

A close-up photograph of coffee cherries on a branch. The cherries are in various stages of ripeness, ranging from bright green to deep red. The background is a soft-focus green, suggesting a healthy coffee bush.

Coffee Forever



CROP TRUST

MAKING COFFEE MATTER

Much of the diversity of some of our most important food crops can be found in the 11 international genebanks managed by CGIAR centres under the auspices of the International Treaty on Plant Genetic Resources for Food and Agriculture. These collections, amounting to over 700,000 samples of wheat, maize, rice, and other cereals, legumes, tubers, forages and trees are held in trust for humanity, and shared with the global community who study and use them to develop improved crop varieties that better serve the farmers that feed us. Unfortunately, the diversity of other crops of global importance is not conserved and shared in the same way. Coffee is a prime example.

Though there are coffee genebanks around the world, they are mostly maintained by national institutes in developing countries, face numerous challenges, and their contents are not widely shared. And yet, produced in 80 countries, coffee provides a livelihood to an estimated 125 million people in Latin America, Africa and Asia. Of the 125 coffee species in the world, global coffee production is based on only two – *arabica* and *canephora* – and we are using just a few varieties of each.

The global multi-billion dollar coffee industry is thus resting on a perilously narrow genetic base. A fast spreading disease for which there is no resistance in any of these varieties could wipe out coffee production entirely. What's more, arabica coffee – which accounts for about 60 percent of total coffee production – is extremely climate sensitive: 75 percent of the land dedicated to growing it will become unsuitable for coffee production within the next 50 years, according to the Climate Institute, due to changes in temperature and rainfall. That is less than the lifespan of a coffee tree.


In Colombia and Central America, reductions in coffee production due to the rust epidemic – a kind of fungus – between 2008 and 2013 had direct impacts on the livelihoods of hundreds of thousands of smallholders and those employed as harvesters. For these people, particularly in Central America, coffee is often a primary source of income used to buy food and inputs for the cultivation of staples.

With a rapidly growing global population of demanding coffee-drinkers, and many climate-related challenges facing the industry, it is crucial that we take a long hard look at the state of coffee diversity to ensure the crop remains viable and profitable.

That is why the Crop Trust, which is among the few international organization in the world whose sole task is making sure we conserve and make available from genebanks the diversity of our most important crops, has partnered with World Coffee Research, a non-profit research and development organization funded by the coffee industry, in a global endeavour to understand how much unique coffee diversity is truly safe and available.

“Genetic diversity is the foundation of all agriculture, including coffee agriculture. Protected reserves of genetic diversity are the bank accounts that we will need to draw on to face the challenges ahead—adapting to climate change, fighting diseases and pests, the discovery of new quality traits,” says Tim Schilling, CEO of World Coffee Research.

“This is why we have partnered with Crop Trust to build a plan to revitalize the world's most important coffee genebanks and build an international system for sharing these genetic resources. The work could not be more urgent. It is impossible to sustain coffee without sustaining its reserves of genetic diversity.”



In order to maintain - let alone increase - coffee productivity, keep up with demand, and outpace climate change, we will need to tap into the wealth of traits found in its diversity. This will enable scientists to develop improved varieties with drought tolerance, pest and disease resistance, and high cup quality.”

Marie Haga
Crop Trust Executive Director

Coffee Forever

A total of 21,016 different coffee specimens (or accessions) are held by the 16 institutions that participated in this study. The oldest collections were established in the 1950s, with more recent collections established in 2005 and 2015. The institutions that host collections are located in Africa, the Americas, Asia and the Asia-Pacific regions.

THE DIVERSITY THEY HOLD CAN BE DIVIDED INTO TWO GROUPS:

'Local and Unique'
accessions

These have been collected from farmers and/or the forest but have not been widely shared, used, or securely conserved. They are likely to capture and maintain a wider range of local adaptations than the international accessions. They are mainly found in Africa and are mainly held in 'origin collections' (see below).

'International'
accessions

These have been widely used and duplicated across genebanks. Much is known about these accessions, and they have had some use, though information is scattered and mistakes may have occurred in labelling in the past.

A coffee farm worker in Cauca, southwestern Colombia. From the Two Degrees Up series of case studies on the effect of climate change on agriculture. Photo: Neil Palmer

In 2017, the Crop Trust carried out a comprehensive, global study to better understand the state of coffee diversity. This was undertaken in collaboration with World Coffee Research (WCR), a non-profit research and development organization funded by more than 30 coffee industry groups. The resulting Global Strategy for Coffee Genetic Resources comprises:

1. A background study on the vulnerability of coffee genetic resources conserved both in genebanks and in the wild.
2. A survey of the status of 16 major coffee genebanks.
3. A costing study of a coffee genebank using the day-to-day operations of the Centro Agronómico Tropical de Investigación y Enseñanza (CATIE)* as an example.
4. Visits to seven key coffee genebanks to better understand the history of the collections and identify the highest priority needs.

Coffee diversity is currently mostly conserved in genebanks that serve exclusively national audiences (farmers, plant breeders, other scientists). The one exception is the international coffee collection held at CATIE, which shares its materials beyond Costa Rica, where it is located. Historically, the managers of these collections have had limited – or no – contact with each other, either bilaterally or as a group. Thus, it has been difficult for the global community of coffee stakeholders to keep track of what has been happening to collections.

How much of total coffee diversity is actually being conserved? And to what degree is it being studied, shared, and used? This study was the first comprehensive, global, systematic attempt to answer such questions in 20 years.

* In 2004, CATIE placed its collections under FAO auspices, and in 2006 signed an agreement with the FAO's Plant Treaty (ITPGRFA), placing its collection under Art.15.



The study recognized the passion, dedication and commitment of the institutes and staff involved in coffee conservation. But it nevertheless found that all collections face huge challenges – from aging trees to lack of proper funding, from deforestation to key staff members reaching retirement age without suitable replacements being available. Also, there is little to no safety duplication of accessions among genebanks.

This means the future of the coffee diversity in these genebanks is at risk:

6.4% of accessions have been lost since the genebanks were established.

11% of accessions are represented by only one tree. If for any reason that tree dies, the world loses that accession forever.

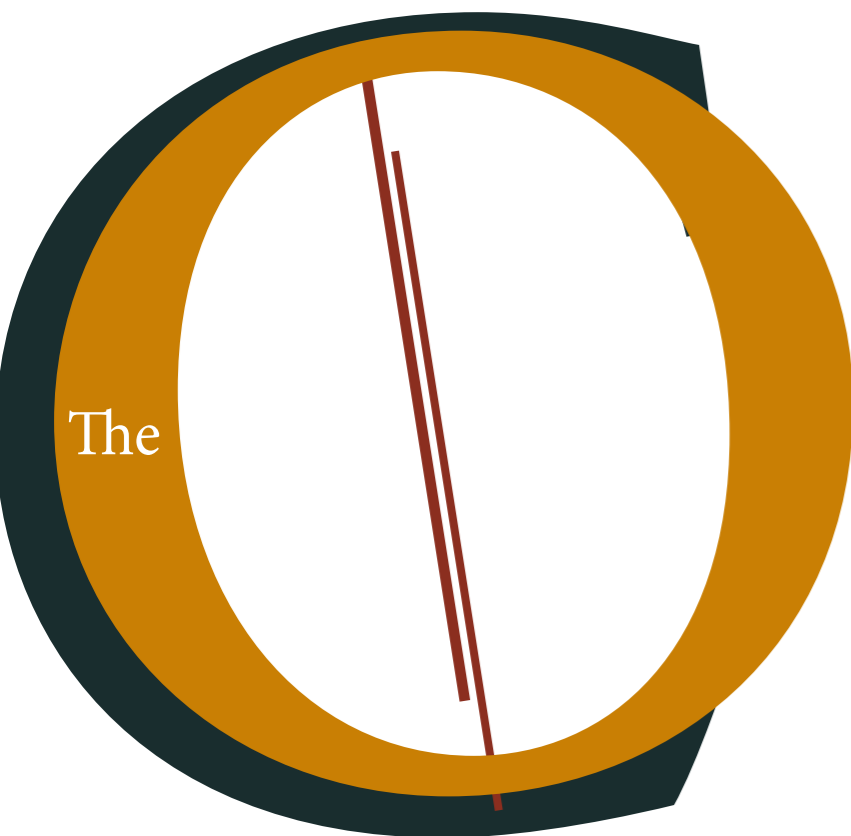
7 of 16 Seven of the 16 genebanks studied have faced funding cuts in the last five years.

In addition, the diversity in genebanks is not being fully utilized. There is limited genotyping and evaluation of accessions, and there is practically no sharing of data. CATIE is the sole institution that publicly shares data about its coffee collection: <https://www.genesys-pgr.org/wiews/CRI001/overview>.

Thus, while considerable progress has been made in assembling and conserving coffee collections over the past four decades, the foundation of the multi-billion-dollar coffee business is in jeopardy. We need to find a long-term solution to ensure that the diversity that underpins it, and the associated data, are safe and available.

Coffee husks at a farm in Cauca, southwestern Colombia. From the Two Degrees Up series of case studies on the effect of climate change on agriculture. Photo: Neil Palmer





origin Collections

Our Strategy identifies four genebanks that are absolutely essential for the long-term preservation of coffee diversity. “Origin collections” are key collections that mainly conserve local, unique accessions and their main focus is long-term conservation. These are the Choche Field Genebank (Ethiopian Biodiversity Institute), Fofifa Kianjavato Coffee Research Station (Madagascar), Centre National de la Recherche Agronomique Coffee Genebank (Cote d'Ivoire). Complementary to the true ‘origin’ collections is CATIE’s collection (Costa Rica). Although it mainly conserves international accessions, this genebank has special status as the only international collection that shares its materials internationally. Providing adequate support to these ‘Origin Collections’ would mean safeguarding the most important and unique coffee diversity that is available today to coffee breeders.

“The Origin Collections, at the heart of the coffee conservation strategy, require constant and long-term maintenance in the field,” says Paula Bramel, Crop Trust Scientific Advisor. “Even brief disruptions or variations in funding can leave materials at risk of permanent loss.”

GENEBANKS	THREATS	TOP PRIORITIES OVER THE NEXT 10 YEARS
<p>ETHIOPIAN BIODIVERSITY INSTITUTE (EBI) CHOCHÉ FIELD GENEBAK ETHIOPIA</p> <p>The Choche Field Genebank was established more than 30 years ago to conserve coffee genetic resources of Ethiopia. It is the largest field genebank of the Ethiopian Biodiversity Institute. The EBI has three locations at different agro-ecological conditions, Choche, Yayu, and Bedessa (Harar). Choche holds 4,592 accessions collected regularly from farmer’s gardens, wild areas in the forest, and commercial farms.</p>	<ul style="list-style-type: none"> The genebank has a lack of skilled manpower with no local specialized staff, especially with advanced degrees. 	<ul style="list-style-type: none"> The genebank needs to establish safety duplication of the collection at a new site. This is being planned. They would like to encourage more research on the collection with researchers through a collaborative agreement. Choche would like to explore the use of cryopreservation for long-term conservation in the future.
<p>CENTRE NATIONAL DE LA RECHERCHE AGRONOMIQUE (CNRA) COFFEE GENEBAK IVORY COAST</p> <p>The coffee collections of CNRA were originally held by ORSTOM (Office de la Recherche Scientifique et Technique Outre-Mer, now known as Institut de Recherche pour le Développement – IRD). The collections were transferred to CNRA ten years ago. Collections were established from 1966 to 1987 with 8,000 accessions from 25 African species and a few cultivars from Brazil. Accessions in the collection have come through prospecting in 8 African countries. Recently, the collection has been expanded to include local accessions of <i>C. canephora</i> from farmer’s fields.</p>	<ul style="list-style-type: none"> There is significant risk of loss of the collections from bush fires. Loggers encroach and cut down big shade trees, impacting the collection in two ways: loss of needed shade, and additional damage to the coffee plants when the trees are cut down and removed. There is no annual budget allocated exclusively to conservation. Currently this comes from the CNRA coffee breeding budget, which has been declining. Staffing is inadequate. They have two full-time staff taking care of the collection. In the past they had eight. 	<ul style="list-style-type: none"> Characterization of the entire collection for coffee berry borer and coffee leaf rust resistance, genotypes, and biochemical traits. Collecting to fill conservation gaps in West and Central Africa. Update their database and make it accessible internally and externally. Conduct a survey of collection sites of wild coffee accessions in Côte d'Ivoire to allocate remaining in situ conserved species.
<p>CENTRO AGRONÓMICO TROPICAL DE INVESTIGACIÓN Y ENSEÑANZA (CATIE) COSTA RICA</p> <p>The CATIE Botanical Garden and germplasm collections were founded in 1947 at the Inter-American Institute for Cooperation on Agriculture in Turrialba, Costa Rica. In May 2004, CATIE placed its germplasm collections under the auspices of FAO and on October 2006 signed an Article 15 agreement with the Governing Body of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA), making the germplasm available for distribution globally for the diversification and improvement of the crops they conserve, which includes coffee.</p> <p>CATIE’s collection is focused on <i>C. arabica</i> and contains nearly 2,000 accessions.</p>	<ul style="list-style-type: none"> The trees are ageing—many are 50 – 60 years old. Thus, there is a backlog of replanting. The site where the majority of the coffee collections are held has poor drainage leading to waterlogging. They have lost quite a few of the trees in this location. During the last two years, the incidence of coffee leaf rust has increased, which has resulted in the loss of trees. After coffee leaf rust, the second most important disease is American leaf spot (<i>Mycena citricolor</i>; Ojo de gallo). There is no resistance to this. In some areas, this is more devastating than leaf rust. 	<ul style="list-style-type: none"> Relocate the collection to a location more suitable for <i>C. arabica</i>, and rationalize the collection to focus on conservation of unique material, minimizing undesired duplication. Molecular characterization of all of the accessions in the collections. Enhance use of collections for breeding for coffee leaf rust resistance, drought tolerance, heat adaptation, and cup quality with comprehensive accession-level information sharing by CATIE and users. Ensure stable annual funding for the routine maintenance of collections.

GENEBANKS	THREATS	TOP PRIORITIES OVER THE NEXT 10 YEARS
<p>‘FOFIFA KIANJAVATO COFFEE RESEARCH STATION (FOFIFA) MADAGASCAR</p> <p>The field genebank in Kianjavato was established in 1954 with the main aim of improving <i>C. canephora</i> (robusta coffee) through selection and making improved varieties available to coffee growers in the Southeast part of Madagascar.</p> <p>Today, it houses the largest collection of <i>Coffea</i> species endemic to Madagascar of any genebank.</p>	<ul style="list-style-type: none"> The biggest concern with this collection is the loss of genetic integrity caused by a method of replacing lost plants with trees propagated from open-pollinated seeds. Many of the species held in the FOFIFA collection are threatened by deforestation. New collecting expeditions are not possible for many of the accessions FOFIFA holds since the forests have disappeared. Another key threat is encroachment into the research station property by squatters, as well as mining rights being given for gold and precious stones in the area adjacent to the research station. 	<ul style="list-style-type: none"> A thorough examination of accession records for the currently planted trees should be undertaken to determine what percentage of the original population still remains in the field. There is a need to invest into documentation databases and global sharing of accession-level information on the collection to encourage greater use. The genebank currently has 44 species but Madagascar has 61 endemic species known in country, 59 are described and three are not. Thus, there is a need to collect and conserve an additional 17 species as a secure back up for the wild populations and to enable use.

The Role of the Crop Trust and World Coffee Research

The Crop Trust and World Coffee Research are now leading the creation of a secure, cost-effective and rational coffee conservation system, as envisioned by the Strategy.

For this system to be in place, and provide the necessary long-term funding to sustain it, Crop Trust and World Coffee Research are seeking to raise USD 25 million for the Crop Trust endowment fund. This will provide the annual USD 1 million needed to fund the coffee Origin Collections forever. The Crop Trust endowment fund was established ten years ago to support internationally important genebanks such as those managed by CGIAR in perpetuity. For the 'Origin Collections' to access this long-term support, there are two critical conditions they must meet: (1) raise their conservation standards to international levels; and (2) share their collections and data with the global community.

As our next step, the Crop Trust is working with CATIE to raise funds to upgrade their international collection and fund it in a sustainable manner over the long term. To support this effort, governments, producers, roasters, and consumers need to recognize they all have a responsibility towards this resource. That is why we are approaching key actors in public, private and multilateral organizations, inviting them – and you – to make sure the world can conserve the diversity of coffee, and in so doing, assure we have Coffee Forever.



CATIE's Coffee Collection

CATIE's International Coffee Collection conserves 11 different species of coffee, although 91% of the collection is focused on *C. arabica*, the most important cultivated species of coffee. Located in Turrialba, Costa Rica, on eight hectares of land, it has some 1,900 accessions from Ethiopia, Yemen, Kenya, Tanzania, Colombia, Brazil, Mexico, and other countries. It is the most important genebank for arabica coffee in the Western Hemisphere. All rust-resistant varieties in Central America can be traced back to it.

But the collection is aging and in need of support. More than two-thirds of its trees are 30-60 years old. Some 53 accessions have been lost due to old age, and pests and diseases.

The collection is located in climatic conditions and at an altitude not ideal for the performance or indeed survival of all the materials. Due to the diverse nature of the collection, it is also in need of a wide variety of

*In 2015, 800 wild accessions of *C. arabica* as well as other species and cultivars of *Coffea* were characterized at the molecular level by WCR. From these, 100 were selected as a "core collection", a subset representing the diversity of wild accessions. This core collection has been regenerated and duplicated at four sites in Costa Rica, El Salvador, and Rwanda. It is being made available to coffee breeders globally through World Coffee Research.*

cultivation practices (for example, cultivated and wild trees differ in their needs for shade, pruning, fertilizer, etc.).

Currently, only CATIE's genebank shares its coffee diversity globally. Furthermore, CATIE has developed a detailed plan to upgrade – and transplant to better locations – its collection. The estimated cost for this undertaking is USD 800,000 over four years.

The current backlog at CATIE is about 720 accessions that need to be urgently replanted, but at the normal rate of 30 accessions per year this would take 24 years



Dr. Sarada Krishnan of World Coffee Research (WCR) presents an overview of the ongoing collaborative efforts between the Crop Trust and WCR to develop a global crop conservation strategy for the world's coffee diversity at the Crop Trust's 2016 Pledging conference.



The Bigger Picture

Upgrading and funding the Origin Collections is the first of a number of steps in the building of a comprehensive global system for the conservation and use of coffee diversity in genebanks. Our Strategy recognizes three types of collections, with different roles and responsibilities:

ORIGIN COLLECTIONS

Ensure long term conservation of coffee genetic resources and have direct connection with users.

FOFIA KIANJAVATO COFFEE RESEARCH STATION, MADAGASCAR

CHOCHE FIELD GENE BANK, ETHIOPIAN BIODIVERSITY INSTITUTE

CENTRE NATIONAL DE LA RECHERCHE AGRONOMIQUE, IVORY COAST

CATIE, COSTA RICA

BREEDING COLLECTIONS

Committed to coffee breeding but maintain a collection as an integral part of their breeding programs.

COLOMBIAN NATIONAL RESEARCH CENTER OF COFFEE - CENICAFÉ

COFFEE RESEARCH INSTITUTE KENYA

INSTITUTO AGRONÔMICO DO PARANÁ, BRAZIL

OTHERS

USER COLLECTIONS

Botanical gardens or private collections would contribute to secure conservation through safety duplication and global sharing of information on accessions.

HACIENDA LA ESMERALDA, PANAMA

OTHERS

USERS

Coffee cuppers sample brews at a cupping session in Pasto, the capital of Colombia's Nariño Department. Photo: Neil Palmer





The Strategy also identified six high-priority actions to facilitate the transition from the current situation to a more effective and efficient global conservation system for coffee.

<p>1. Secure and stable funding for long-term conservation of the origin collections through the Crop Trust Endowment Fund.</p>	<p>The conservation of coffee diversity in genebanks is a long-term task. Only stable, predictable support such as that from an endowment fund can guarantee a global system of long-term conservation for a resource that is conserved in such a manner as coffee.</p>
<p>2. Upgrade facilities and capacity of origin and breeding collections.</p>	<p>Currently, many genebanks operate at a sub-optimal level with a high risk of loss of accessions, especially with the increased impact of climate change at the genebank sites. The development of a global initiative to assess the specific upgrade needs, determine the urgency of the actions required, and implement these upgrades with adequate resources is needed.</p>
<p>3. Develop and use an Access and Benefit Sharing system (ABS) that will facilitate germplasm exchange and use.</p>	<p>There is a general recognition that increased germplasm exchange and use of conserved germplasm is needed. The current constraint to exchange is the lack of a clear ABS mechanism. The establishment of a legally binding ABS regime for the 'origin collections' in congruence with the Nagoya Protocol and the ITPGRFA is a high priority for ensuring their long-term conservation, but negotiating a general framework for this ABS amongst all genebanks is also a high priority to facilitate overall germplasm conservation and exchange.</p>
<p>4. Establish a global platform for collaboration in coffee genetic resources conservation and use, including an information system.</p>	<p>There is a need to secure the resources to enhance the long term linking of collections and users for a secure global system. The establishment of the global platform for collaboration in coffee genetic resources conservation and use will be the priority.</p>
<p>5. Ensure the safety duplication of all conserved coffee genetic resources.</p>	<p>There is an urgent need to ensure the safety duplication of all conserved accessions. The role for cryopreservation or other complementary strategies needs to be explored globally through strategic research. In addition, efforts need to be made by individual collection holders to duplicate their accessions in additional field sites within and outside the country. Agreed international standards for safe transfers of coffee planting material and safety duplication for coffee genetic resources will be an important first step.</p>
<p>6. Enhance the complementarity of <i>ex situ</i> and <i>in situ</i> conservation activities.</p>	<p>Genebanks need to actively engage with <i>in situ</i> or protected area conservation. In some cases, species have disappeared from their original sites and the <i>ex situ</i> collections are the sole source of living materials. Efforts in reforestation or protection will be enhanced with the engagement of the expertise at and germplasm held by the genebanks.</p>



The Crop Trust Endowment Fund

SECURING STABLE FUNDING FOR CONSERVATION

Contributions made to the Crop Trust Endowment Fund by governments, industry, or individual donors are invested securely for the long term to generate interest that will be used on an annual basis. Thus, the support provided to genebanks comes solely from investment income earned, leaving the endowment itself untouched. Each year, a portion of the endowment fund's value is paid out to support basic operations to maintain and make available diversity held in key genebanks.

The basic conservation needs of the four key coffee collections are estimated to require around USD 1 million per year, based on the costing study of CATIE. This will require a USD 25 million contribution to the Crop Trust Endowment Fund. This will allow the Crop Trust to draw USD 1 million from the fund annually, at an average investment return of 4% per year, while also safeguarding the real value of the endowment against inflation.

The Crop Trust Endowment Fund can only support collections that meet the eligibility requirements of its Fund Disbursement Strategy. Some of the key eligibility criteria are that the accessions held in the collection are of global significance; that the genebanks are supportive of a rational, cost effective, and sustainable global system;

and that the accessions held are available to users upon request under an access and benefit sharing framework such as that of the International Treaty on Plant Genetic Resources for Food and Agriculture. Currently, only CATIE would meet all these eligibility criteria. Given the more international nature of the CNRA collection, especially the *C. canephora* accessions, it is possible that accessions in this Origin Collection could be made more readily available in the near future. Over time, it is hoped that the lack of availability of the accessions held in Ethiopia and Madagascar could be resolved, since it is the main issue affecting their eligibility for funding. The long-term target of the Crop Trust Endowment Fund is to cover the annual basic operational costs of all four collections.



THE GENE BANK OPERATIONS THAT THE CROP TRUST ENDOWMENT WOULD SUPPORT IN THE LONG-TERM ARE AS FOLLOWS:

COLLECTION ACQUISITION	Acquisition of germplasm through collecting activities.
PROPAGATION/ REGENERATION	All activities leading to the introduction of new materials in the collection, including quarantine. Nursery, grafting, seed propagation, clonal propagation, field establishment. Routine propagation for replacement of dead or injured trees.
FIELD MAINTENANCE	Pruning, fertilization, pest and disease control, harvesting of berries, rejuvenation, and composting. It also includes costs of field preparation and accession labeling.
MORPHOLOGICAL CHARACTERIZATION	Data collection of morphological characteristics of each accession.
MOLECULAR CHARACTERIZATION	Verification or identification of the materials using molecular techniques.
HEALTH TESTING	This activity involves the testing of plant health, often carried out upon acquisition or during regeneration process.
DISTRIBUTION	Sending accessions upon request (e.g., preparation, shipment, etc.), which includes propagation of the materials.
SAFETY DUPLICATION	Replication of the accessions in another field collection.
INFORMATION MANAGEMENT	This activity includes data entry, processing and management, including catalogue preparation and descriptor development. It also includes database management.
GENERAL MANAGEMENT	This includes management activities, genebank manager and administration time as well as office and administration expenses in supplies and services.
TRAINING/ CAPACITY DEVELOPMENT	Activities related to the training of staff carrying out any of the activities of the collection management.
RESEARCH	Evaluation, breeding or other research that add value to the collection.



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