CGIAR

RESEARCH PROGRAM FOR Managing and Sustaining Crop Collections

CROP TRUST

ANNUAL REPORT 2016

GENEBANKS CRP

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A. Key Messages

The CGIAR Centers have an obligation to the world to conserve and make available the 35 *ex situ* crop and tree collections under their management according to the provisions of the International Treaty of Plant Genetic Resources for Food and Agriculture (ITPGRFA). The Genebanks CGIAR Research Program (Genebanks CRP) provides security in funding until 2016 to enable the CGIAR to fulfill this obligation by supporting the routine operations of the genebanks. It is a CRP in name only; it does not include research and thus reporting is done in a different format, with performance indicators reflecting the status and use of the genebanks.

a) Status of the genebanks

The CGIAR genebanks presently manage 757,767 accessions, including 23,682 *in vitro* accessions and 29,122 accessions held as plants or trees in the field. Approximately 77% of total accessions are immediately available for international distribution under the SMTA (Figure 1). The genebanks' work this year continues the steady increase in the availability of accessions since the CRP was initiated in 2012, when 66% accessions were available. A total of 119,011 accessions are now immediately available that were not before, added to which routine multiplication has supported the distribution of 590,936 samples over the course of the past five years. Of the seed accessions, 56% is secured in safety duplication at two levels, and 88% of accessions of clonal crop collections is safety duplicated in the form of *in vitro* or cryopreserved samples. Currently, 87% of accessions has passport or characterization data accessible online.

A total of 111,117 germplasm samples was provided by the CGIAR genebanks to users in 2016 (Figure 2); 50,058 distinct accessions were provided to CGIAR Research Programs (CRPs) and 27,265 accessions were distributed outside the CGIAR to advanced research institutes & universities (40%), farmers and the private sector (24%) and NARS (22%) in 102 countries.

Figure 1. Status of availability and safety duplication of CGIAR genebanks, 2012 to 2016

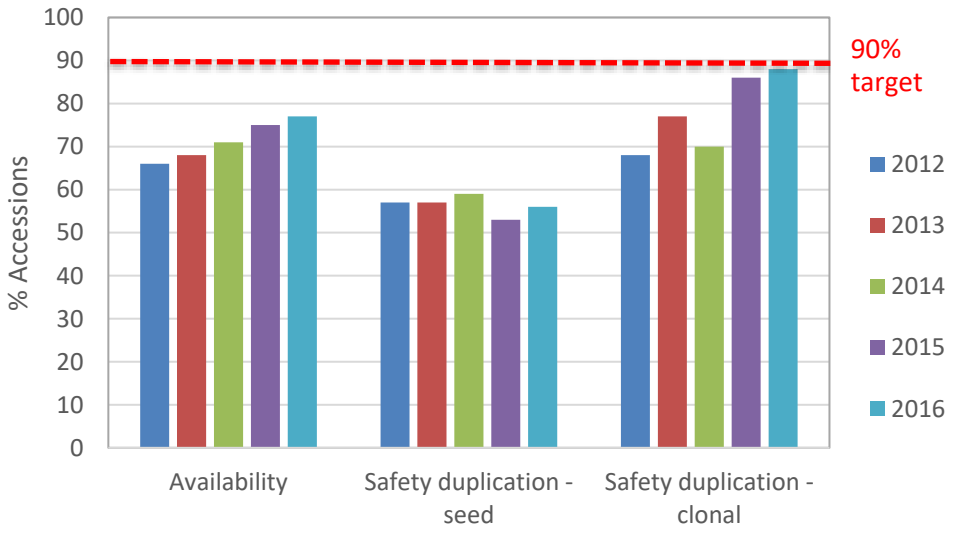
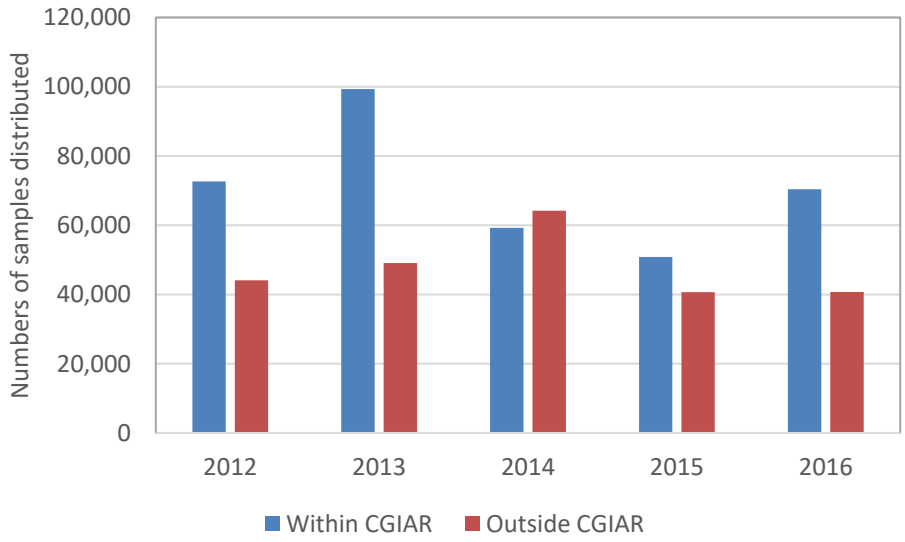


Figure 2. Annual total samples distributed, 2012 to 2016



b) Two significant achievements in 2016

ICARDA regeneration and deposit of seeds to SGSV

In 2015, ICARDA withdrew 39,524 accessions from the Svalbard Global Seed Vault (SGSV) in order to commence the long-term effort to reconstitute the entire active collection of approximately 150,000 accessions, which is otherwise maintained in Aleppo under difficult conditions and limited access.

In 2015, 20,181 accessions of barley, wheat, chickpea, lentil, faba bean, various crop wild relatives, forages and range species were planted in addition to routine regenerations – more than 32,000 accessions in total. One of the severest droughts in many years hit Morocco during the growing season. Despite widespread crop failure in the region, the preparations of the ICARDA genebank staff and the irrigation equipment put in place with the support of the CGIAR Investment Plan, enabled the genebank to harvest accessions with a 95% success rate, producing enough seed for long-term and medium-term storage, as well as for safety duplication. ICARDA prepared 15,160 accessions for re-deposit in SGSV and planted a further 32,326 accessions for harvest in 2017.

These events have given credibility to the skills and capacity of the CGIAR to ensure the safety of these unique global goods in the face of the worst kind of disaster that can befall a living collection. This has been recognized by a number of external bodies, including the Gregor Mendel Foundation, which awarded ICARDA the Gregor Mendel Innovation Prize to honour its “extraordinary commitment for rescuing genetic resources of the genebank in Syria”. Congratulations are due to ICARDA staff!

Quality management systems

One of the primary foci of the Genebank CRP has been to ensure that the 11 CGIAR genebanks are complying with international standards and operating at a high level of competency through developing and strengthening genebank-specific Quality Management Systems (QMS). In its first phase, the genebank managers agreed to pursue five goals:

- document procedures in a common format,
- train national staff and strengthen succession planning,

- identify and mitigate risks,
- barcode all accessions in all procedures, and
- secure genebank facilities with access control systems.

By the end of 2016, the genebanks have put in place a major part of the first phase QMS elements (Table 1). While all genebank staff follow well-practiced procedures that generally adopt accepted or published norms and guidelines, the specific steps and actions taken were not always comprehensively documented. Genebank staff have now documented the step-by-step procedures that they have developed and implemented, in some cases over many years. In total, 39 standard operating procedures (SOPs) have been written, reviewed and approved by genebank staff and their managers. The exercise provides a prompt for staff to question the efficiency of what they do, while recognizing their expertise and empowering them in their roles. At a time, when many national and international staff members are reaching retirement age, this exercise has contributed importantly to staff succession.

The CRP has allowed the sharing of templates, approaches and technical assistance, while each genebank is responsible for developing their own individual QMS. To facilitate sharing further, four Genebank Operations & Advanced Learning (GOAL) workshops were organized between 2015 and 2016 and a total of 101 genebank personnel from 11 CGIAR centers received expert training in key genebank topics. To date, 31 partners from 22 national genebanks have also received training in QMS. The 2016 evaluation by the Independent Evaluation Arrangement highlighted the Genebank QMS as a major initiative that was a "success without parallel".

Table 1. Summary of achievements as part of the work on QMS

Center	SOPs		Risk Management		Capacity Building	Succession Planning	Barcoding	Access control in all entryways
	SOPs mapped	SOPs ready by end 2016	Risk Assessment	Business Continuity Plan	CGIAR staff at GOAL workshop			
AfricaRice	7	4	✓	✓	9	✓	✓	✓
Bioversity	6	5	in collaboration with KU-Leuven		9	✓	✓	✓
CIAT	17	8	✓	✓	10	✓	✓	✓
CIP	ISO accredited				8			
CIMMYT	ISO certified				9			
ICARDA	10	5	✓		7	✓	✓	✓
ICRAF	11	5	✓	to be reviewed by BoT in 2017	12	*	to be met in 2017	✓
ICRISAT	18	5	✓	✓	8	✓	✓	✓
IITA	15	5	✓	✓	14	✓	✓	✓
ILRI	pending visit in 03/2017		*	*	7	*	*	*
IRRI	9	5	✓	✓	8	✓	✓	✓
TOTAL	**93**	**39**			**101**			

Notes: ✓ = on track to finish by end of 2016. * = not visited/verified yet.

c) Financial summary

Table 2. Expenditures and financing sources, 2012 to 2016

Expenditures*	**2012**	**2013**	**2014**	**2015**	**2016**	**TOTAL**
Genebank Core Operations	14,080,840	15,960,423	15,929,859	16,402,197	19,178,852	**81,552,171**
ICRAF	344,916	874,648	1,106,506	1,018,179	1,792,795	**5,137,044**
Cryobanking	-	186,898	457,098	596,402	1,012,585	**2,252,983**
Acquisitions and collecting	-	36,860	152,606	86,727	21,691	**297,884**
Optimizing collections	-	-	220,004	559,254	3,279,515	**4,058,772**
Outreach, capacity building	-	69,252	305,492	777,648	2,138,711	**3,291,102**
Genesys, GRIN Global*	-	232,720	215,698	184,007	444,634	**1,077,059**
Management & Program Costs	727,985	866,179	890,305	875,872	1,090,777	**4,451,118**
ICARDA Investment Plan	-	-	72,170	841,309	696,521	**1,610,000**
Bioversity Overhead	-	377,336	25,000	25,000	25,000	**452,336**
CropTrust bilateral projects	-	225,451	427,205	161,037	314,172	**1,127,865**
Projects funded by bilateral donors, W3, Center funds	1,208,417	3,988,183	2,930,198	-	-	**8,126,798**
Total	**16,362,158**	**22,817,950**	**22,732,140**	**21,527,631**	**29,995,253**	**113,435,132**
Financing Sources						
Crop Trust LTG & other	2,522,928	3,688,715	2,291,465	2,337,289	2,384,034	**13,224,431**
Window 1	18,200,000	18,400,000	18,600,000	18,700,000	18,927,899	**92,827,899**
ICARDA Investment Fund	-	-	953,000	657,000	-	**1,610,000**
Projects funded by bilateral donors, W3 and Center funds	1,362,552	3,981,983	3,935,284	-	-	**9,279,819**
Total	**22,085,480**	**26,070,698**	**25,779,749**	**21,694,289**	**21,311,933**	**116,942,149**

Note: * Expenditures reported do not include Crop Trust in kind contribution of USD 2m as in CRP proposal.

Table 3. Status of the genebanks with respect to performance targets

Center	% Availability 2016	% Increase from 2015	% Safety duplication 2016	% Increase from 2015	Comments
AfricaRice	84	2	49	23	Efforts continued to multiply seed to increase accession availability, number of accessions in long-term storage and in safety duplication.
Bioversity	62	0	60	13	New strategy to deal with Banana Streak Virus disease will improve availability but will take time to action. New batch of cryopreserved accessions safety duplicated in 2016.
CIAT seed	69	10	76	6	Significant increases in availability and safety duplication.
CIAT cassava	88	44	38	15	Increase in available accessions after testing for cassava frogskin virus.
CIMMYT wheat	86	0	59	-2	16% increase in safety duplication planned in 2017
CIMMYT maize	67	8	87	200	Data on safety duplication was updated after inventory of duplicates held at USDA.
CIP	14	-18	85	6	CIP is systematically resolving the identity of in vitro accessions, which has led to a temporary decline of availability. Level of safety duplication has greatly increased.
ICARDA	59	-3	50	-2	Major effort to reconstitute the collection from deposits from SGSV is underway. Figures are expected to gradually increase.

Note: Figures are calculated from accession numbers reported in the Online Reporting Tool.

(continued)

Table 3. Status of the genebanks with respect to performance targets (continued)

Center	% Availability 2016	% Increase from 2015	% Safety duplication 2016	% Increase from 2015	Comments
ICRAF	49	26	14	-7	% Availability and safety duplication is expected to change as ICRAF determines its acquisition and retention plan and identifies those tree species which will never reach targets due to low seed number and long generation spans.
ICRISAT	92	6	15	0	Reaches targets for availability. Safety duplication is low because of lack of first level duplication. Major duplication expected in 2017.
IITA seed	62	35	50	6	Strong efforts in regeneration has resulted in significant increases in availability and safety duplication.
IITA clonal	45	73	68	6	Significant increases in availability through introducing field accessions into in vitro and increased health testing.
ILRI	52	6	19	0	Low levels of safety duplication because only 39% is in long-term storage and the slow rate of regeneration of forages. Planning significant safety duplication in 2017.
IRRI	94	0	91	0	Reaches and sustains targets.

Note: Figures are calculated from accession numbers reported in the Online Reporting Tool.

Table 4. Indicators for the aggregate collection, 2012 to 2016

Indicator	Description	2012	2013	2014	2015	2016
1. Total number of accessions	Base number of accessions in the collections. It does not include the barley collection at CIMMYT, rice collection at CIAT, Rhizobium collection at ICARDA, or regional collections of ICRISAT.	710,001	725,244	738,215	750,604	757,767
2. Total number 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
3. Number seed accessions held in LTS and safety duplicated at two 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
4. Number RTB accessions in cryopreservation and safety duplicated	Number of vegetative-propagated accessions in cryopreservation or safety duplicated as in vitro samples.	15,643	16,141	15,554	19,369	19,803
5. Stage (from 1 to 5) in QMS development	A qualitative assessment of where the genebanks are in the development of their quality and risk management system.					See table 1
6. Number accessions with passport and characterization data available (online)	Number of accessions with passport and characterization data available online and/or through the GeneSys web portal	392,959	444,742	542,197	653,836	659,540
7a. Average time from seed harvest to storage	As an illustration of the efficiency of seed processing and conservation, this indicator measures one of the most critical factors affecting seed longevity: the average number of days between last day of harvest and first day of storage in LTS.	Proposed indicator for efficiency. The full definition has not yet been agreed and data have not been compiled.				
7b. Average time between tissue subculture	Efficiency indicator for clonal crop collections: average number of days between first day of previous culture and day of initiation of new culture.	Proposed indicator for efficiency. The full definition has not yet been agreed and data have not been compiled.				

(continued)

Table 4. Indicators for the aggregate collection, 2012 to 2016 (continued)

Indicator	Description	2012	2013	2014	2015	2016
8. Number countries receiving germplasm	Number of countries receiving germplasm from the genebanks	105	122	112	114	102
9. Number germplasm requests	Total number of legitimate external requests for germplasm. This indicator illustrates trends in demand outside the CGIAR. It does not include requests where lack of follow up on the side of the requester resulted in the request being dropped.	2,331	1,721	2,054	2,366	1,913
10. Number accessions distributed within CGIAR	Number of distinct accessions provided to the host institute or other CGIAR Centers. This indicator reflects the diversity of germplasm being requested.	61,645	67,800	35,167	32,850	50,058
11. Number accessions distributed outside CGIAR	Number of distinct accessions provided to users outside the CGIAR. This indicator reflects the diversity of germplasm being requested.	27,538	30,965	32,625	20,010	27,283
12. Total number of samples distributed	Number of samples provided to all users. This number reflects the overall quantity of germplasm being requested. This number includes DNA samples in the case of Bioversity, where germplasm distribution is restricted because of Banana Streak Virus.	131,181	154,894	123,067	91,506	111,117
13. Average overall satisfaction of genebank users	This represents the average score for overall satisfaction with genebank services according to surveys returned.	Proposed indicator for efficiency. The full definition has not yet been agreed and data have not been compiled.				
14. Number accessions in Genesys	Number of accessions currently held in the Genesys web portal.	2.35 million	2.35 million	2.7 million	2.6 million	3.6 million
15. Number users of Genesys	Number of visitors on the Genesys web site.	>1000/mnth	>1000/ mnth	>1000/mnth	>2000/mnth	>2,500/ mnth
16. % genebank routine operating costs covered by Crop Trust endowment	Funds provided by the Trust as a proportion of the total routine costs of the 10 genebanks (excluding ICRAF)	16%	17%	15%	17%	11%

B. Progress along the Impact Pathway

a) Progress towards performance targets

All genebanks are actively improving the availability and safety duplication of the collections through seed multiplication, viability testing and disease cleaning. These activities have been funded through individual Recommendation Action Plans, which were developed by each Center in response to review recommendations. Of the total aggregate collection, an 13% (100,223) of accessions were planted out in the field for multiplication or regeneration or subcultured in vitro in 2016. The individual status of the genebanks is provided in Table 3 and for the CRP as a whole in Table 4.

b) Additional activities

In addition to the routine operations of the genebanks, the CRP proposal envisaged a number of additional activities that contribute to improved conservation methods and genebank efficiency. These activities are as follows:

i. Genesys
ii. Cryopreservation
iii. Acquisitions and collecting
iv. Optimizing collections

i) Genesys

In 2016, Bioversity, CIP, IITA and ILRI uploaded new accession data into the global portal, Genesys, (www.genesys-pgr.org). The Passport Data Completion Index (PDCI) increased for these Centers as illustrated in Table 5. At the end of 2016, Genesys contained records on 3.61 million accessions. The increase is due to significant data contributions also from the Australian Pastures and Grains Genebanks (83,465 and 138,016 accessions respectively), the Centre for Pacific Crops and Trees (2,163 accessions) and the World Vegetable Center (61,952 accessions).

Table 5. Passport Data Completeness Index in Genesys

Center	Average PDCI 2015	Average PDCI 2016
AfricaRice	5.62	5.62
Bioversity	5.27	5.77
CIAT	4.51	4.51
CIMMYT	5.30	5.31
CIP	5.38	5.43
ICARDA	5.83	5.75
ICRAF	5.34	5.34
ICRISAT	6.05	6.05
IITA	4.66	4.69
ILRI	6.46	6.56
IRRI	5.22	5.50

New tools were added to the Genesys website to help genebanks validate taxonomy and georeference data for their accessions. In 2016, the Genesys Advisory Committee met in Mexico and agreed new terms of reference (https://www.croptrust.org/blog/genesys-advisory-committee/).

In the course of 2016, CIAT, CIP, IITA and ILRI progressed in migrating data holdings from pre-existing platforms to GRIN-Global. Major activities included mapping data, development of migration tools, ensuring compatibility, and training staff. All source codes are placed in the public domain.

ii) Cryopreservation

CIP, IITA and Bioversity continued their efforts towards building cryobanks of potato, sweet potato, cassava, yam and banana collections. Of particular note, a total of 591 potato accessions were cryopreserved in 2016, bringing the total number of potato in CIP cryobank to 1,742. The percentage survival and recovery of accessions continues to increase (Table 6) and levels of contamination or low viability continues to decrease (Figure 3). The success of the current cryopreservation method reached 95.4% (Figure 4).

Table 6. Average survival and recovery rates of potato accessions cryopreserved at CIP, 2013 to 2016

Year	No accessions cryopreserved	Average Survival Rate*	Average Recovery Rate**
2013	119	66.6 %	49.8 %
2014	440	68.3 %	53.2 %
2015	461	70.2 %	59.3 %
2016	591	71.4 %	60.8 %

Notes: * Survival rate is defined as % of cryopreserved samples that showed visible signs of growth 30 days after retrieval from the cryotank. ** Recovery rate is defined as % of cryopreserved samples that develop healthy plants in vitro 60 days after retrieval from the cryotank.

Figure 3. Trends in "Poor practice events" recorded by CIP between 2013 and 2016

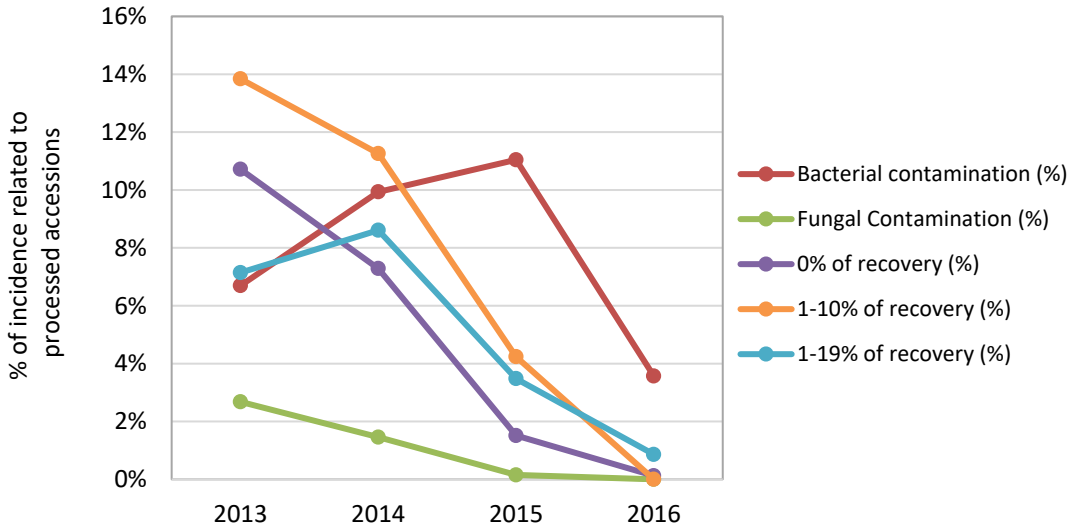
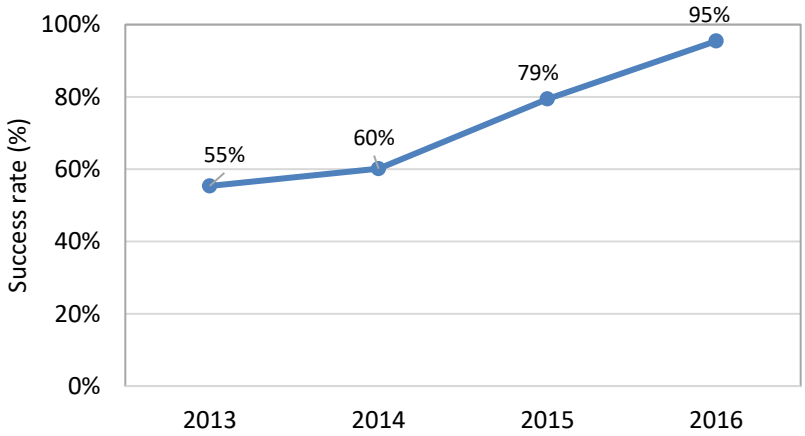


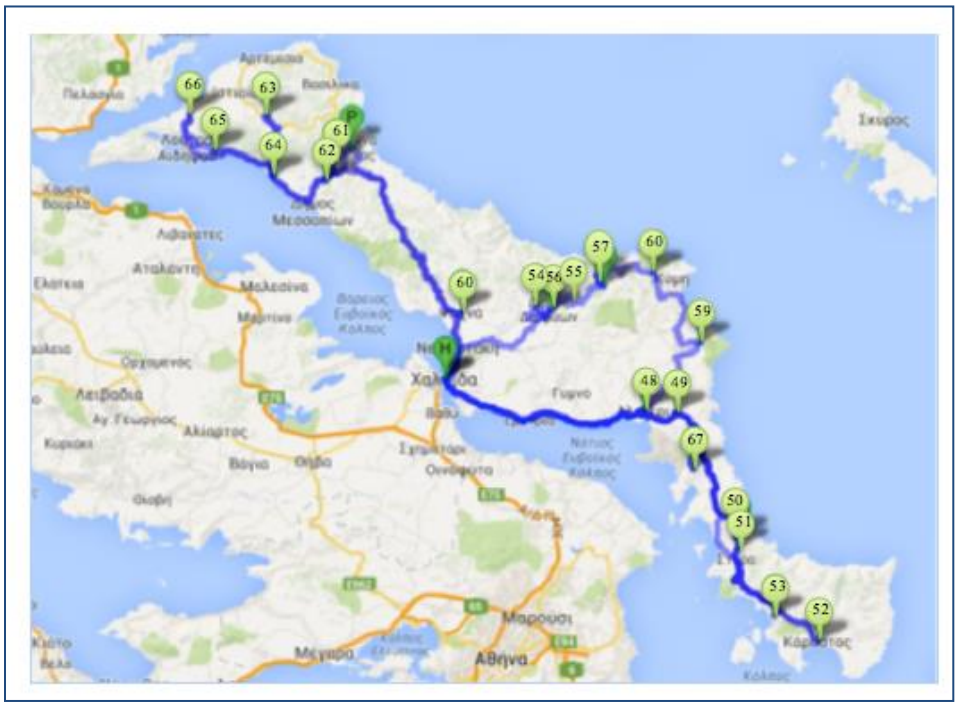
Figure 4. % Success rate of potato cryobanking (% accessions > 30% recovery rate)



iii) Additional acquisitions and collecting

In 2016, ICARDA, IITA and IRRI completed collecting missions to fill priority gaps in their collections. All missions were successfully concluded with activities focused mainly on multiplication and characterization of the collected accessions and their introduction into long-term storage (Table 7). The collecting projects improved the representation of crops and their wild relatives in both CGIAR and national genebanks, contributed to knowledge of landrace distributions and strengthened CGIAR's partnership with national genebanks. Some of these collecting trips could be considered as "rescue" missions as a considerable number of indigenous landraces are threatened by extinction (Figures 5 and 6).

Figure 5. ICARDA collection mission on Euboea island (Greece)



Note. The island was found to be home to a number of threatened landraces: einkorn (*Triticum monococcum*), durum wheat, grasspea (*Lathyrus ochrus* and *L. cicera*), faba bean, pea, and chickpea.

Figure 6. (A) Interviews with local farmers (B) traditional landraces (C) collection of *Hordeum vulgare* ssp. *spontaneum* during ICARDA's collecting mission in Greece

Table 7. Summary and outcomes of the collection missions in 2016

Centre	Crops collected	Number accessions	Country	Outcome
ICARDA	Landraces of multiple cereals, legumes and vegetables	248	Greek islands and mainland	All collected accessions were characterized, multiplied and introduced into ICARDA. Copies of all materials were transferred to a national partner.
	Crop wild relatives, forage and range species	1,349	Greek islands and mainland	
IITA	Yam	1,437	Nigeria, Benin	All accessions were introduced to IITA. 1,176 accessions were characterized using 49 descriptors. After harvest, tubers were also transferred to University of Abomey-Calavi (Benin) and NACGRAB (Nigeria).
IRRI	Rice	1,132	Bangladesh	Accessions are being processed to identify duplications. First 185 accessions were introduced into IRRI. All samples are also kept by the national partner, Bangladesh Rice Research Institute (BRRI).

iv) Optimizing collections

The 11 genebanks have achieved a large number of significant efficiencies that will play a role in improving germplasm conservation and use and reducing costs. Although such efficiencies are not systematically monitored or quantified, Table 8 attempts to report some examples:

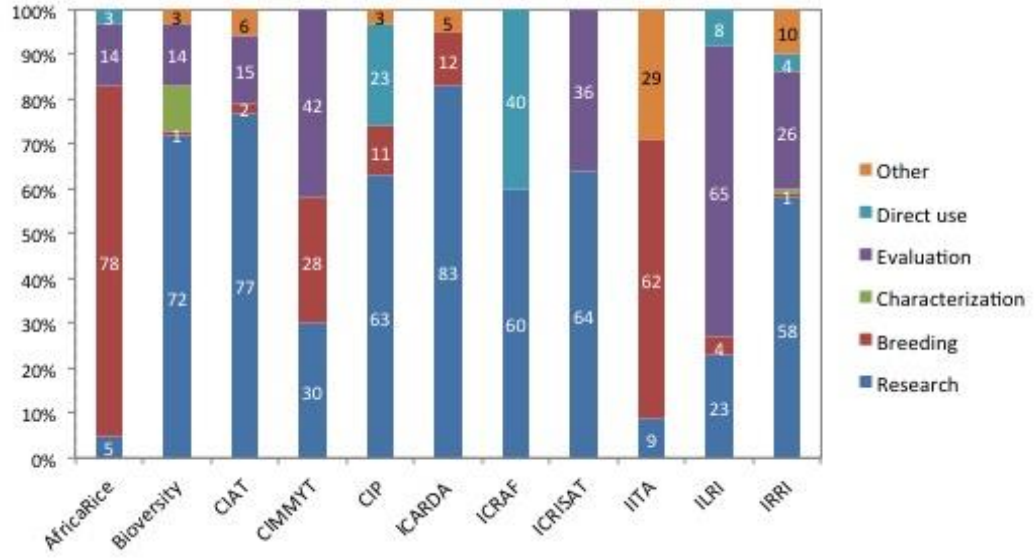
Table 8. Examples of gains made in efficiency

Center	Reported conservation management efficiencies
Africa Rice	• Increased rate of annual seed multiplication by 50% • 72% increase in accessions in long-term storage (from 42% of the collection to 67%) since 2012 • 67% reduction in seed processing time from harvest to storage from 6 to 2 months • Germination tests indicate 97% accessions have maintained adequate viability over 20 year period in long-term storage
Bioversity	• Safety measures (e.g. oxygen alarm) put in place to manage liquid nitrogen • Measures agreed to make available approx. 30% of the collection affected by banana streak virus • 66% accessions genotyped using SSR markers • Establishment of virus indexing services in University of Liège and reduction of pre-indexing procedure from 6 months to 3 months or less
CIAT	• Species prioritization enables the stratification of the forages collection and potential archiving of 52% of grass and 58% legume species • 10% increase in acceptance rate of forage accessions and 5% in bean accessions through heath testing after improved seed production in the field • Deployment of hand-held devices for all data collection • 81% of cassava accessions now available after entire collection screened for cassava frogskin disease
CIMMYT	• New stratified curation policy will result in archiving of wheat accessions and reduction in monitoring needs • New drying room for maize collection has improved seed processing
CIP	• 36% reduction in size of field/screenhouse collections since 2012 • Installation of a liquid Nitrogen plant saving USD18K/yr in supply costs • Barcoding in place for all transactions in seed processing chain from acquisition to distribution • First level duplication established at Huancayo significantly increasing security of the collection and reducing need for in vitro multiplication • 40% potato collection cryobanked and substantial gains in efficiency of cryopreservation process described under section B.a.ii
ICARDA	• Construction of genebanks and resumption of routine genebank operations in two Lebanon and Morocco • 200 isolation cages installed for regeneration of cross-pollinating (mainly wild) species
ICRAF	• Major improvement in storage conditions and seed packing • Dormancy breaking procedure improved for baobab and other species resulting in increased levels of viability • Consolidation of field collections and field sites under way as part of acquisition and retention strategy
ICRISAT	• Construction of 3 new cold room modules to increase capacity of medium and long-term storage
IITA	• Rationalization of seed lots reducing significantly the need for germination monitoring • Increased capacity in cold rooms by transfer of seeds to aluminum foil bags • Increased annual seed health testing by a factor of 10, from 620 acc/yr to 6331 acc/yr since 2012
ILRI	• Species prioritization enables the stratification of the forages collection and potential archiving of 52% of forage grass species and 58% legume species • Major institutional investment in upgrading genebank facilities • Reviewed and revised viability monitoring rates
IRRI	• Barcoding in place for all transactions in seed processing chain from acquisition to distribution • Reduced days of seed processing from harvest to storage by 30%

c) Contribution to impact

The activities of the Genebank CRP are targeted specifically to bring about *increased conservation and use of genetic resources*. The contribution of the genebanks to the CGIAR System Level Outcomes may be partially assessed through the use values of the genetic resources. Figure 7 confirms that the purpose of requesting germplasm from the CGIAR is largely for research related to crop improvement. The specific use of germplasm is crucial because it contributes to the development of new and improved varieties that will deliver on improved productivity and quality of crops.

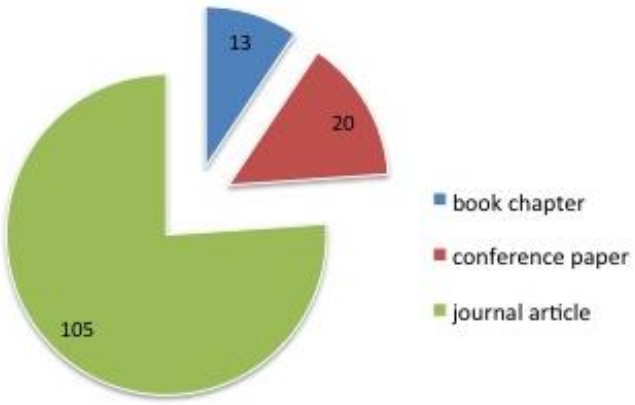
Figure 7. Purpose of germplasm requests by Center



Note: Based on Center reports on ORT question "*ARI.05: Indicate the generic purpose of requests for germplasm. Include only those that receive germplasm & state an estimated percentage users stating the purpose".*

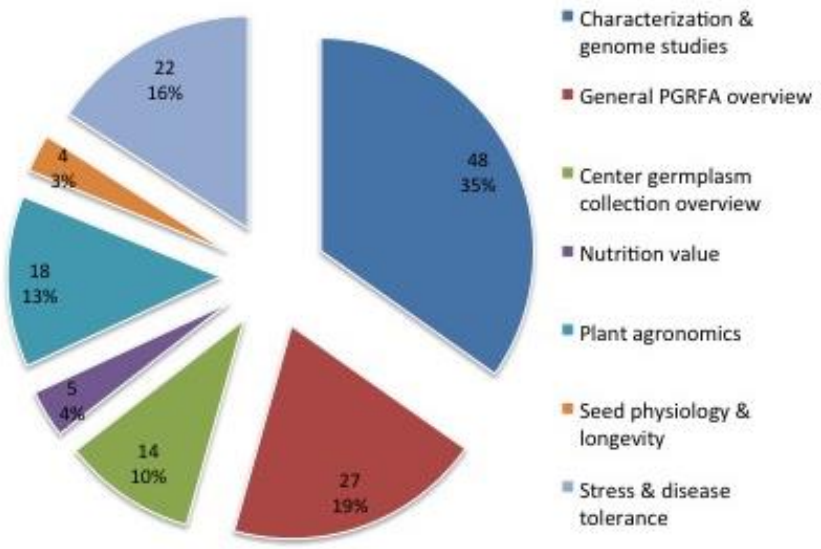
The use of genetic resources can also be assessed though scientific publications. In 2016, the genebanks reported a total of 138 publications in journals, conference proceedings, and book chapters published by genebank staff (Figure 8), covering a wide range of topics (Figure 9). The number of journal publications by Center is presented in Figure 10.

Figure 8. Genebank publications in 2016



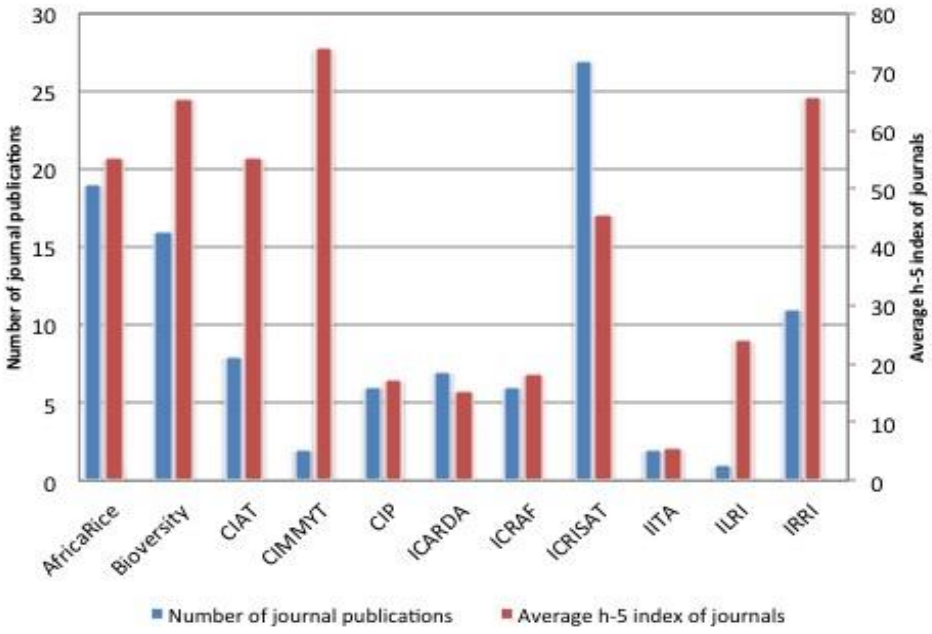
Note: Based on Center reports on ORT question "*ARI.03: Provide any citations relating to the use of the collections."*

Figure 9. Genebank publications by topic in 2016



Note: Based on Center reports on ORT question "*ARI.03: Provide any citations relating to the use of the collections."*

Figure 10. Journal publications in 2016 by Center



Notes: H5-index is the average h-index for articles published in the journal in the last 5 complete years, as indexed at Google Scholar as of April 04 2017. It is the largest number h such that h articles published in 2011-2015 have at least h citations each. The value for "average H-5 index of journals" presented in the chart is used as proxy for the quality of journal where articles have been submitted, & does not infer to the citation impact of the submitted article. It takes some time for articles published in 2016 to generate significant citations. Total number of journal publications = 105. Average h-index of journals where articles have been submitted= 47.9.

C. Partnerships building achievements

Partnership building is essential to achieve effective integration in the management of genetic resources around the world, and reflects the willingness and commitment to multilateral cooperation on the management, conservation and distribution of plant genetic resources for food and agriculture. The CGIAR genebanks work with different types of partners, most on research but a few oriented towards delivery and impact. Aside from distributing germplasm, examples of partnership building activities in 2016 with NARS and national genebanks are presented in Table 9 and with other Centers and CRPs in Table 10.

Table 9. Partnership building with NARS & national genebanks by Center

Center	Partnership building activity
AfricaRice	Germplasm health testing
	Safety duplication of rice collections from Madagascar
Bioversity	Germplasm health testing service with Université de Liège
	Germplasm characterization with IEB (Institute of Experimental Botany, Czech Republic) & USDA (Puerto Rico)
	Seed lots of a wide range of wild banana species were received from USDA, Puerto Rico, CIRAD, Guadeloupe, NARI, Papua New Guinea for conservation research
	Banana collecting mission conducted in Bougainville, PNG by NARI (PNG), Bioversity, Botanic Garden Meise (Belgium)
	Future Food project (Norwegian Government) with NIBIO, Piql, Bioversity on the development of a secure storage & future proof-access system for data of cryopreserved biological material
	Phenseedata, Belgian Development Cooperation funded project (July 2016-June 2017) aims to expand the services of the Bioversity International Musa germplasm Transit Centre (ITC) & the use of the global banana collection
CIAT	Germplasm explorations in Costa Rica with the University of Costa Rica
	Selection of 5,000 landraces from Latin America through the Bean-Adapt Project (Italy, USA, Germany)
	Cassava clones distributed to 6 NARS of Central America
	Cassava clones distributed to the International Atomic Energy Agency for herbicide tolerance & starch with novel properties
CIMMYT	CIMMYT germplasm bank received 2,735 visitors in 2016, including Bill & Melinda Gates Foundation CEO Susan Desmond-Hellmann
	Buena Milpa project in Guatemala involves repatriation of maize landraces (785 acc)
CIP	Temporary conservation and monitoring of INIA's Andean root & tuber crops (ARTCs) *in vitro* collection.
	In vitro conservation of 212 Andean landraces from Cuzco-Peru genebank in collaboration with the Andean communities in Parque de la Papa
	Safety duplication for INIA-Peru National Genebank
	Potato accessions were repatriated to 15 rural communities in the Peruvian Andes
ICARDA	Multiplication of forages with the New Zealand Forde Margot Genebank
	157 sources of resistance to diseases were shared with Australian breeders within GRDC funded project
	Breeding activities with Australian counterparts through the evaluation of FIGS subsets for resistance to major biotic & abiotic stresses (CRP Food Legumes)
	Wild Cicer accessions collected from Turkey received from the University of California Davis & lentil accessions from USDA
	Collecting missions conducted in Lebanon with the Lebanese University (LU) which resulted in 585 accessions currently being multiplied & characterized

(continued)

Table 9. Partnership building with NARS & national genebanks by Center (continued)

Center	Partnership building activity
ICRAF	Regional projects: Global Climate Change (Mali), Calotropis (Mali & Kenya), Evergreen project (Kenya), & AfricaRising (Mali, Malawi & Tanzania)
	Collaboration with national partners in 16 countries in the management of field genebanks
	Collaboration with the African Orphan Crops Consortium (AOCC) on the following: – Ministry of Agriculture Tanzania - Gliricidia sepium – Ministry of Agriculture Rwanda - Faiderbia albida – Vikki Tropical Resources Institute (VITRI) in Somalia- several species
ICRISAT	Collecting of landraces in East Africa
	Safety duplication on behalf of NARS in West & Central Africa
IITA	Yam collecting missions with NACGRAB (Nigeria) & University of Abomey-Calavi (Benin Republic)
	Pre-breeding with national programs in Nigeria, Burkina Faso & Niger.
	Evaluation of farmer desired land races of Bambara groundnut in collaboration with the Crops for the Future Research Center in Malaysia
ILRI	Laboratory services (e.g., seed scarification & rhizobia)
	Forage seed germination for the national genebank of Kenya
	High-level event with the Ethiopian Biodiversity Institute to celebrate crop diversity in Ethiopia
IRRI	Safety duplication for the Philippine national genebank
	Collecting missions in Bangladesh & East Africa

Note: Based on Center reports on ORT questions "*ARI.07: Please list any additional services you provide to partners" and "ARS.12: Describe any significant outputs, activities or events in your partnerships with other CRPs or with NARS*"

Table 10. Partnership building with other CGIAR centers and CRPs

Center	Partnership building activity
CIAT	Germplasm health testing service to CIAT bean program
	Provision of germplasm to Livestock Plus CRP & Food Legumes CRP
CIMMYT	Regeneration for ICARDA
CIP	Laboratory services
	Reduced price of liquid nitrogen
ICARDA	Collaboration with CRP Wheat on the following: – Meeting between ICARDA & CIMMYT to establish one Global wheat program – Use of wild relatives in pre-breeding – Wheat Initiative through the Expert Working Group on Germplasm Conservation & Use
	Multiplication at ICARDA Lebanon of 780 accessions of Aegilops & wild Triticum
ICRISAT	Provision of germplasm for crop improvement/molecular studies, agronomic evaluation, & screening against biotic stresses to the CRP on Dryland Cereals
IITA	Contributed to the development of new RTB cluster on genetic diversity
	Laboratory services to IITA breeders, including storage & distribution
	Maize collection was sent to CIMMYT as lyophilised leaf samples & run through the Seeds of Discovery 'pipeline' to assess diversity.
	Participation in the International Maize Germplasm Resources Advisory Committee
ILRI	Laboratory services (e.g., seed scarification & rhizobia)
IRRI	Partnership with other GRiSP scientists

Note: Based on Center reports on ORT questions "*ARI.07: Please list any additional services you provide to partners" and "ARS.12: Describe any significant outputs, activities or events in your partnerships with other CRPs or with NARS*"

D. Capacity building

Capacity building in the context of crop diversity conservation is defined here as activities that enhance the abilities of individuals and their organizations to perform genebank operations efficiently and effectively. The genebanks undertake numerous individual capacity building activities to the benefit of both CGIAR staff and partners. At the CRP level, five capacity building events were organized in 2016 in collaboration with other projects managed by the Crop Trust (Table 11). Statistics on workshop participants are summarized in Table 12. A total of 153 participants from 39 countries have been trained. The events help to improve the organizational capacity of at least 36 partner institutes where the trainees are currently affiliated.

Satisfaction rating. Out of 153 trainees in total, the majority of the 131 respondents (response rate of 86%) agree that the workshops were well-organized and that the trainers/facilitators were effective (Q1, Table 13).

Improved capacity of trainees. More than 70% of the respondents confirmed gaining new knowledge and/or updating their current knowledge on genebanking activities as the main benefits of the workshop (Q2, Table 14).

Relevance. The majority of respondents also confirm that the workshops were highly relevant to their work responsibilities (Figure 11), indicating that workshop participation and content were well targeted.

Table 11. List of capacity-building events in 2016

	Date	Event	Location	Number of participants
1	8-12 Feb 2016	GRIN-Global	Prague, Czech Rep.	23
2	7-11 Mar 2016	GOAL	Ibadan, Nigeria	39
3	11-15 Apr 2016	GRIN-Global	Cali, Colombia	20
4	20-24 Jun 2016	Genebank barcoding	Berlin, Germany	25
5	25-30 Sep 2016	GOAL	Nairobi, Kenya	46
			Total	**153**

Table 12. Key numbers on workshop participants in 2016

Detail	Value	Percent
Number of participants	**153**	
… CGIAR participants	113	74%
… non-CGIAR participants	40	26%
Number of participating institutions	**36**	
… CGIAR centers	11	31%
… non-CGIAR institutions	25	69%
Number of countries represented	**39**	
Number of female participants	**51**	**37%**
Educational background		
…with PhD degrees	34	22%
…with MS degrees	67	44%
…with BS degrees	35	23%

Table 13. Workshop evaluation

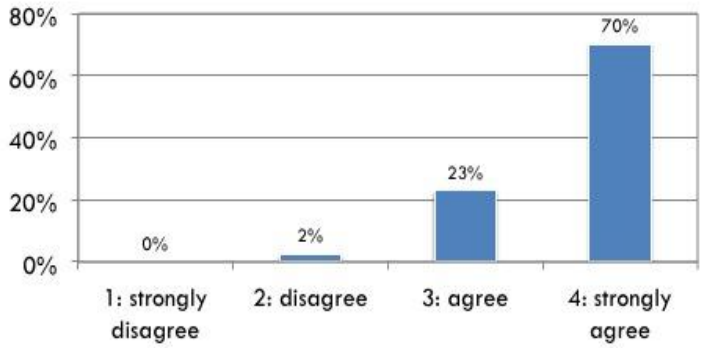
Q1. Level of agreement with the statements (out of 4 highest)*	
The workshop was well-organized.	3.74
The trainer/facilitator was effective.	3.70
The meeting rooms & facilities are adequate & comfortable.	3.69
The accommodation facilities were adequate & comfortable.	3.63
My expectations of this workshop were met.	3.51
The materials distributed are useful.	3.38
The level of difficulty is just right.	3.22
The time allotted to the workshop is sufficient.	3.13

Note: * 1=Strongly Disagree to 4=Strongly Agree

Table 14. Benefits of workshop participation

Q2. What were the main benefits of this activity for you?	
Gained new knowledge	74%
Updated knowledge	72%
Expanded professional network	71%
Shared knowledge	66%
Improved skills	59%

Figure 11. Was the workshop relevant to your job responsibilities?



a) With NARS and national genebanks

While the focus of the GOAL and GRIN-Global workshops is to enhance the capacity of staff of the CGIAR genebanks, the participation of partners from NARS has contributed to increased learning within the Global System for the conservation and use of PGRFA. Table 15 summarizes capacity-building activities in 2016 with NARS. The CGIAR genebanks also serve as the primary knowledge hub in their respective regions for the crops they conserve. In this capacity, CGIAR genebank staff members serve as technical resource points for NARS, and are sought after for expert advice on the management of germplasm collections of national genebanks.

Table 15. Capacity building with NARS & national genebanks by Center

Center	Capacity building activity
AfricaRice	Knowledge hub on African rice
Bioversity	Training of staff from national genebank partners in Germany, China, & South Korea on tissue culture of vegetatively propagated crops, cryopreservation of banana & other vegetative crops, genebanking & genebank data management – Leibniz Institute of Plant Genetics & Crop Plant Research (IPK) – Institute of Tropical Crop Genetic Resources, Chinese Academy of Tropical Agricultural Sciences – National Agrobiodiversity Center, National Institute of Agricultural Science, RDA
	NARS partner training on: – Tissue culture of vegetatively propagated crops, cryopreservation of banana & other vegetative crops, genebanking & genebank data management (Gembloux Agro-Bio Tech, Université de Liège) – Musa characterization & documentation for regional partners in East & Southern Africa
	Graduate student scholarship in partnership with Bioversity, KULeuven, & RBG Kew
	NARS partner training on Musa characterization & documentation. Curators from 16 NARS collections from East & Southern Africa attended the workshop in Uganda
CIAT	Knowledge hub in the region
	Contributed to global forage strategy
CIMMYT	Training of staff from Guatemala national genebank on maize conservation
	Staff exchange with USDA
	NARS partner training on genebank management
	Farmers' field days with local communites on highland maize
	Knowledge hub on wheat & maize germplasm
CIP	Training of INIA staff – in 2016, topics include: diagnosis methods for ARTCs viruses, RNA extraction, bioinformatics for virus genomic sequencing, molecular diagnosis methods, & improved data management
	Expert advice for INIA on the development of improved methods for *in vitro* conservation of oca
	NARS partner training on: – *in vitro* (INIA, Universidad San Cristobal de Huamanga, Universidad de Huanuco) – identification of sweetpotato accessions with local community – climate change research, integrated pest management, participatory selection/breeding (Parque de la Papa – Cuzco)
	Technical resource person in various events with the following institutions in Peru: – Annual Conference of the American Council for Medicinally Active Plants (ACMAP) – Universidad Nacional Agraria La Molina (UNALM) – Universidad Femenina del Sagrado Corazón (UNIFÉ) – Universidad San Ignacio de Loyola (USIL) – Instituto Nacional de Innovacion Agraria (INIA) – Programa Nacional de Innovación Agraria (PNIA) – Central Restaurante

(continued)

Table 15. Capacity building with NARS & national genebanks by Center (continued)

Center	Capacity building activity
CIP	Collaboration with NASA to model climate change in Potato Park using their satellite data
	2016 CGIAR Borlaug International Agricultural Science & Technology Fellowship with Washington State University to characterize Andean Tuber Crop wild Oca (Oxalis tuberosa)
	Publishing of operational procedures on : – *In vitro* conservation of sweetpotato - OP026 – *In vitro* conservation of potato - OP025
	NARS partner training on: – *in vitro* conservation of roots & tubers (INIA, Universidad San Cristobal de Huamanga; & Universidad de Huanuco) – scientific methods (DRGB-INIA, UNALM, Buenos Aires University)
ICARDA	Expert advice to establish Morocco's national genetic resources center
	Expert advice for rehabilitation of genebanks in Bahrain, Jordan & Saudi Arabia
	NARS partner training on best practices for conservation of genetic resources in Lebanon in February 2016, participated by 23 trainees from 11 countries
	Graduate research scholarship, University of Ibn Tofail, Kenitra
ICRAF	Knowledge hub on tree seed conservation and use
ICRISAT	Knowledge hub in the region: assistance/guidance in establishing genebanks & training needs from universities, NARS, & NGOs
	Graduate research scholarships at universities in India
IITA	Expert advice to NACGRAB on improving data management system
	NARS partner training in in vitro conservation
	Graduate research scholarship, University of Ibadan (Nigeria)
	Joint publications with partners from Benin Rep. (University Abomey-Calavi) within the CRP RTB
ILRI	Support to Kenya national genebank to build capacity in germination testing
	Training on scientific methods (e.g., DNA extraction, disease diagnostics, & aflatoxin)
	Contributed to the development of the global forage strategy
IRRI	Technical resource person for trainings with NBPGR India, PhilRice Philippines, UPLB Philippines, ICABIOGRAD Indonesia & through IRRI's regular training courses
	Knowledge hub on rice germplasm

Note: Based on Center reports on ORT questions "*ARI.07: Please list any additional services you provide to partners" and "ARS.12: Describe any significant outputs, activities or events in your partnerships with other CRPs or with NARS "*

b) With other CG Centers and CRPs

Table 15 cites some of the capacity-building activities of genebank staff with other Centers and CRPs. While the primary function of the CGIAR genebanks is the provision of germplasm materials, the genebanks collaborate on various activities, (e.g., germplasm health testing), that contribute to improved genebank management practices and standards. There are more concrete examples of capacity-building across Centers that share common crops.

Table 16. Capacity building with other CGIAR centers

Center	Capacity building activity
AfricaRice	Enhancing the capacity of AfricaRice genebank staff on seed management & seed longevity with IRRI's support
CIMMYT	Collection of genome profiles of accessions from the genebanks at CIMMYT & ICARDA represented in a searchable MasAgro Seeds of Discovery 'Wheat Molecular Atlas'.
CIP	Partner training with the following: – CIP-Africa, ICRAF, ILRI, Bioversity, IITA, & AfricaRice on data management using barcodes & mobile software solutions – CIP-China on genebank management – IITA on variety identity verification, LIMS, Cryopreservation, ISO/QMS & barcoding system
ICARDA	Pre-breeding activities with ICARDA breeders on Crop Wild Relatives grant on barley & grasspea
IITA	GBS characterisation of the cowpea mini core
	GBS characterization of cassava from GRC collection within CRP RTB
	GBS characterisation of diversity in our yam collection through CRP RTB complementary funds with colleagues in IITA
	Joint publications with partners within the CRP RTB
IRRI	Major initiative to assess historical viability monitoring data and provide backstopping to improve seed quality management in all CGIAR genebanks managing seed collections.
	GRC-led research on sequencing rice diversity
	Technical resource person for trainings with CIAT & AfricaRice

Note: Based on Center reports on ORT questions "*ARI.07: Please list any additional services you provide to partners" and "ARS.12: Describe any significant outputs, activities or events in your partnerships with other CRPs or with NARS* "

E. Risk Management and Mitigation

1. ***Risk management in the genebank*:** The risks influencing the operations of each of the 11 genebanks and the way that they are managed are highly individual. Through the activities on QMS much has been done to support Center management in strengthening their control of such risks and to highlight the need to critically review risk management measures in place specifically for the genebank, ensuring that a detailed plan is in place for the physical evacuation of the collections in the event of a disaster. All of the routine procedures followed in day-to-day management of the collections address the multitude of risks that affect a living collection (e.g. contamination, disease, loss of genetic integrity, etc.). These processes are documented in SOPs and have been the subject of QMS activities and GOAL workshops.

2. ***Risk management in the CRP***: At the level of the CRP, the main objectives of the original CRP proposal have been wholly or partially fulfilled. The need to continue supporting the CGIAR genebanks' work as a program has been recognized and the Genebank Platform is now approved for implementation. The Platform is taking on two new areas of work, which were not included in the CRP, as a direct response to identified risks. Firstly, the lack of coordinated representation and engagement of the CGIAR in international plant genetic resources policy processes in the past five years has resulted in a lack of visibility and negative consequences. The new Platform will include a dedicated Policy Module that will provide a helpdesk and build capacity systemwide to support the

CGIAR's compliance and engagement in international policy. Secondly, the systemic lack of investment in Center germplasm health units (GHUs) puts strain on their capacity to provide the level of service required by genebanks and research programs. The Genebank Platform is directing resources for upgrading and strengthening quality management in the GHUs following a similar approach to that taken with the genebanks, contributing importantly also to performance targets on the availability of accessions.

F. Lessons Learned

The data provided by the genebanks in 2016 continue to strengthen and improve in consistency. The indicator on the safety duplication of clonal collections is affected by the use of different forms of conservation and methods of safety duplication (seeds, in vitro and cryopreservation). The figure in 2016 take better account of these different forms and improves the accuracy of this indicator. There remain areas of potential inconsistency between Centers, such as determining whether an accession is healthy for storage and distribution. National and international phytosanitary controls are not standardized and the needs of importing countries are liable to change. This affects the indicator on availability. Equally individual approaches deployed by the genebanks to assess genetic integrity affects the indicator availability.

It is also important for genebanks to periodically review the genetic representation of collections under their management in order to respond to the needs of users and of research and breeding partners who may want certain stocks to be conserved. Changes in acquisition or curation policies are likely to affect baseline accession numbers and indicators. For instance, IRRI is now accepting genetic stocks for medium-term conservation but will not be safety duplicating them. Similarly, CIMMYT is in the process of archiving a large number of accessions that will effectively render them no longer available. While the targets will remain the same: 90% of designated accessions will be available and safety duplicated, a more sophisticated assessment of baseline numbers will be required in the Genebank Platform.

The partnership of the CGIAR and Crop Trust since 2004 has proven highly productive and continues to strengthen in the wake of the CRP. The genebanks are able to speak in one voice through the CRP/Platform Management Team. It is highly significant that the Genebank Platform proposal presents several areas of collective work on policy, seed quality management, gap analysis, data management, etc. This has been made possible through the mechanisms and trust that have matured through the CRP.

Since the pledging conference of April 2016, the Crop Trust has redoubled its efforts to attract a range of donors to contribute to the endowment for the long-term funding of the international collections. The achievements of the past five years have provided a vivid illustration of the benefits of secure funding on genebank operations and capacity. These are described in the IEA's report on the Genebank CRP. The funding to the Genebanks CRP has not been cut and the support shown by the Center and CRP Directors to safeguard this funding has been highly significant. In 2017, while the endowment total continues to gradually increase (currently at USD 189 million), the income earned will provide USD 6.75 million to the genebanks, almost half of their needs for strictly routine operations. The experiences of the past five years strongly reinforces the importance of pushing the endowment total towards its target of USD 500 million.

RESEARCH PROGRAM FOR
Managing and Sustaining Crop Collections

CROP TRUST

CGIAR Research Program on Managing and Sustaining Crop Collections. Annual Report 2016.
Genebanks CRP and the Global Crop Diversity Trust.