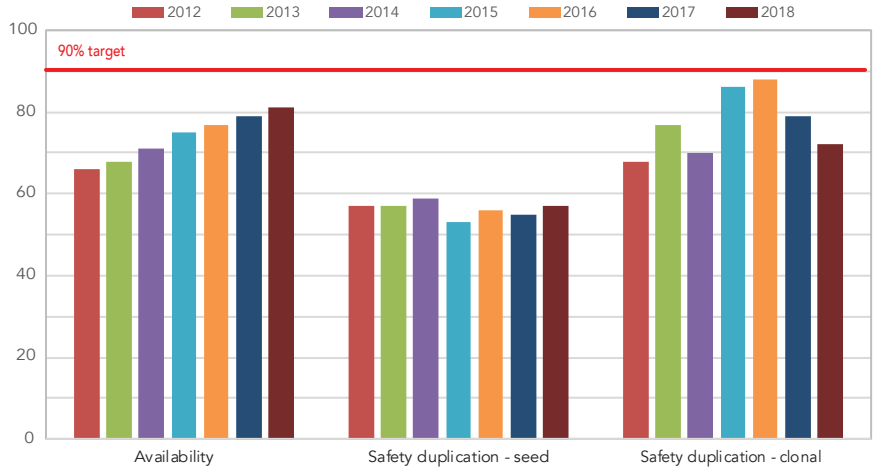


Figure 6. Status (%) of availability and safety duplication of CGIAR genebanks between 2012 and 2018

Figure 7. Status (%) of availability of seed collections between 2012 and 2018 (top) and clonal collections (bottom) between 2012 and 2018

Table 3. Status of CGIAR genebanks with respect to performance targets in 2018

Center	% Availability 2018	% Increase from 2017	% Safety duplication 2018	% Increase from 2017	Comments
AfricaRice	91	3	62	0	AfricaRice succeeded in bringing the collection together at one location in Cote d'Ivoire for the first time in 15 years in their newly constructed genebank. Expect to reach targets in 2021.
Bioversity	63	0	69	17	Efforts are underway to address the presence of Banana Streak Virus, which is main constraint to availability. Expect to reach targets after 2022.
CIAT seed	80	7	84	3	Continued increases in availability and safety duplication. Rationalization of the forages collection has started. Expect to reach targets in 2021.
CIAT cassava	78	50	59	-9	New methods are being explored for safety duplication including using bonsai plants and nano-propagation. Expect to reach targets in 2020.
CIMMYT wheat	91	0	80	-1	Seeds are being bulked up for final safety duplication. Rationalization also under way in 2019. Expect to reach targets in 2020.
CIMMYT maize	64	3	76	0	Gradual improvement in regeneration success rates are helping to improve availability. Seeds are being bulked up for safety duplication in 2019 and 2021. Expect to reach targets after 2022.
CIP	37	21	88	13	Important progress made on both health testing and verifying identity. Expect to reach targets after 2022.
ICARDA	64	8	35	21	These figures still include the collection in Syria. Wheat, barley, lentil and chickpea are due to reach targets in 2021. Expect to reach targets in other crops after 2022.
ICRAF seed	75	36	17	40	Field accessions (not included here) are available only locally and are not sufficiently safety duplicated. However, field collections are in the process of being rationalized. Expect to reach targets after 2022.
ICRISAT	95	0	15	0	ICRISAT continues to negotiate with the Indian Government in order to release shipments for first level duplication. Expect to reach targets in 2022.
IITA seed	94	5	48	3	Phyosanitary issues are resolved with Colombia and IITA is expected to be able to safety duplicate at CIAT in 2019 which will allow it to reach targets in 2020.
IITA clonal	39	11	33	-21	Yam meristem culture continues to be the main constraint to conservation activities. Levels of safety duplication decreased because of renovation works in Benin laboratory. Expect to reach targets after 2022.
ILRI	0	-100	21	11	Alignment of operations with CIAT has required the retesting of all accessions for specific seed-borne diseases. There is a current moratorium on distribution until the testing is complete. The Ethiopian Government is also imposing additional conditions on the distribution of non-Annex 1 material. Expect to reach targets after 2022.
IRRI	93	1	89	0	Safety duplication due to take place as soon as legal agreements are signed with partners in the USA. Long-term partnership agreement awarded in 2019.

1.2 Platform progress towards outputs and outcomes

1.2.1 Overall Platform progress

The activities of the Genebank Platform are closely following those of the 2016 proposal and the 2018 Plan of Work and Budget (POWB), with steady improvement overall in the status of the collections and the operations of the genebanks and germplasm health units (GHUs). Table 4 presents the achievement of milestones. Progress in the availability of accessions is proceeding as expected but there is a noted delay in progress for a number of genebanks in achieving safety duplication targets. This has been due to three reasons: two Centers are currently constrained from allowing certain parts of the collection outside of the host country while negotiations are ongoing (see 2.6 Management of Risks), a number of Centers have delayed the shipment of safety duplicates to CIAT because of new national phytosanitary regulations in Colombia, and ICARDA has been using safety duplicates from SGSV to reconstitute active collections of wheat, barley,

Table 4. Progress against 2018 milestones

Module	Platform outcome (2022)	POWB 2018 milestone	Progress an milestone status	Evidence
Conservation	Output 1.1 Disease-free, viable documented germplasm made available	80% accessions available	Achieved	Online reporting, Genesys
		60% seed accessions safety duplicated	57% seed accessions safety duplication	Safety duplication is currently hampered by various factors
		75% clonal accessions safety duplicated	72% clonal accessions safety duplicated	Safety duplication of clonal collections is repeated annually and is influenced by multiple factors.
		80% relevant requests met	90% requests met	Online reporting
	Output 1.2 Crop diversity conserved in a rational and effective global system	40 Standard Operating Procedures (SOPs) in place	156 SOPs in place, relating to key operations of genebanks and GHUs (e.g., acquisition, distribution, conservation, regeneration, etc.)	Drafted SOPs are compiled but not yet publicly available
		500 accessions successfully introduced into cryobanks	702 accessions introduced into cryo: 55 banana at Bioversity, 563 potato at CIP, 60 sweetpotato at CIP, 24 cassava at IITA	Cryotanks at Bioversity, CIP and IITA
		Diversity trees developed representing 14 crop genepools	Achieved	Online reporting
		20 NARS staff involved in capacity building events	186 NARS staff involved capacity-building events at Platform level and >2,000 NARS staff involved in Center-organized capacity building events and >5,000 participated in genebank visits	Online reporting
Use	Output 2 More effective access and use of germplasm enabled	100% accessions with Digital Object Identifiers (DOIs)	97% accessions with DOIs	Genesys
		One new subset for a defined user developed in each genebank	Achieved	Report available. Subsets will be made available through Genesys in 2019.
Policy	Output 3 Supportive policy environment developed	CGIAR contributions to 4 intergovernmental meetings under rubric of the Convention on Biological Diversity/ Nagoya Protocol and the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)	CGIAR representation at 6 international meetings	Reports available at CGIAR Sharepoint upon request
		CGIAR guidance document on transferring plant genetic resources for food and agriculture (PGRFA) under development	Guidance provided in 2 documents: *i) Guidelines on the Nagoya Protocol for CGIAR Research Centers* *ii) Guidance Note on CGIAR Research Center Public Disclosures related to the Management of Intellectual Assets*	Documents available at CGSpace: http://bit.ly/2I64rWb http://bit.ly/2W9Wglu

lentil and chickpea in Morocco and crop wild relatives, forages and food legumes in Lebanon. Center management and staff are actively pursuing resolution of the former issues. The plans of the GHU Community of Practice to develop a "GreenPass" system to recognize and facilitate the movement of germplasm from CGIAR Centers represents a longer-term effort to address the possibility of national phytosanitary agencies imposing unwarranted regulations. In general, however, these issues do not appear to be preventing the distribution of germplasm to requesters with an overall 90% of requests being met.

Important progress is being made in strengthening quality management systems (QMS) of both genebanks and GHUs with staff in key positions continuing to draft and improve standard operating procedures (SOPs) and all genebanks undergoing documentation audits for key procedures. Expected milestones for drafted SOPs have been significantly exceeded due to the rapid progress made by the GHUs in developing their SOPs. The audits ensure that the written SOPs are following expected standards. Planned *in situ* expert reviews in 2019 and 2020 will use the audits and genebank annual reports to validate the reported status of the collections and the implementation of the SOPs.

CIP have succeeded in cryopreserving more than 50% of the clonal potato collection. With nearly 3,000 accessions established in cryotanks, this makes the CIP collection one of the largest crop cryo-collections in the world. Cryopreservation represents the most secure way of conserving clonal crop collections in the long term, with less threat from contamination and somaclonal variation than field or tissue culture collections, but the technique demands a tremendous amount of team discipline and skill to ensure accessions are disease-free, true-to-type and able to be successfully regenerated after cryopreservation, which sometimes requires optimized protocols for individual genotypes. Cryopreserved samples can be safety duplicated, precluding the need for the annual multiplication and shipment of *in vitro* duplicates to multiple locations, and cryopreserved collections also pave the way for rationalization of field and *in vitro* collections. The CGIAR, having achieved this scale of implementation in cryopreservation, is in a unique position to build on this capacity and to provide support to cryopreserve other clonal crop collections on a large scale elsewhere.

Efforts to promote the use of diversity in the collections are focusing on the association of existing or new data with genebank accessions, including characterization and evaluation data and published or available trait data. The Genebank Platform has also spearheaded a global effort, instigated by the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), to enable the traceability of accessions through the use of Digital Object Identifiers (DOIs). Targets for the implementation of DOIs are now effectively met with all genebanks having applied DOIs to all collections. The next steps

CIP in Peru is rapidly building one of the largest cryopreserved clonal crop collections in the world.
Photo: Luis Salazar/Crop Trust.

are to mainstream the use of DOIs in genebank processes and to encourage their use once accessions have left the genebank. All genebanks are also engaging different users, both inside and outside the CGIAR, to develop subsets based on desirable traits, environmental parameters or genetic diversity. The subsets developed are listed in Table 7 and collaborations are summarized in Table 11. A major effort will begin in 2019 to bring accession-level characterization and evaluation data for all CGIAR collections into one place in the global online portal, Genesys.

The Policy Module has played a very active role in 2018 in international negotiations and events relating to plant genetic resources for food and agriculture (PGRFA) policy and has worked to ensure CGIAR activities, guidelines, and reporting processes comply with legal and other requirements. The Policy Module has set up and developed consultation processes with multiple CGIAR decision-making and implementation bodies, including the System Management Board (SMB), System Management Office (SMO), Director Generals of Centers that are signatory to the Article 15 of the ITPGRFA, the newly established CGIAR Genetic Resources Policy Working Group, and also external stakeholders. Planned participation in international meetings and development of publications and guidance documents in 2018 have all been achieved.

Finally, a large proportion of the activities of the Genebank Platform involve capacity building; internally through strengthening QMS, training events, sharing practices and expertise, studentships and Platform-level meetings, and externally through workshops, exchange visits, project collaborations and particularly through ad hoc advice and support that is provided not just for the selection of germplasm but for a wide range of purposes. Figure 13 provides an indication of the range of services and advice that genebanks provide. According to reported figures, more than 3,000 NARS scientists and farmers have been involved in capacity building events and more than 5,000 people have participated in tours of CGIAR genebanks in 2018. The work on QMS and staff succession has been particularly timely given the retirement of six long-serving genebank managers. The dedication of these managers to the long-term conservation of plant genetic resources was recognized by the Crop Trust with a "Legacy Award" at the tenth anniversary of the Svalbard Global Seed Vault.

1.2.2 Progress by Platform Modules

Conservation Module

The progress of individual genebanks in upgrading collections and reaching performance targets is described above. Further significant outputs of the Conservation Module in 2018 are:

IRRI and Crop Trust enter into a Long-term Partnership Agreement (LPA)

Marking an important milestone in the functioning of the Crop Trust endowment and achieve-

Recipients of the Crop Trust Legacy Awards during the celebrations of the tenth anniversary of the Svalbard Global Seed Vault. Photo: Neil Palmer/Crop Trust

Ahmed Amri from ICARDA genebank redepositing safety duplicates after regeneration at the Svalbard Global Seed Vault in Norway. Photo: Neil Palmer/Crop Trust

Marie Haga (Crop Trust) and Matthew Morell (IRRI) at the signing of the Long-term Partnership Agreement during the fifth International Rice Congress in Singapore. Photo: Shawn Landersz

ment of the Genebank CRP and Platform, the Crop Trust and IRRI signed a new and unique agreement that guarantees funding for the IRRI genebank into the distant future at an event held at the International Rice Congress in October 2018. The Long-Term Partnership Agreement (LPA) was made possible due to IRRI genebank sustaining performance targets under a fixed budget for more than five years. The agreement is underpinned by a comprehensive business plan which places the genebank at the heart of the "Harnessing rice genetic diversity to accelerate impact" outcome theme in IRRI's institutional strategy, with the Crop Trust covering all essential operations of the genebank and funding from IRRI to support complementary activities including capacity building, conservation research, and promotion of the use of diversity in the collection.

ICARDA re-deposits seeds at SGSV

Since 2016, ICARDA has been regenerating extraordinary numbers of accessions retrieved from the SGSV. In the past two years, staff succeeded in regenerating 38,073 safety duplicates over two seasons despite unseasonably dry conditions in Morocco. Exceeding expectations, ICARDA had produced enough seed to populate base and active collections in Lebanon and Morocco and to deposit 43,000 accessions, including both new and "old" materials, back into SGSV in October 2018 (Figure 8). One of the complementary outputs of this massive regeneration effort has been the newly gathered characterisation data. The regeneration continues with support from the Genebank Platform. At the same time, CIMMYT and ICARDA are working together to develop a business plan for a single rationalized CGIAR wheat collection managed under harmonized processes and standards, which will potentially form the core of a new LPA with the Crop Trust. An Arte film[1] that documents ICARDA's efforts was broadcast in 2018.

[1]https://www.arte.tv/en/videos/080754-000-A/seeds-of-war/

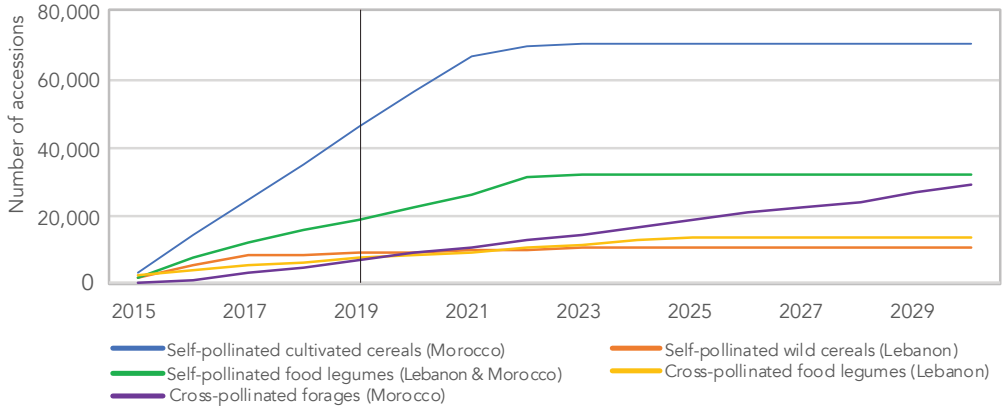


Figure 8. Reconstitution of ICARDA's active and base collections in Lebanon and Morocco

Measuring diversity and gap analysis

ICARDA, CIAT, and the Crop Trust have teamed together to develop methods and metrics to measure the level of representation of crop diversity in CGIAR genebanks and to identify gaps for targeted collecting. The Crop Trust has developed 14 crop genepool "diversity trees" based on consultations with 43 experts and more than 200 scientific papers. Genebank accessions are mapped onto the trees and visualizations developed to help assess where genetic groups are well represented or not at all in CGIAR collections (Figure 9).[2] Diversity trees have been developed for more than 14 crops and a further 8 are under development.

Germplasm Health Units (GHUs)

In 2018, the GHUs health-tested a total of 250,400 samples, including samples for import (10,236) and export (61,236) from Agri-Food System CRPs (AFS CRPs) as well as those for genebanks. GHUs facilitated distribution of germplasm and breeding lines to 132 countries. AFS CRPs account for 66% of the distribution events but a total of 71% of the samples health-tested were for conservation in the genebanks (Table 5 and Figure 10).

GHU activities under the Genebank Platform aim to develop improved processes to remove bottlenecks in health testing. A significant achievement is the adoption of Next Generation Sequencing (NGS)-based indexing in a cross-Center initiative for clonal crop collections. Other developments have led to significant results, including:

- Molecular tools for detecting and eliminating cassava frogskin-associated viruses have increased the availability of the CIAT cassava collection from 9% in 2017 to 78% by the end of 2018.
- CIMMYT developed a new protocol for testing maize lethal necrosis for bulk sample analysis.
- IITA developed a polyclonal antibody-based ELISA assay for testing cassava bacterial blight in stems and plants.
- ICARDA developed an improved seed management package that contributed to the decrease of wheat accessions infected with common bunt from 1.7% in 2014 to 0.06% in 2018.

[2] Diversity trees are based on a concept first published in van Treuren, R., et al. 2009. Optimization of the composition of crop collections for ex situ conservation. *Plant Genetic Resources: Characterization and Utilization* 7(2); 185-193 doi:10.1017/S1479262108197477.

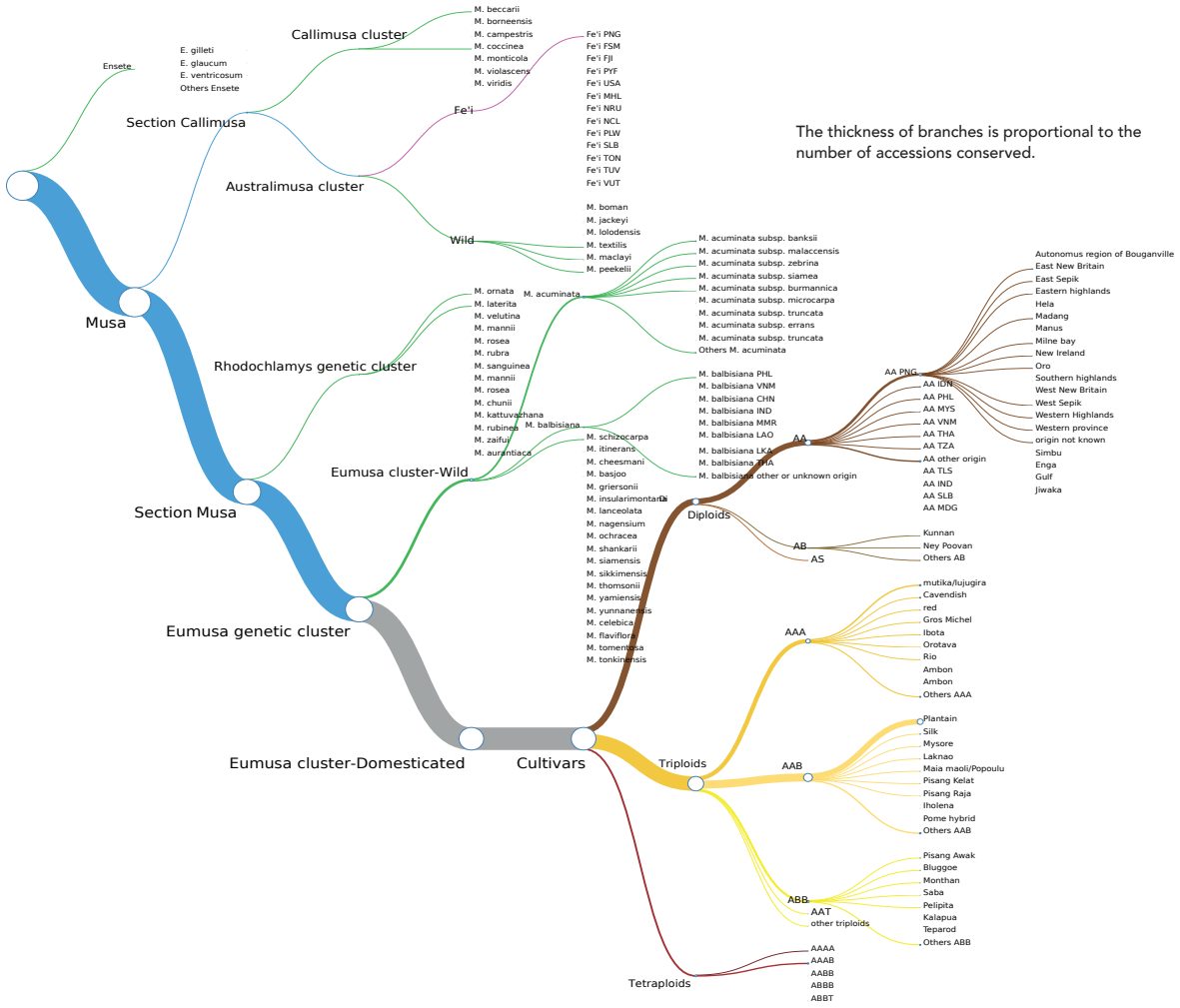


Figure 9. Banana cultivated and wild genepool illustrated in a "diversity tree"

Table 5. Germplasm samples processed for conservation and distribution by GHUs in 2018

Center	Total accessions analyzed	Total samples analyzed	Total samples rejected	Total diagnostic reactions
AfricaRice	1,459	1,710	-	2,610
Bioversity	192	374	92	1,104
CIAT	10,520	12,145	1,348	61,255
CIMMYT	8,194	1,489	151	22,778
CIP	2,420	7,342	702	56,057
ICARDA	30,178	24,328	446	309,472
ICRAF	531	531	-	-
ICRISAT	6,778	6,792	842	13,584
IITA	7,846	118,614	7,074	138,505
ILRI	1,204	1,739	256	6,922
IRRI	12,185	-	643	-
Total	**81,507**	**175,064**	**11,554**	**612,287**

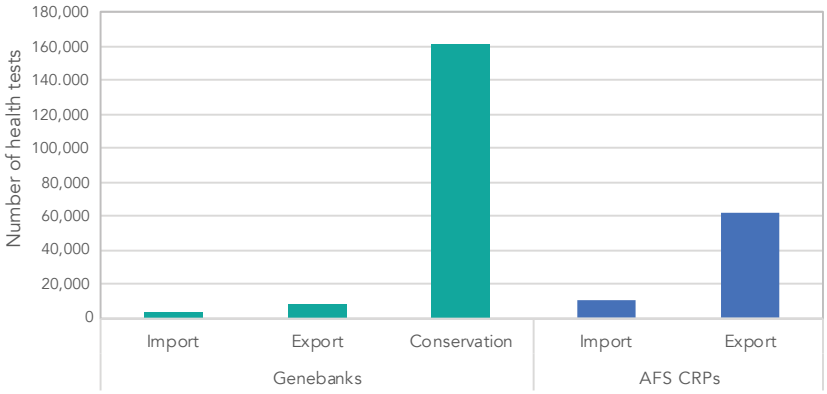


Figure 10. Numbers of health tests carried out by GHUs for genebanks and AFS CRPs in 2018

CIAT and ILRI have made major progress towards aligning tropical forages collection, including exchange visits of key staff such as Arsenio Ciprián (CIAT). Photo: Shawn Landersz

Efforts to improve germination testing are underway at ILRI. Photo: Shawn Landersz

Use Module

Digital Object Identifiers (DOIs)

CGIAR Centers are among the first institutes worldwide to implement DOIs for genebank accession identification under the Global Information System (GLIS) of the ITPGRFA. DOIs provide a global standard by which germplasm may be traced as it moves from collections to release as improved varieties or to research leading to publications. In 2018, 97% of CGIAR genebank accessions were assigned a DOI (Table 6). The focus is now on mainstreaming the use of DOIs in genebank operations and beyond the genebanks for research and breeding. Training events and presentations have been made to national genebanks in Lebanon and Indonesia, and breeders at AfricaRice, CIP, ICARDA, IITA, and IRRI.

Genesys (www.genesys-pgr.org)

Genesys is a recognized pillar of GLIS. In 2018, with co-funding from Germany's Federal Office for Agriculture and Food (BLE), the Crop Trust worked with national partners, the WorldVeg, CATIE, and the CGIAR genebanks to incorporate phenotypic datasets into the online portal. Rather than attempting to standardize formats for trait data, the new application allows different file formats to be uploaded and searched using standardized meta-data. Images and maps are also being incorporated into the portal. In 2018, trait data were published involving more than 230,000 accessions. In addition, Australia, Brazil, and Kenya national genebanks added data on more than 200,000 accessions to Genesys. Passport Data Completeness Index (PDCI) also continued to improve (Table 6).

Subsetting

All genebanks are actively developing user-focused subsets of genebank accessions to promote the use of new diversity in research and breeding. In 2018, subsets were made available online or elsewhere (Table 7).

Genesys portal -- the global gateway to genetic resources. www.genesys-pgr.org

Table 6. Status of CGIAR germplasm data in 2018 in Genesys

Center	Number of accessions uploaded	Number of accessions with DOI	% target accessions with DOI	Passport data completeness index (PDCI)*			
				2015	2016	2017	2018
AfricaRice	21,300	18,934	89%	5.62	5.62	5.60	5.89
Bioversity	1,566	1,566	100%	5.27	5.77	5.57	5.94
CIAT	66,787	66,787	100%	4.51	4.51	6.70	6.94
CIMMYT	209,216	204,415	98%	5.3	5.31	5.65	6.22
CIP	17,901	17,883	100%	5.38	5.43	5.61	7.53
ICARDA	155,414	153,256	99%	5.83	5.75	6.76	6.65
ICRAF	5,391	5,391	100%	5.34	5.34	6.69	6.68
ICRISAT	126,830	120,431	95%	6.05	6.05	6.89	6.95
IITA	33,713	33,713	100%	4.66	4.69	4.69	5.12
ILRI	18,643	18,638	100%	6.46	6.56	6.88	6.80
IRRI	130,154	124,489	96%	5.22	5.50	5.45	5.40
All	**786,915**	**765,503**	**97%**	**5.42**	**5.50**	**6.04**	**6.34**

*Van Hintum, T., Menting, F., & Van Strien, E. (2011). Quality indicators for passport data in *ex situ* genebanks. *Plant Genetic Resources*, 9(3), 478-485. doi:10.1017/S1479262111000682.

Table 7. Subsets made publicly available from genebanks in 2018

Genebank	Subsets
AfricaRice	Minicore of *Oryza glaberrima* developed from DArTSeq data
Bioversity	Banana reference set
CIAT	Cassava subsets with phenotypic extremes in selected traits: Dry matter content (%) HCN content (ppm) Total sugars (%) Amylose (%) Paste clarity (%) Pulp color
CIMMYT	Wheat: over 300 subsets developed • Milling, baking, nutritional quality, and tasty flours • Heritage, hallmark and high impact wheat varieties • Heat or drought tolerance, and high grain yield with broad adaptation • Tolerance to diseases, insects, viruses, nematodes • Physiological traits, tolerance to abiotic stresses, and promiscuous wheat Available by choosing "wheat" at: http://wgb.cimmyt.org/gringlobal/descriptors.aspx? Maize: • Jala, *Tripsacum*, *Teosinte* subsets • Morelos 1966-67 Collection • CIMMYT maize lines: Popping and nutritional set
CIP	• Potato artisanal colored set (2017) • Potato mini core (2017) • SWP artisanal colored set (2018) • SWP mini core (2018)
ICARDA	New FIGS subsets: • Wheat *Septoria* (115 accessions) • Lentil frost-resistance (115 accessions) • Lentil *Ascochyta* Blight-resistance (87 accessions) • Barley Leaf Blight (110 accessions) • Barley Spot Blotch-resistance (52 accessions)
ICRAF	• *Faidherbia albida* by molecular characterization (data to be linked with the reverse phenology phenotypes) • *Allablackia* spp by molecular characterization (data to be linked with oil content phenotypes) • *Adansonia digitata* accessions by nutritional characteristic
ICRISAT	• Core collections: chickpea (1,956 accessions), groundnut (1,702 accessions), sorghum (2,246 accessions), pearl millet (2,094 accessions), pigeonpea (1,290 accessions), finger millet (622 accessions), foxtail millet (155 accessions), proso millet (106 accessions), barnyard millet (89 accessions), kodo millet (75 accessions) and little millet (56 accessions) • Mini-core collections: sorghum (242 accessions), pearl millet (238 accessions), chickpea (211 accessions), groundnut (184 accessions), pigeonpea (146 accessions), finger millet (80 accessions), foxtail millet (35 accessions). • Reference sets: sorghum (375 accessions), pearl millet, chickpea, pigeonpea, groundnut finger millet and foxtail millet (300 accessions each).
IITA	• Cassava, cowpea, yam core collections • Cowpea mini core • Cowpea FIGS-drought and heat subsets (with assistance from ICARDA)
ILRI	• Lablab core • Highland core • Dryland core
IRRI	• False smut panel (60 accessions) • New subsets for drought plus disease screening (2 panels of 100 accessions) • New subset for salinity (200 accessions from Indonesia) • Breeder selected subset from 3K accessions for India

Policy Module

Enhancing Centers' contributions to international PGRFA policy fora

The Policy Module coordinated CGIAR's engagement in the ongoing negotiations of the ITPGRFA's multilateral system of access and benefit sharing. In 2018 in consultation with the CGIAR Genetic Resources Policy Working Group, the Policy Module developed and subsequently promoted agreed CGIAR policy positions at meetings of key negotiators convened by the ITPGRFA Secretariat and the Open-Ended Working Group to Enhance the Functioning of the Multilateral System of Access and Benefit-Sharing (WG-EFMLS). Reception to CGIAR positions, so far, has been positive. The Policy Module also coordinated CGIAR participation in multiple meetings under the aegis of the Convention on Biological Diversity (CBD) and Nagoya Protocol to provide technical guidance and inputs in discussions on the use of digital sequencing information (DSI). One CGIAR submission to the CBD concerning DSI was substantially reproduced in a peer reviewed journal article in 2018.

In 2017, the Governing Body of the ITPGRFA adopted Resolution 4/2017 inviting CGIAR to submit annual reports concerning the use of restrictive licenses and intellectual property applications over Centers' improved plant genetic resources. In 2018, the SMB recognized possible reputation risks for the CGIAR and adopted the Policy Module's recommendations, calling for systemwide efforts to generate and share information in the Annual Intellectual Assets Management Reports and Centers' public disclosures. The Policy Module is working with the SMO and Centers to improve reporting and to develop a submission in response to Resolution 4/2017 in the first half of 2019.

Promoting compliance of CGIAR Centers with PGRFA policies and laws

The Policy Module organized its second in a series of annual, regionally-focused capacity building workshops for CGIAR scientists and key national partners, as well as training workshop and webinars for genebank staff and Intellectual Property (IP) focal points. It set up a CGIAR Genetic Resources Policy Helpdesk for use by CGIAR scientists and responded to numerous requests for assistance.[3] Policy statements on biotechnology and gene editing were drafted with inputs from approximately 20 scientists from across the CGIAR and will be considered and adopted in 2019. The SMB also adopted the Guidelines on the Nagoya Protocol for CGIAR Research Centers developed by the Policy Module in 2018.

In addition, the Policy Module convened a multistakeholder consultation to get feedback from civil society organizations, negotiators in the ITP-

[3]Requests can be sent to: GRPolicy-Helpdesk@groups.cgiar.org

Wheat accessions from CIMMYT being prepared for distribution. In 2018, CIMMYT distributed more than 5,000 samples of wheat to users outside the CGIAR from its headquarters in Mexico. Photo: Luis Salazar/Crop Trust

GRFA process, and the seed industry on CGIAR positioning in the Treaty negotiations, in response to resolution 4/2017 and on internal policies and best practices.

Capacity building for national programs to implement international genetic resources agreements

Two decision-making tools for national policy makers were finalized and published in 2018 involving members of the Policy Module as lead authors:

- *Decision-making tool for national implementation of the ITPGRFA's multilateral system of access and benefit-sharing;*
- *Mutually supportive implementation of the Nagoya Protocol and the ITPGRFA: Scenarios for consideration by national focal points and other interested stakeholders.*

The Policy Module coordinated, together with CIP, Bioversity, and partners, a workshop in Peru for the National Focal Points for the ITPGRFA and the Nagoya Protocol involving 13 countries in the region. The focus of the workshop was the mutually supportive implementation of the ITPGRFA and the Nagoya Protocol.

1.2.3 Variance from Planned Program for this year

Under the Use Module, an opportunity was taken to pool resources between seven genebanks and to send samples from multiple crops to Diversity Arrays in Australia for DArTseq genotyping. The project focused on assessing the genetic heterozygosity within and between seed accessions in order to inform both managers and users on patterns of diversity within collections, potentially having implications for the sampling and management of conserved materials. The project succeeded in sending 14,000 DNA samples from 865 accessions to Diversity Arrays. The resulting data will be analyzed in 2019 and plans are being made to ensure that the initiative is associated with capacity building efforts to ensure that NARS partners benefit from any new information and approaches.

1.2.4 Publications

The Center genebanks' management of genetic resources and associated data complies with the CGIAR Principles on the Management of Intellectual Assets and Open Access Policy. Genesys publishes data supplied by CGIAR and genebanks worldwide in accordance with data sharing agreements between the Crop Trust and the individual data providers. In total, more than 1.9 million records were updated in Genesys in 2018. Genesys now contains records on 4 million accessions from 461 institutes.

The Genebank Platform website (www.genebanks.org) provides links to research papers, policy briefs, conservation protocols, training materials, and submissions to international policy fora in conformance with the CGIAR Open Access and Data Management Policy. In 2018, the genebanks reported a total of 150 publications by genebank staff in journals, conference proceedings, books and book chapters, covering a wide range of topics (Figure 11). Out of 79 peer-reviewed journal articles, 80% are publicly available in open-access publications and 73% are published in ISI journals.

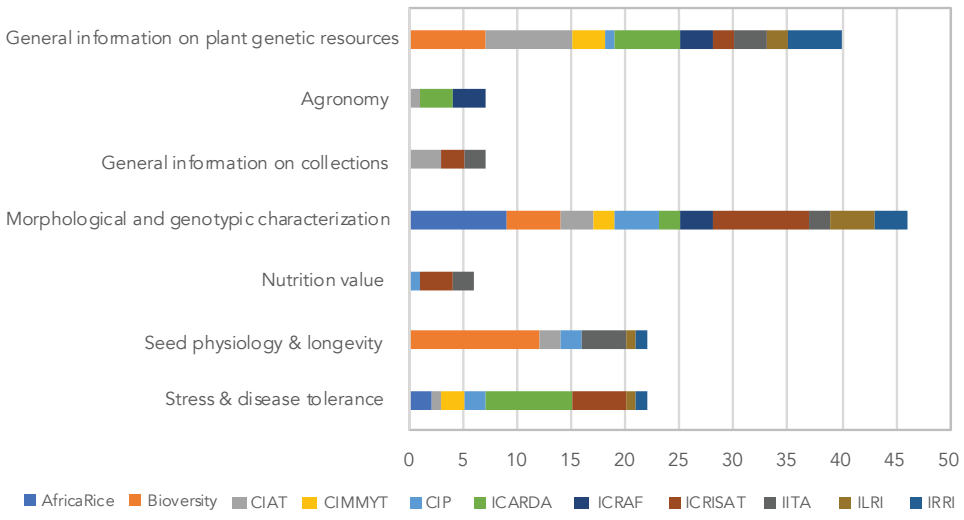


Figure 11. Publications authored by genebank staff in 2018 by topic (excluding publications from the Policy Module)

1.3 Cross-Cutting Dimensions

1.3.1 Capacity Development

The Genebank Platform undertakes numerous capacity building activities to the benefit of both CGIAR staff and national partners at the level of the Platform, Modules and individual Center genebanks, many are supported by bilateral funding sources. At the Platform level, 18 capacity building events took place in 2018 involving 436 participants from 11 CGIAR Centers plus national partners (Table 8). The participants of the listed capacity building events gained knowledge and skills that allowed them to adhere to international standards and policy in genebank management and the distribution of germplasm and related information.

While the Genebank Platform primarily carries out services to CRPs and national partners to conserve, test, clean and distribute germplasm, the genebanks also serve as the primary knowledge hub in their respective regions for the crops they conserve. In 2018, more than 800 capacity building events took place across the Center genebanks (Table 9). The activities involved more than 8,000 participants in 85 countries. This includes 660 tours of genebanks provided to visitors to promote the importance of crop diversity and the work of CGIAR. Outreach to NARS and national genebanks has contributed to increased learning within the global system for PGRFA conservation and use.

Table 8. Platform and Module level capacity building events in 2018

Date	Event	Location	Number of participants	% CGIAR	% Female
10–12 Apr	Expert consultation workshop to facilitate adoption and application of the FAO Genebank Standards	Bonn, Germany	25	12%	68%
16–20 Apr	ILRI-CIAT forage collections harmonization meeting	ILRI, Ethiopia	6	100%	50%
4–8 Jun	Genesys and GRIN-Global workshop	Porto, Portugal	47	57%	19%
8–15 Oct	LRI-CIAT forage collections harmonization meeting	ILRI, Ethiopia	22	62%	38%
1–6 Nov	Annual Genebank Meeting	Fortaleza, Brazil	45	100%	45%
	Policy module workshops				
18–19 Jun	Multi-stakeholder Consultation Meeting	Paris, France	13	46%	8%
1–20 Sep	Capacity building workshop on genetic resource policies for CGIAR scientists and partners from Near East and neighboring countries	Beirut, Lebanon	34	59%	38%
25–28 Sep	Workshop for Nagoya Protocol and Plant Treaty National Focal Points in Latin America and the Caribbean	Lima, Peru	64	22%	39%
31 Oct–1 Nov	Pre-AGM special session on Genetic Resources Policy	Fortaleza, Brazil	19	79%	37%
	GHU workshops				
18–19 Apr	CGIAR GreenPass Phytosanitary Protocol for Germplasm Exchange: Expert Consultation Workshop	Rome, Italy	6	33%	50%
23–27 Apr	3rd working group meeting of the CGIAR GHUs	IRRI, Philippines	28	100%	57%
27 Apr–2 May	Seed Health Testing Procedures	IRRI, Philippines	7	100%	57%
25–29 Jun	Library Preparation and Bioinformatics for Virus Indexing by sRSA	ICRAF, Kenya	18	67%	22%
	QMS workshops				
2–7 Apr	QMS intensive	ICARDA, Lebanon	15	100%	40%
30 Apr-4 May	QMS intensive	IRRI, Philippines	8	100%	63%
14–18 May	GOAL workshop	IICA, Costa Rica	31	10%	52%
3-7 Sep	Crawford GOAL	Kuala Lumpur, Malaysia	32	9%	44%
8–19 Sep	QMS intensive	SPC-CePaCT, Fiji	16	0%	69%
	Total		**436**	**50%**	**42%**

Table 9. Capacity building events in 2018

Event category	Number of events	Number of participants	% non-CGIAR	% female	Number of countries involved
Genebank visits and tours	660	5,574	90%	39%	71
Genebank-organized training/workshop	17	521	77%	50%	30
Genebank staff as resource person in a capacity development event	47	550	52%	45%	20
Visit from partners for research/scientific work	60	309	92%	19%	21
Hosting a scholar/student in the genebank for educational purpose	62	168	57%	39%	19
Farmers' open day	3	1,041	100%	34%	2
Total	**849**	**8,163**	**87%**	**39%**	**85**

1.3.2 Climate Change

The most relevant aspect of the work to address climate change under the Genebank Platform is the development of subsets to promote the evaluation and use of diversity in the collections. Table 7 presents the subsets available from each genebank, including more than 300 wheat subsets from CIMMYT, many of which contain accessions that have the potential to address abiotic or biotic stresses in multiple environments. in the context of climate change The FIGS (Focused Identification of Germplasm Strategy) approach developed by ICARDA associates specific traits with environmental conditions and allows users to screen collections to identify those accessions from target environments that are likely to harbor desired traits. Through the Genebank Platform, ICARDA is also consulting users to identify where gaps may exist in collections for priority traits.

2. Effectiveness and Efficiency

2.1 Management and governance

There have been no major changes to governance arrangements. A Memorandum of Understanding was signed between the Crop Trust and CGIAR reinforcing the partnership in overseeing and sustaining funding to the CGIAR genebanks.

2.2 Partnerships

2.2.1 External partnerships

The key external partnerships are presented in Table 10. The primary partners of the genebanks and GHUs are the wide-ranging users from the many countries who requested germplasm, advice and information in 2018. The exchange of germplasm takes place within a policy frame-

Table 10. Key external partnerships of the Genebank Platform in 2018

Module	Description	Name of partner	Main area of partnership
Conservation	Ultimate safety duplication of CGIAR germplasm.	SGSV	Risk management
	Research collaboration, partnership for germplasm distribution, safeguarding of genetic resources, recipient of capacity building and other genebank services	National genebanks	Capacity building and Risk management
	Collaboration in the delivery of the Global Plan of Action	CGRFA	International policy
	Collaboration in safe exchange of germplasm	IPPC & national plant protection agencies	Phytosanitary and international policy
	Provision of germplasm, clean planting materials, information and advice.	>80 countries	Delivery
Use	Global information system (GLIS) on PGRFA	ITPGRFA	Delivery and Policy
Policy	International PGRFA policy development and compliance, capacity building for policy implementation at national level	ITPGRFA & CBD Secretariats	International policy

work that demands close partnership with the ITPGRFA, the Commission on Genetic Resources for Food and Agriculture (CGRFA), and the International Plant Protection Convention (IPPC). The SGSV 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. Individual genebanks provide a range of services, capacity building and support to national partners (Figure 12). The services rendered involved working with 80 institutes in 39 countries.

2.2.1 Cross-CGIAR Partnerships (CRPs and other Platforms)

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 and the health-testing and distribution of germplasm from genebanks to research and breeding programs. In 2018, 1,592 samples were acquired from CGIAR breeding programs and 40,173 samples were sent to breeding programs. In addition, many exchanges occurred between genebanks, GHUs and other Platforms or CRPs, some of which are captured in Table 11.

Rice accessions sorted by country of origin at IRRI. IRGC 611 is from Indonesia (DOI: 10.18730/1Q2XS). Photo: Shawn Landersz

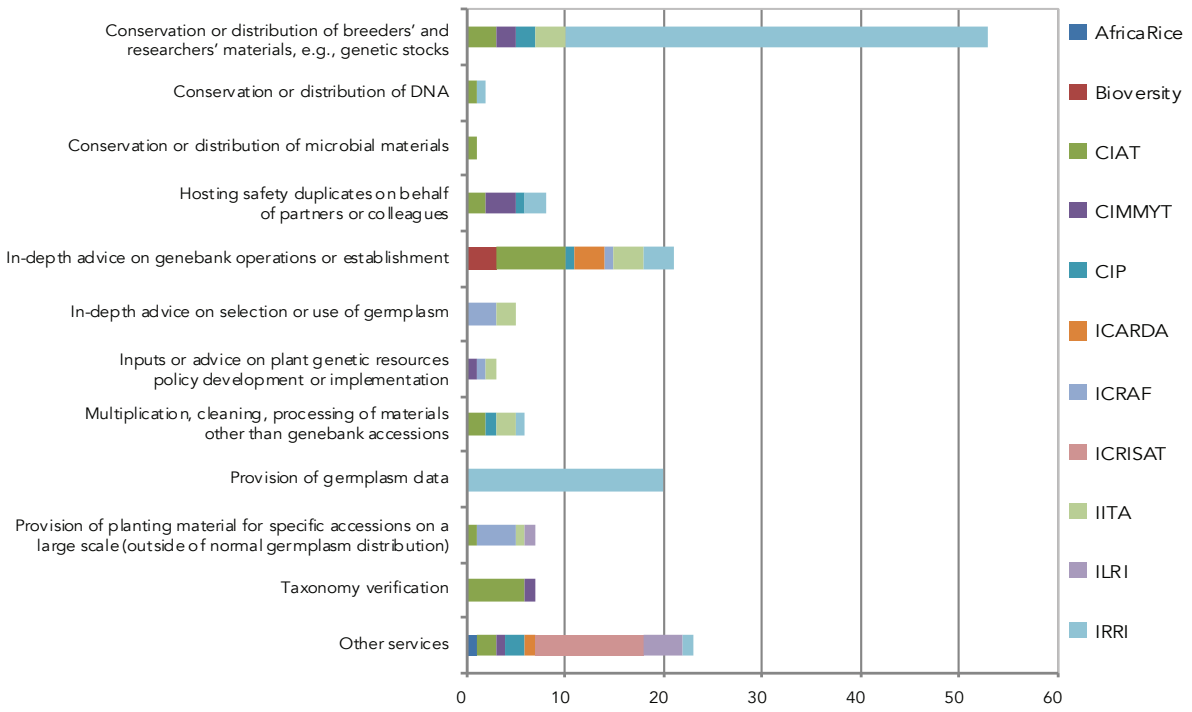


Figure 12. Number of genebank services provided to partners by category in 2018

Table 11. Internal Cross-CGIAR Collaborations

Brief description of the collaboration	Name of collaborator
• Participated in BrAPI hackathon in Paris to develop the compliance of MGIS with BrAPI and link breeding and genebank data. (Bioversity) • Presentation of the banana phenotyping module was presented at the PhenoHarmonis workshop. (Bioversity) • Participation in Expert Advisory Groups for all EiB Modules (multiple Centers) • Coordination with Module 5 to design an enterprise system for data management including BMS, genotypic data management system and genebank documentation systems. (ICARDA) • Adopted GIGWA for genotypic data management and will start uploading genebank accessions data mid 2019. (ICARDA) • Interaction on germplasm genotyping and data analysis (ICRISAT) • Development of genotyping services in cowpea and use of genetic resources in pre-breeding in Module 1 (IITA) • Testing of low-cost low-density SNP chips for identity verification as a quality control tool to guard against labelling errors during regeneration and characterization. The 10 SNP chip is adequate for breeders but not for genebanks. The 24 SNP chip is better but still not sufficiently informative. (IRRI) • Collaborating on B4R ("Breeding for Rice", the breeders' workflow management system) to include SMTA processing, DOI assignment, and workflow management. (IRRI)	EiB
• Selection and development of new forage options, including subjecting 105 Napier grass accessions to Genotyping-by-Sequencing to demonstrate the variation in the collection and identify unique materials received from EMBRAPA. The diversity analysis has helped determine the suitability of the population for genome-wide association studies (poster presented at the "Global Nutrition Symposium", Jan. 2018, Ethiopia). (ILRI) • Identification of a "core" subset of 12 accessions that best represents the diversity held in the entire collection for further characterisation and evaluation. (ILRI) • 84 accessions are currently being evaluated in the field for nutritional value, agronomic performance and water use efficiency and 14 accessions, representing the phenotypic and genetic diversity, have been identified for future research on performance under well-watered and water-deficit conditions. (ILRI) • Development and evaluation of FIGS subsets for diseases resistance in barley and use of wild relatives in interspecific crosses. Also 421 accessions of *Lathyrus* were evaluated for low ODAP content and resistance to *Orobanche*. Interspecific crosses with grass pea were initiated. (ICARDA)	Livestock
• Promotion of use of genebank collection under FTA projects and the following bilateral projects: Fruit Africa, PATSPO-Ethiopia, ACIAR-Rwanda, Re-greening Africa (Sahel); Tree for Food Security project-Eastern Africa. Generation of evaluation data from FTA projects and other bilateral such as the African Orphan Crop Consortium (AOCC) genome sequencing and FruitAfrica (ICRAF)	FTA
• Development of FIGS subsets and other sets for evaluation for *Fusarium* wilt in wild lentil. Selection for resistance to *Ascochyta* blight and for mechanization of harvest among chickpea and lentil accessions regenerated in Morocco. (ICARDA)	GLDC
• In collaboration with Grain Quality and Postharvest Unit at AfricaRice, evaluation of the 350 minicore African rice accessions for various grain physicochemical properties. Additional grain physicochemical data will be collected in 2019 before final analyses to detect genes and quantitative trait loci associated with each trait using genome-wide association analysis. (AfricaRice) • The new multi-disciplinary Outcome Theme "Harnessing Genetic Diversity to Accelerate Impact" embeds the Business Plan of the IRRI-Crop Trust LPA. This draws in other expertise on policy, gender, breeding, sustainable systems and economics, with the aim of ensuring a complete integrated pathway to impact from genebank to consumer. All subsets developed by the genebank were designed and used as an integral component of the Rice CRP, Flagship Project 5. The genebank has been able not only to define and manage the subsets, but to participate in their evaluation and subsequent data analysis, in collaborative trials funded mainly by the users. (IRRI)	Rice
• Development of FIGS subsets for wheat and their evaluation by students, use of wild relatives in pre-breeding activities, participation in the global wheat breeding training course. (ICARDA) • Extensive definition and description of wheat germplasm subsets was undertaken. To date, more than 80 wheat subsets have been defined using data from more than 120 publications, and from nearly a dozen CIMMYT research programs. (CIMMYT) • Publication citations of more than 1,300 scientific articles describing 4,139 accessions held in the Wheat Germplasm Collection have been uploaded into GRIN Global. (CIMMYT)	Wheat
• Support for open access publication (AfricaRice) • Data Sprint award for the largest number of datasets with quality metadata for the Bioversity institutional repository (Bioversity) • Storage and curation of genotyping data (ICRISAT)	Big Data

Brief description of the collaboration	Name of collaborator
• Research to develop seed cryopreservation and conventional low temperature conservation protocols. Project funded by the Directorate-General for Development Cooperation (DGDC), Belgium to focus on developing and optimizing cryopreservation protocols for plant species that have the potential to be cryopreserved, and training of technicians and researchers mainly from developing countries. Also seed conservation research and collecting of *Musa* accessions in target regions (Bioversity) • BBTV mitigation and management in Nigeria and screening wild banana progenitors for resistance. (Bioversity) • Within the scope of the DGDC, Belgium, "More fruit for food security: developing climate smart bananas for the Great Lakes region" project, high throughput phenotyping of the Bioversity genebank for drought tolerance identified 32 drought tolerant accessions. (Bioversity) • Descriptors of Banana have been included in the ontology. A variable submission tool has been developed in collaboration with BTI, to easily submit new terms to the Crop Ontology. (Bioversity) • A large historical dataset comprising evaluation data for approximately 70% of CIAT's cassava collection, obtained across seven agroecological environments in Colombia, was obtained from CIAT's Cassava Program, curated and standardized for future integration with CIAT's online database and Genesys. (CIAT) • Collaborative collection missions were designed and executed as part of the Crop Wild Relative Project with INIA-Peru. Eleven collecting missions were made in 2018 with a combined collection for the project of 337 new accessions from 46 taxa according to Hawkes. (CIP) • Collaboration with Cluster D1.4 include mapping of diversity hotspots for yam species in Benin carried out with the University of Abomey-Calavi, which is connected to genotyping work undertaken under the Genebank Platform and the BMGF funded project on improved detection and cleaning of viruses in clonal crops. (IITA)	RTB
• CGIAR Genetic Resources Policy Working Group (Policy Module)	EiB, Big Data, SMO, Science Leaders Group, CLIPNet, CGIAR Centers

2.3 Intellectual assets

(a) How have intellectual assets been strategically managed by the Platform in order to maximize their global accessibility and/or impact in line with the CGIAR Principles on the Management of Intellectual Assets?

All CGIAR genebanks have agreements with the ITPGRFA, placing their germplasm collections under the Multilateral System of Access and Benefit Sharing. In 2018, 95% of samples externally distributed by the Centers where transferred under Standard Material Transfer Agreements (SMTA).

(b) Indicate any published patents and/or plant variety right applications (or equivalent) associated with intellectual assets developed in the Platform and filed by Centers and/or partners involved in the Platform

The collections and germplasm contained within them remain publicly available and no patents or plant variety protection rights are sought on the germplasm.

(c) List any critical issues or challenges encountered in the management of intellectual assets in the context of the Platform

Critical issues and challenges involving the CGIAR genebanks are addressed and reported under the Policy Module.

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

Evaluations, reviews, and audits are important activities in monitoring the performance of each genebank. Table 12 summarizes key evaluation exercises.

Quality management systems (QMS)

Documentation audits on standard operating procedures (SOPs) for individual genebank operations are under way. In 2018, SOPs for conservation, regeneration and characterization were audited to verify CGIAR genebank compliance with FAO genebank standards, International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) policy and International Standards for Phytosanitary Measures (ISPMs), as well as other relevant international standards. In total, 160 findings were made and addressed. Additional documentation audits will be performed on remaining SOPs in 2019-2020. So far, 156 SOPs have been drafted by genebanks and GHUs under the Genebank Platform (Figure 13).

Table 12. Monitoring, Evaluation, Learning and Impact Assessment (MELIA)

Studies/learning exercises planned for this year	Status	Type of study or activity	Comments
CGIAR IEA evaluation	On-going	Program evaluation	An Independent Evaluation Arrangement (IEA) commissioned study on the "Evaluation of the CGIAR research support program for Managing and Sustaining Crop Collections: Genebanks CRP" was published in April 2017. The report listed several recommendations with implications to the activities of the Genebank Platform in 2018, particularly the costing reviews and QMS audits.
Costing reviews	On-going	Program evaluation	A costing review started in late 2017 with a visit to IRRI to collate data on routine costs for genebank operation. In 2018, reviewers visited CIAT, CIMMYT, CIP and ICARDA to gather new data on operational costs. The results of the analysis will feed into a systematic review of the financial allocations to individual genebanks for essential operations.
Document audits for Regeneration, Characterization, and Conservation	On-going	Audit	Two documentation audits were conducted during 2018. 7 genebanks participated in the Regeneration and Characterization Audit. 58 findings were found and all were closed by November 2018. 9 genebanks participated in the Conservation audit. 102 findings were found and all were closed by November 2018.
Genebank Impacts Fellowship	Extended	Outcome study	The workplan supported 6 fellows to work on documenting the impact of the CGIAR genebanks. The following research papers are expected to be completed in 2019: • Impact of IRRI genebank on rice productivity on farms in Eastern India • Contribution of CIAT genebank in the development of high-iron bean varieties and farm-level impacts in Rwanda • Role of the CIMMYT and ICARDA genebanks in the development, use, and impact of wheat synthetic hexaploids • Use and impact of ICRAF tree germplasm distributions: *Calliandra calothyrsus* and *Gliricidia sepium* in E. Africa • Use and impact of ILRI forage germplasm: *Pennisetum purpureum, Sesbania sesban*, and *Medicago sativa* • Assessing the economic impacts of CIP genebank • Impacts of Jala maize rematriation by CIMMYT genebank to farm communities • Use and impact of Musa ITC germplasm in Asia and Africa
External technical reviews and validation of quality management systems (QMS)	On-going	Program evaluation	The first meeting of the technical reviewers was held in December 2018 in Bonn, Germany. In 2019, review visits are scheduled for five genebanks.

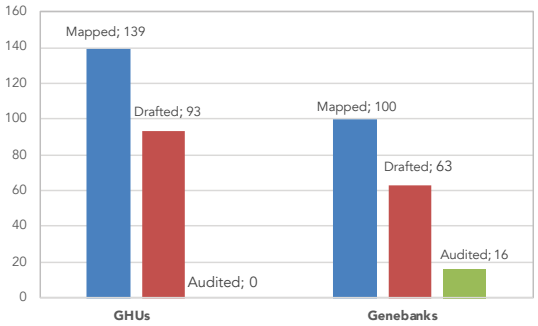


Figure 13. SOPs mapped, drafted and audited in 2018

2.5 Efficiency

In 2018, a second systemwide costing study of the genebanks was initiated. The previous study took place in 2009 and has provided the basis for the individual budgets for the CGIAR genebank's routine operations under the CRP and the Platform. Detailed costs and transactions are reviewed for each genebank within a framework of defined routine operations. The costing reviews will be complemented by expert external technical reviews, which will take place in 2019 and 2020. The technical reviews will validate genebank SOPs, the status of collections, and the efficiency of operations. Findings from both financial and technical reviews will be assessed at a system level by a High-Level Panel with the aim of determining new genebank budgets for 2022.

ILRI's reported zero availability this year does have a silver lining. The change represents a major alignment between CIAT and ILRI in the management of tropical and sub-tropical forages collections. Key staff from both institutes met together for the first time in Ethiopia and compared processes in depth with the facilitation of an expert consultant. As a result, 15 recommen-

Simon Kang'ethe (ICRAF) conducts seed characterization of *Annona squamosa* using the Marvin5 seed analyser. Photo: Michael Major/Crop Trust

Raja Srinvias and Naga Jyothi from ICRISAT analyzing seed moisture. Photo: Michael Major/Crop Trust

dations were formulated and both Centers are working towards strengthened operations, developing more complementary roles, aligning data and data resources and rationalized collections. Meanwhile, each genebank continues to address ongoing recommendations from previous reviews, QMS audits and from expert visits (e.g. on seed quality management). Under the QMS framework, genebanks submit annual improvement plans. In total, 158 improvements have been fully or partly addressed in 2018. Notable improvements and gains in efficiency include:

- Reduced seed processing time (e.g. pneumatic seed counting trays at CIMMYT, high volume thresher at IITA, automated seed sorter at IRRI)
- Improved seed monitoring and storage processes for seed longevity (CIP, ICARDA, IITA, ILRI)
- Improved screenhouses and regeneration techniques (CIAT, ICARDA, IITA)
- Barcoding of laboratory and field operations (AfricaRice, CIAT, CIP, ICARDA, IITA, ILRI)
- Use of mobile devices and apps to capture data (Bioversity, CIAT, IITA, ILRI)
- Improved lighting and conditions of *in vitro* conservation to extend subculture period and reduce contamination (CIAT, CIP, CIP/EMBRAPA, IITA)
- Improved indexing and regeneration success rate through modified facilities or procedures in the field (CIAT beans and forages, CIMMYT maize, IITA)
- Testing of trueness-to-type and removal of off-types (Bioversity, CIP, IITA)
- Improvements in *in vitro* and cryopreservation protocols (CIP, CIAT, IITA)
- Elimination of duplicate samples or duplicate accessions (CIMMYT, CIP, IITA, ILRI)
- Improved capacity for phytosanitation and seed health testing (all Centers)
- Increased rate of germplasm health testing (CIAT, ICARDA, ICRISAT, IITA)

2.6 Management of Risks to Your Platform

Programmatic risks

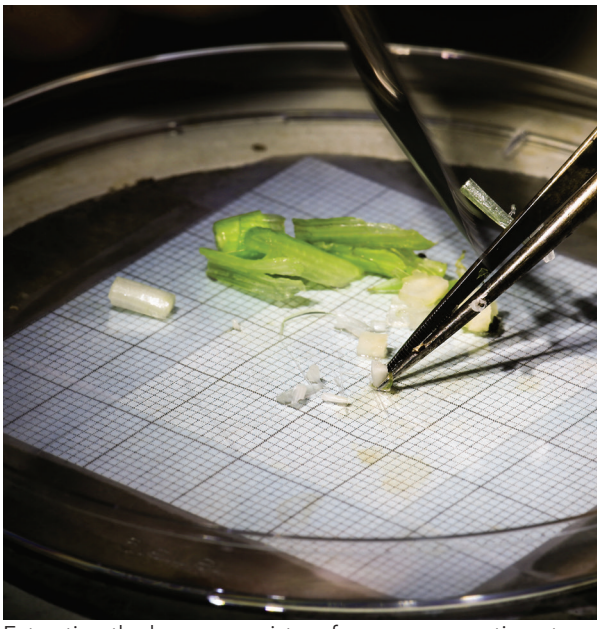
The Crop Trust works assiduously to raise funds to support both the Genebank Platform and its endowment fund for the long-term support of the CGIAR genebanks. The investment policies of the Crop Trust permit the annual withdrawal of up to 4% of the average market value of the endowment fund over the previous 12 quarters. In 2018, 2.5% (USD 5 million) was withdrawn from the endowment fund of which 92% was provided to the international genebanks of CGIAR. In 2018, the Crop Trust raised more than USD 5 million in bilateral funds to support the Genebank Platform. Thanks to contributions from the European Union, and the Governments of Germany, Switzerland and Finland, the Crop Trust was able to reach its commitment of USD 9 million to the Genebank Platform. In 2019, the commitment from the Crop Trust rises to USD 11.5 million, and increases ultimately to USD 15 million in 2021, which presents a very considerable fund-raising challenge to the Crop Trust. While the Genebank Platform Management Team is putting contingency plans in place, a shortfall of more than 4% in funding would have grave consequences to the functioning of the genebanks, GHUs and Policy Module.

Contextual risks

A number of CGIAR host countries are constraining the safety duplication of genebank accessions from CGIAR Centers, which poses a major risk to the security of the collections. In two cases, political measures are preventing the distribution of materials that should be available in accordance with those Centers' ITPGRFA Article 15 Agreements. The Centers involved are in active discussions with the countries in question. The situation is preventing the genebanks from reaching performance targets and thus securing funding through the Crop Trust endowment. It may become necessary to reconsider longer term funding commitments for, and management of, those collections.

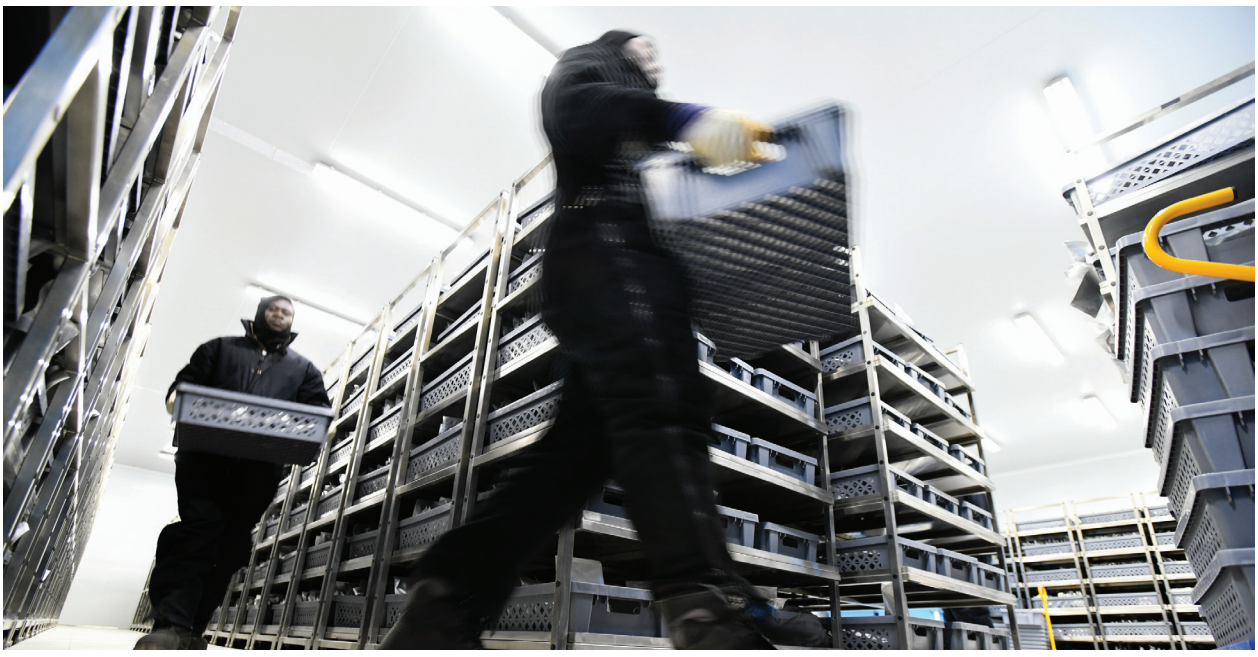
Institutional risks

Institutional financial management practices continue to constrain the management of genebank budgets and the pursuit of cost efficiencies. Genebank budget holders appear to have access only to limited up-to-date information on expenditures and have only minor inputs into the attribution and reporting of expenditures. Constraining issues arise from general financial management practices, attribution of full-cost recoveries, effectiveness of data management tools, procurement practices and the effects of unexpected and last-minute changes in institutional income.



Extracting the banana meristem for cryopreservation at Bioversity in Leuven. Photo: Shawn Landersz/Crop Trust

Charlotte Lusty (Crop Trust/Genebank Platform Coordinator) presenting on genebank costs. Photo: Michael Major/Crop Trust



AfricaRice genebank is now re-established in one location in Côte d'Ivoire. Photo: Neil Palmer/Crop Trust

Wheat regeneration plots at the American University of Beirut's AREC station near ICARDA's Terbol station in Lebanon's Beqaa Valley. Photo: Michael Major/Crop Trust

2.7 Use of W1-2 funding

In 2018, 30% of the Genebank Platform cost was funded by the Crop Trust and the rest was funded by W1-2 funding. The Crop Trust funding covers a significant part of the essential operations of nine of the 11 genebanks. The W1-2 funding covers the remaining costs in all 11 genebanks. The W1-2 funding also supports other activities of the Genebank Platform including upgrading of the genebanks and GHUs, and activities of the Conservation, Use and Policy Modules. All of the achievements described in the report have been either fully or partly funded by W1-2 funding.

3. Financial Summary

Table 13. Platform financial report for 2018

	Planned budget 2018 (USD millions)			**Actual expenditure 2018 (USD millions)**			**Difference (USD millions)**		
	W1-2	W3/ bilateral	Total	W1-2	W3/ bilateral	Total	W1-2	W3/ bilateral	Total
Module 1	16.63	9.06	**25.69**	16.84	8.98	**25.83**	(0.21)	0.08	**(0.13)**
Module 2	1.19	0	**1.19**	1.13	-	**1.13**	0.05	-	**0.05**
Module 3	0.81	0	**0.81**	0.81	-	**0.81**	-	-	**-**
Management & Support Costs	0.69	0	**0.69**	0.69	-	**0.69**	-	-	**-**
Genebank Platform costs	1.75	0	**1.75**	1.70	-	**1.70**	0.05	-	**0.05**
Other Commissioned Expenses	(0.02)	0	**(0.02)**	-	-	**-**	(0.02)	-	**(0.02)**
Platform Total	**21.06**	**9.06**	**30.12**	**21.18**	**8.98**	**30.16**	**(0.12)**	**0.08**	**(0.05)**

Annex 1

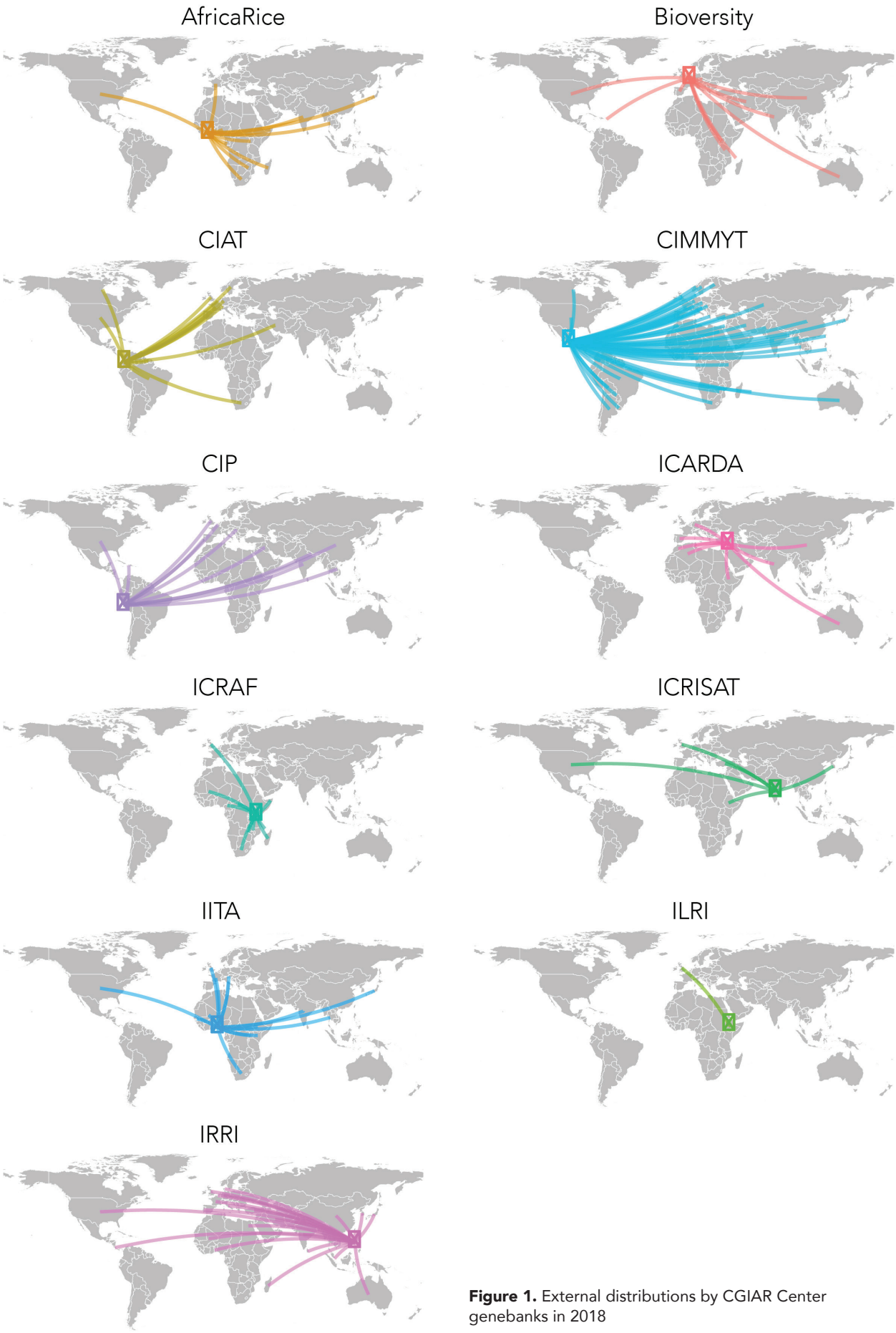


Figure 1. External distributions by CGIAR Center genebanks in 2018

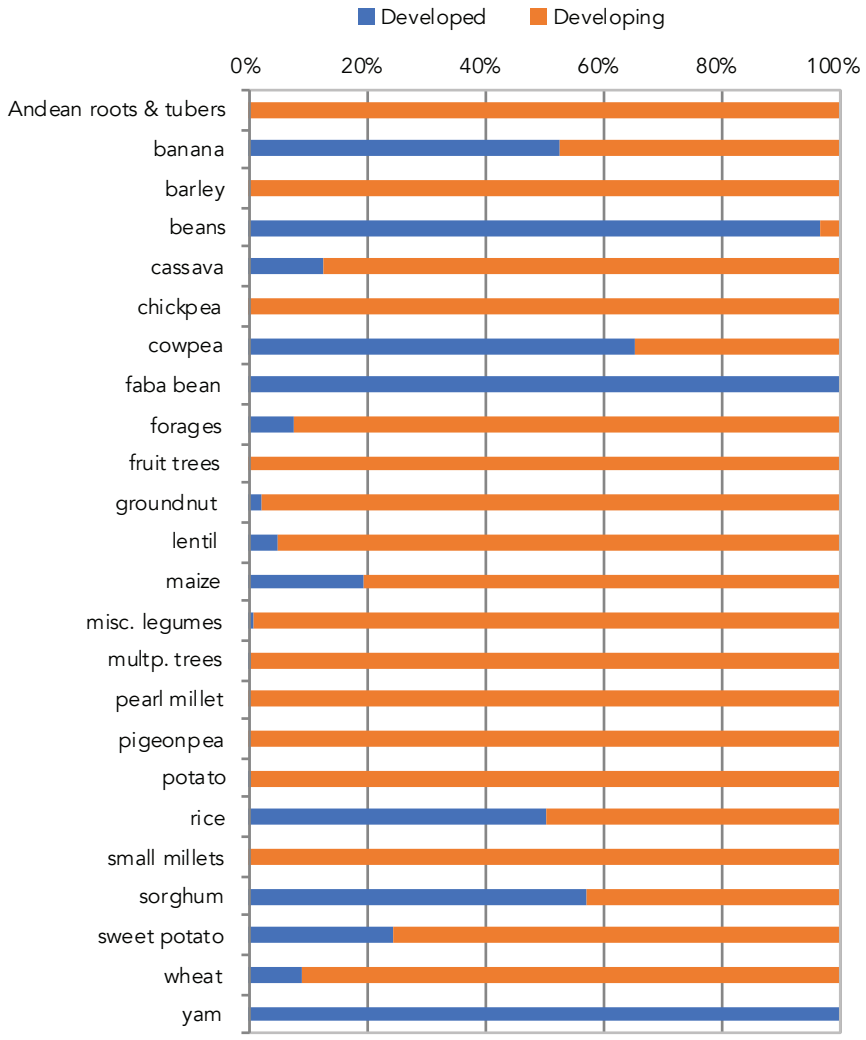


Figure 2. Distribution by crop to developed and developing countries in 2018

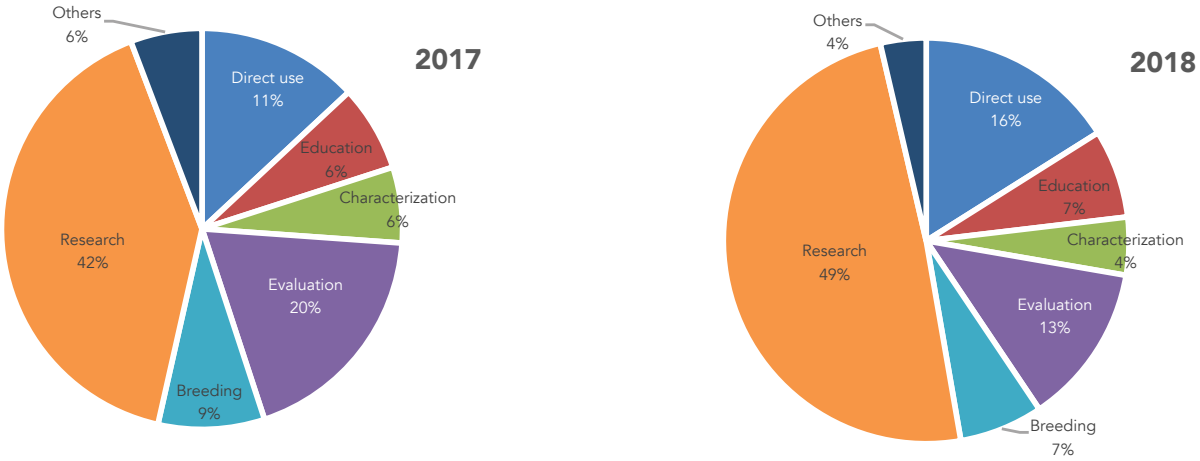


Figure 3. Types of request for stated purposes in 2017 and 2018

Table 1. List of policy contributions

Name and description of policy, legal instrument, investment or curriculum to which CGIAR contributed	Level of Maturity	Link to sub-IDOs (max. 2)	CGIAR cross-cutting marker score				Link to evidence
			gender	youth	capdev	climate change	
Guidelines for CGIAR Research Centers on the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization to the Convention on Biological Diversity: finalized the text of the draft Guidelines on the Nagoya Protocol for CGIAR Research Centers. The guidelines were adopted by the CGIAR SMB in March 2018.	1= Research taken up by next user (decision maker or intermediary)	Increased conservation and use of genetic resources	0 – Not targeted	0 – Not targeted	1 – Significant objective	0 – Not targeted	http://bit.ly/2I64rWb
Updating the 2009 Guide to the Standard Material Transfer Agreement (SMTA) under the International Treaty for Plant Genetic Resources for Food and Agriculture (ITGRFA): currently revising the 2009 Guide to the Centers' use of the SMTA, taking into account intervening developments since 2009. These plans were shared with the genebank managers at the annual genebank meeting (AGM) 2018 in Brazil. Once the draft revision is completed, it will be submitted for consideration and approval by the Article 15 DGs and the CGIAR SMB.	1= Research taken up by next user (decision maker or intermediary)	Increased conservation and use of genetic resources	0 – Not targeted	0 – Not targeted	1 – Significant objective	0 – Not targeted	http://bit.ly/2MgsUxa
GreenPass Protocol to facilitate the exchange of phytosanitary clean germplasm from CGIAR centers: Germplasm Health Units (GHUs) are working towards developing an accredited system for GHU procedures, termed as "GreenPass Protocol", which will facilitate the exchange of phytosanitary clean germplasm from CGIAR centers. Implementation of GreenPass will require accreditation from the International Plant Protection Convention (IPPC).	1= Research taken up by next user (decision maker or intermediary)	Increased conservation and use of genetic resources	0 – Not targeted	0 – Not targeted	1 – Significant objective	0 – Not targeted	http://bit.ly/2Ms0aBZ

Table 2. Number of peer-reviewed publications from current reporting period

	Number	Percent
Peer-reviewed publications	79	100
Open-access	63	80
ISI	58	73

Table 3. Update on Actions Taken in Response to Relevant Evaluations

Name of the evaluation	Recommendation number	Text of recommendation	Status of response to this recommendation	Concrete actions taken for this recommendation	By whom	When	Comments
Evaluation of the CGIAR research support program for Managing and Sustaining Crop Collections: Genebanks CRP	CGIAR IEA evaluation	Revisit the Parity Study to establish realistic and transparent budget for each Center genebank	On-going	Costing reviews	Platform management	Visits per Center planned in 2018-2020	2017 – IRRI 2018 – CIAT, CIMMYT, CIP, ICARDA 2019 – ICRISAT, IITA, ILRI, ICRAF, Bioversity 2020 – AfricaRice
		Promote the Genebank Platform communications	On-going	Genebank Platform website actively maintained and promoted. Facebook and Flickr pages were launched in mid-2018	Science communications specialist		Website received 9,491 users during 2018 who accounted for 24,884 page views. Facebook page has more than 500 followers and monthly reaches nearly 7,000 people. Flickr page offers 618 images. Two email newsletters were sent out in 2018.
		External validation of QMS	On-going	Technical reviews	External reviewers	Visits per Center planned in 2019-2020	
		Enhance linkages between genebank characterization and breeders' evaluation and pedigree data	On-going	Minting of DOIs Enriching data on collections through focal subsets	Use module		97% of accessions with DOIs Genesys has 2,187 subsets published

Debre Zeit Research Center of the Ethiopian Institute of Agricultural Research. Photo: Shawn Landersz

CGIAR Genebank Platform

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AfricaRice genebank.
Photo: Neil Palmer/Crop Trust