# GPG2 Non-Plant Taxa Survey – Summary of Results

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**Prepared by Muris Korkaric and Fen Beed (IITA)**

## Background:

The GPG2 Project is about working together to make the CGIAR In-Trust collections an essential component of conservation and use systems and is a critical step towards gaining the credibility to ensure the long-term future, sustainability and competitiveness called for in the change process of the CGIAR and the global arena.

In November 2006, the World Bank approved funding for Phase II of the Collective Action for the Rehabilitation of Global Public Goods in the CGIAR Genetic Resources System or GPG2 in short. GPG2 is being implemented under the aegis of the CGIAR System-wide Genetic Resources Program, which involves combination of individual center action to an agreed agenda to, among other issues, secure the in-trust collections for the long term and facilitate their use. The principal implementing agency of GPG2 is Bioversity International of the CGIAR. In phase I, the emphasis was solely on plant genetic resources. GPG2 continues to place major emphasis on plant genetic resources, but also includes a component of non-plant taxa. In principle, all CGIAR centers dealing with genetic resources are participants of GPG2. IITA has been given the responsibility of coordinating the non-plant taxa component of GPG2 and is collaborating with international repositories.

The plan was to assemble, characterize, store and catalogue collections of non-plant taxa to facilitate regeneration and distribution under appropriate material transfer agreements. However, due to funding constraints, the GPG2 implementing agency restricted the non-plant taxa activity to "Survey of available microbial, fungal, insect and nematode collections, and analysis of the CGIAR's comparative advantage or otherwise for involvement in their management". The non-plant taxa activity has two sub-activities:

- Survey of collections within the System and in international repositories.
- Recommendations on options and policies for conserving the collections.

A survey was designed as follows:

| Questionnaire Section | | Content |
|---|---|---|
| Background information | - | Capturing basic contact details, organizations' governance and primary function |
| Collection | - | Scope, size (and change of size) of collection in number of specimens |
| Staffing | - | Number of staff, qualification, change of staffing, challenges |
| Funding | - | Core vs. project based funding, future outlook |
| Facilities | - | Adequacy of storing space and facilities, curation and preservation practices, technologies in collection characterization, preservation methods used, standards applies in preservation and documentation |
| Uses and users | - | Primary purpose and users of collection, specialist service provided |
| Accessibility | - | Proportion catalogued and web-accessible, policy on management of collections |
| Intellectual property rights | - | Intellectual property rights (IPRs) associated with objects in collection, policy on IPRs for non-commercial use |

Data have been collection during 2008 – 2009. The finalization of data collection was delayed due to a low response rate to survey requests. However, by the end of 2009, 52 surveys have been collected: 23 from CGIAR centres, 3 from CGIAR associated centre (AVRDC and ICIPE) and 26 from non-CGIAR collections (international repositories).

## Constraint

*There are several sources for bias in these data. More surveys were obtained from individuals who were connected to the project on a certain level (e.g. knew the project activity coordinator personally or are from the same centre) and not all existing collections are represented in the survey. The fact that most of the collections of the reporting units were expanding in size could reflect a bias in who responded i.e. only those responsible for active and growing collections might deem it appropriate to spend time entering data into the survey, presumably to gain recognition for their efforts and to safeguard funds for their future development.*

## Overview of non-plant taxa collections within the CGIAR

Scientists from different CGIAR centers are involved in collection, conservation and sustainable use of insects, mites, fungi, plant-associated microorganisms, viruses and nematodes. These collections are used in two main areas: i) crop health and productivity, where the collection support screening for resistance in breeding programs, pathogen diagnostics and the development of biological control ii) soil health, fertility and ecosystem resilience where collections e.g. support the development of bio-fertilizers.

The non-plant taxa held by the CGIAR are mainly linked to research activities rather than to provide a service. Unlike the plant genetic resource collection, the collection and preservation of non-plant taxa and their conservation is not coordinated and harmonized between centres.

Some collections are maintained long-term, whilst others are only kept for the lifetime of projects. In other cases, CGIAR centres have helped to create and maintain important collections through colleting activities, co-funding and capacity building. Often these collections are held by national partners or deposited in international repositories. All of these collections represent public goods which were generated by the CGIAR and should be recognized as such. However, this survey did not inventorize the collections now held outside the CGIAR. This information would be a valuable addition to the existing inventory created through this survey and would give a clearer picture of the CGIAR's work on collating non-crop genetic resources.

The following list gives an overview of the available non-plant taxa collections per CGIAR centre

## Non plant taxa collections at CGIAR centers

(Collections marked with (•) provided a complete survey, while the collections marked with (-) provided some information during email correspondence but did not take the survey. Abbreviations: L = living, NL = not living, C = catalogued, A = available).

## CIAT - Centro Internacional de Agricultura Tropical

| | Unit / Program / Info | Location | Taxa | Number of specimens |
|---|---|---|---|---|
| • | Collection of rhizobium strains for tropical forage legumes and common bean | Colombia | Bacteria (Rhizobia)<br>Fungi (mycorrhizae) | 5651 (L, C)<br>1204 |
| - | Agrobiodiversity unit | Colombia | Arthropods | >20,000 |
| - | The Tropical Soil Biology and Fertility Institute (*CIAT-TSBF*) | Nairobi, Kenya | Bacteria | ~500 |

## CIMMYT - The International Maize and Wheat Improvement Center

| | Unit / Program / Info | Location | Taxa | Number of specimens |
|---|---|---|---|---|
| • | Global Wheat Program | Mexico | Fungi (wheat pathogens, rust) | 360 (L, C) |
| - | Soil Borne Pathogen program | Turkey | Fungi (Crown Rot)<br>Nematodes (Cereal Cyst Nematodes) | 12<br>10 |

## CIP - International Potato Center

| | Unit / Program / Info | Location | Taxa | Number of specimens |
|---|---|---|---|---|
| • | The 3 working collections, maintained by 3 different staff groups. | Lima, Peru | Insects:<br><br>Oomycete:<br>*Phytophthora infestans*<br><br>Bacteria:<br>Phytopathogenic<br>Beneficial<br><br>Nematodes:<br>Entomopathogen<br><br>viruses/viroid :<br>Virus<br>Viroid<br>Phytoplasma | No living ("museum") 500 (400 non identified)<br><br><br>1042 (L, C)<br><br><br>440 (L, C)<br>257 (L, C)<br><br><br>42 (L, C)<br><br><br>64 (L, C)<br>1 (L, C)<br>2 (L, C) |

## ICARDA - International Center for Agricultural Research in the Dry Areas

| | Unit / Program / Info | Location | Taxa | Number of specimens |
|---|---|---|---|---|
| • | Genetic Resources Section | Aleppo, Syria | Bacteria (Rhizobia) | 1853 (L, A, C) |
| • | IPM-BIGM Program | Aleppo, Syria | Fungi | 260 (L, C) |
| • | Pathology | Aleppo, Syria | Fungi | 400 (L, A) |
| - | Virology | Aleppo, Syria | Viruses (Food legume and cereal viruses) | ? |

## ICRISAT - International Crops Research Institute for the Semi-Arid Tropics

| | Unit / Program / Info | Location | Taxa | Number of specimens |
|---|---|---|---|---|
| • | Cereals Pathology | India | Fungi<br>Viruses | 8 (L, C)<br>2 (L, C) |

| | | | | | |
|---|---|---|---|---|---|
| • | Legumes Pathology | India | Fungi | 9 | (L, A) |
| • | Biocontrol unit | India | Bacteria | 17 | (L, A) |
| • | Entomology | India | Insects | 5025 | (25 L, C; 5000 NL, C) |

## IITA - International Institute of Tropical Agriculture

| Unit / Program / Info | | Location | Taxa | Number of specimens | |
|---|---|---|---|---|---|
| • | Biodiversity Centre | Cotonou, Benin | Insects | 360,000 | (NL, A, C) 2500 (L, A, C) |
| | | | Fungi | 901 | (L, A, C) |
| | | | Bacteria | 66 | (L, A, C) |
| | | | Viruses | 36 | (L, A, C) |
| | | | Living cells | 9 | (L, A, C) |
| • | Nematology unit | Cotonou, Benin | Fungi | 32 | 6 (L, A) + 26 (L, C) |
| | | | Bacteria | 1 | (L, A, C) |
| | | | Nematodes | 3 | (L, A, C) |
| • | Cereal-legume IPM | Cotonou, Benin | Insects | 15 | (L, A) |
| | | | Fungi | 6 | (L, A) |
| | | | Viruses | 3 | (L, A) |
| • | Pathology | Ibadan, Nigeria | Fungi | 11,000 | (L, A; 8000 L, C) |
| | | | Bacteria | 20 | (L, A, C) |
| • | Nematology unit | Ibadan, Nigeria | Nematodes | 7 | (L, A) |
| • | Pathology | Ibadan, Nigeria | Viruses | 21 | (L, C) |
| - | Soil Microbiology unit | Ibadan, Nigeria | Bacteria (Rhizobia) | ? | |
| • | Nematology unit | Namulonge, Uganda | Fungi | 7 | (L, A) |
| | | | Bacteria | 2 | (L, A) |
| | | | Nematodes | 50 | (10 L, A; 40 slides) |
| • | Biocontrol | Namulonge, Uganda | Fungi | 100 | (L, C) |
| | | | Nematodes | 10 | (L, C) |

## ILRI - International Livestock Research Institute

| Unit / Program / Info | | Location | Taxa | Number of specimens |
|---|---|---|---|---|
| • | Biological services | Nairobi, Kenya | Living cells | 12420 |
| - | ILRI | ? | Bacteria (i.e. Rhizobia) | ? |
| | | | Insects | |

## IRRI - International Rice Research Institute

| Unit / Program / Info | | Location | Taxa | Number of specimens | |
|---|---|---|---|---|---|
| • | N2-fixing organisms collection | Philippines | Bacteria | 680 | (L, A) |
| | | | Blue-green algae | 167 | (L, A) |
| • | Plant Pathology Cluster | Philippines | Fungi | 738 | (L, A, C) |
| | | | Bacteria | 11961 | (L, A, C) |
| - | Arthropod collection | Philippines | Arthropods | ~90,000 | |

## Africa Rice Centre (WARDA)

| Unit / Program / Info | | Location | Taxa | Number of specimens | |
|---|---|---|---|---|---|
| • | Entomology unit | Cotonou, Benin | Insects | 30 boxes (NL, A) | |
| • | Plant Pathology | Cotonou, Benin | Fungi | 300 | (L, A, C) |
| | | | Bacteria | 350 | (L, A, C) |
| | | | Viruses | 400 | (living, catalogued) |

## Non plant taxa collections at CGIAR associated centers

### AVRDC - The World Vegetable Center

| Unit / Program / Info | Location | Taxa | Number of specimens |
|---|---|---|---|
| • Plant Pathology | Taiwan | Insects | 10 (L, A) |
| | | Fungi | 2200 (L, C) |
| | | Bacteria | 2500 (L, C) |
| | | Viruses | 18 (L, C) |

### ICIPE - African insect science for food and health

| Unit / Program / Info | Location | Taxa | Number of specimens |
|---|---|---|---|
| • Biosystematic Support Unit | Nairobi, Kenya | Insects | 30,000 (NL, A) |
| • Thrips IPM Program | Nairobi, Kenya | Insects (Thrips) | 2100 (NL, C) |

### Overview of international repositories

Several international repositories participated in the survey ranging from small research collections stored at universities, to biological resource centres with large numbers of accession and a broad range of services. Many of them hold collections important for food and agriculture. The largest of the surveyed collections is the U.S. National Fungus Collection within the U.S Dept. Agriculture (USDA) - Agricultural Research Service (ARS). This collection focuses on systematics of fungi important as biological control agents and plant pathogens and holds over 1 million specimens. Another example is the Collection of Microorganisms and Cell Cultures (Deutsche Sammlung von Mikroorganismen und Zellkulturen (DSMZ) in Germany, which is the most comprehensive Biological Resource Centre in Europe. It holds more than 18,000 microorganisms, 1,200 plant viruses, 600 human and animal cell lines and 770 plant cell cultures. The main mission is to serve biotechnology. The international repositories that participated in this survey are listed below.

**International repositories:**
Collections marked with an asterisk provided information but did not complete the survey.

- BPI: U.S. National Fungus Collections - USDA Agricultural Research Service (ARS)
- Royal Botanic Gardens Kew; UK
- U.S. National Parasite Collection – Dept. Agriculture - ARS
- CABI - Centre for Agriculture and Biosciences International, UK*
- CIRAD - Umr CBGP, France*
- Swedish university of agricultural sciences, Department of ecology
- Plant Pathology Herbarium - New South Wales Department of Primary Industries, Australia
- CCUG - Culture Collection, University of Goteborg, Sahlgrenska University Hospital, Sweden
- ARC - Plant Protection Research Institute; Agricultural Research Council of S.A, South Africa
- Nematology Laboratory, US Department of Agriculture
- BIOTEC - National Center for Genetic Engineering and Biotechnology, Thailand
- BCCM/LMG Bacteria Collection - Gent University, Belgium
- DSMZ: German Collection of Microorganisms and Cell Cultures
- FCUG: Fungal Cultures University of Goteborg, Botanical Institute, Sweden
- USDA-ARS Biological Integrated Pest Management Research Unit - Collection of Entomopathogenic Fungal Cultures

- NCIMB: National Collections of Industrial Food and Marine Bacteria, UK
- NBIMCC: National Bank for Industrial Microorganisms and Cell Cultures, Bulgaria
- VTCC: Vietnam Type Culture Collection (VTCC), Vietnam National University
- CFBP: Collection Française de Bactéries Phytopathogenes, Institut National de la Recherche Agronomique (INRA)
- CARDI - Cambodian Agricultural Research and Development Institute - Plant Protection Division
- NCIM: National Collection of Industrial Microorganisms, National Chemical Laboratory (CSIR), France
- CCAP: Culture Collection of Algae and Protozoa, Scottish Association for Marine Science, UK*
- The Bacillus Genetic Stock Center (BGSC) The Ohio State University, USA
- USRCB - Odessa National University; Department of Genetics, Ukraine
- EMCC: Egypt Microbial Culture Collection (Cairo MIRCEN), Ain Shams University
- FCBP: First fungal culture bank of Pakistan, University of Punjab Lahore Pakistan
- MEAN: Micoteca da Estacao Agronomica Nacional, Estacao Agronomica Naciona, Portugall
- Institut de Recherche pour le Développement – UMR Génome and Développement des Plantes, France

Clearly the conservation and characterization of collections is costly and no collection can store all biodiversity. Even the largest collection registered at the World Data Centre for Microorganisms holds less than 2% of all strains held by all WFCC members in total. Collections tend to have a clear mission statement and acquisition of new material is restricted to the purpose for which they were established.

Permanent dialogue between culture collections is mediated via the likes of World Federation for Culture Collections (WFCC) and some regional networks such as the European Culture Collections Organisation (ECCO) or the Asian Network on Microbial Research (ANMR).

Semi-permanent cooperation exists through projects aiming at increasing networking and communication. Examples are GBRCN (Global Biological Resources Centres Network), EBRCN (European Biological Resources Centres Network), and EMbaRC (European Consortium of Microbial Resources Centres). Bilateral cooperation exists between collections for basic as well as applied research activities. But for international culture collections there is nothing comparable to the CGIAR structure in terms of scope of objectives.

A worldwide directory of currently 568 culture collections exists at the WDCM (World Data Centre for Microorganisms). Straininfo.net is a single portal interface which integrates data from 55 Biological Resource Centres (BRCs) into an integrated strain database.

## Survey data analysis – collection characteristics

In the following sections, a summary of findings from the survey data is provided.

### Collections size

CGIAR collections are mainly located in the tropics and sub-tropics while the large international repositories are located in developed countries e.g. in Europe and North America (Figure 1). The geographical scope of objects in CGIAR collections is mainly regional (50%) followed by worldwide (30%) and national (20%), while international repositories have a more global mandate and their scope of collections is mostly worldwide (60%).

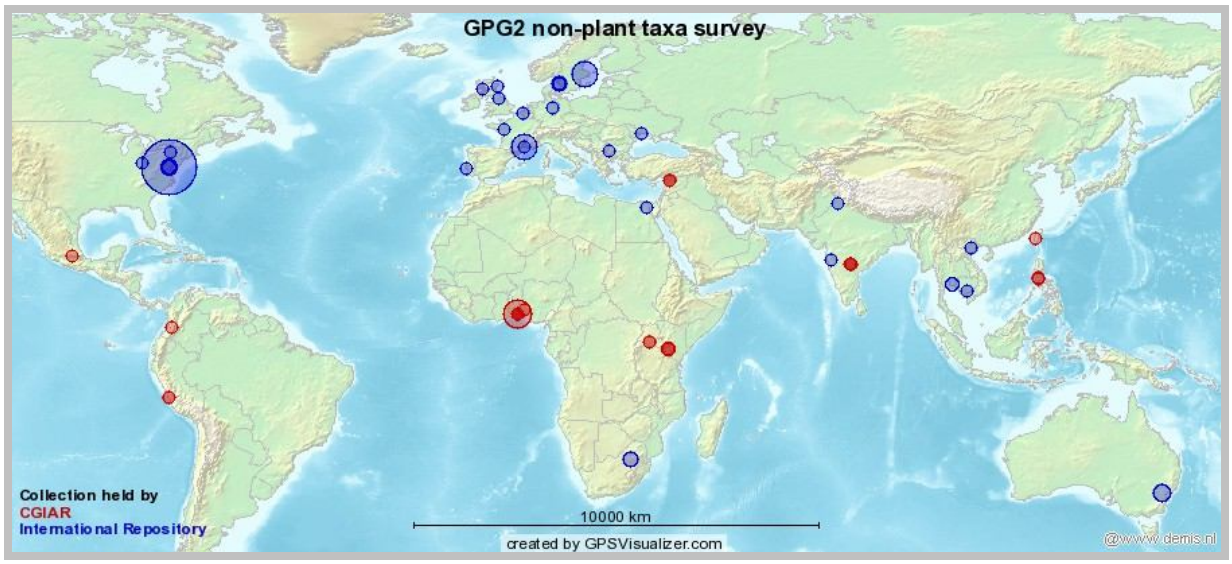


**Figure 1: Distribution map of surveyed Non-plant taxa Genetic Resource collections. (Red dots: CGIAR Collections, including ICIPE and AVRDC collections; blue dots: International repositories. The sizes of the dots are indicative for the relative size of the collection in terms of the number of specimens in the collection. Note that some collections are at the same location and dots are therefore overlapping. Map was created using GPS Visualizer (http://www.gpsvisualizer.com/)**

**Table 1. An overview of the size of the surveyed collections, the percentage of living specimens in the collection and the number of collections which hold one or more of the respective taxa; CG = CGIAR collections (n=26) and INT = International repositories (n=26)**

| Taxa | Number of specimens | | % living specimens | | Number of collections holding these taxa | |
|---|---|---|---|---|---|---|
| | CG | INT | CG | INT | CG | INT |
| Insects | ~ 420,000 | ~4 Million | > 0.6 | < 0.04 | 6 | 5 |
| Fungi | 17,228 | ~2 Million | 100 | > 3 | 14 | 17 |
| Bacteria | 23,245 | 156.534 | 100 | 85 | 12 | 15 |
| Viruses | 156 | 2.470 | 100 | 22 | 4 | 5 |
| Nematodes | 113 | ~573.838 | > 64 | < 0.01 | 5 | 5 |
| Living Cells | 12,429 | 906 | > 88 | 100 | 2 | 4 |
| Others | 167 | 516.752 | 100 | > 0.3 | 1 | 5 |

Most of the surveyed collections hold fungi and bacteria, followed by insects, nematodes, viruses and living cells. The research collections within the CGIAR are smaller in size and often hold fewer taxa compared to international repositories/service collections that tend to better integrate a more diverse group of taxa. However, the surveyed CGIAR collections hold a higher percentage of living specimens compared to the international repositories. However, it was not further indicated in which form the non-living specimens are stored (e.g. dried fungi, DNA etc.).

*Several respondents were from the same institute but managing discrete collections often of similar taxa but also of different taxa. Hence, there is scope for intra- and inter-institutions harmonization of collections.*

*One major concern is that the survey only records number of specimens per taxon but not the number of species or isolates. Further, the level of characterization and the biodiversity represented is not captured in the survey. It is therefore impossible to determine the commercial or ecological value of the collections. Function and use of objects is key to the value of a collection. There is also no information about duplication or uniqueness of holdings.*

Most of the collections were expanding in size since year 2000. This growth rate is expected to continue over the next 5 years. Multiple answers could be given to explain the processes which lead to either change or to steady state of collection sizes. Figure 2 shows that the main reasons for the described change in size of the collections was through collections that were made by research staff and students, changes in funding and staffing levels and collections which have been made by researchers from other institutions. Unlike international repositories, CGIAR collections rarely received or given away orphaned collections.

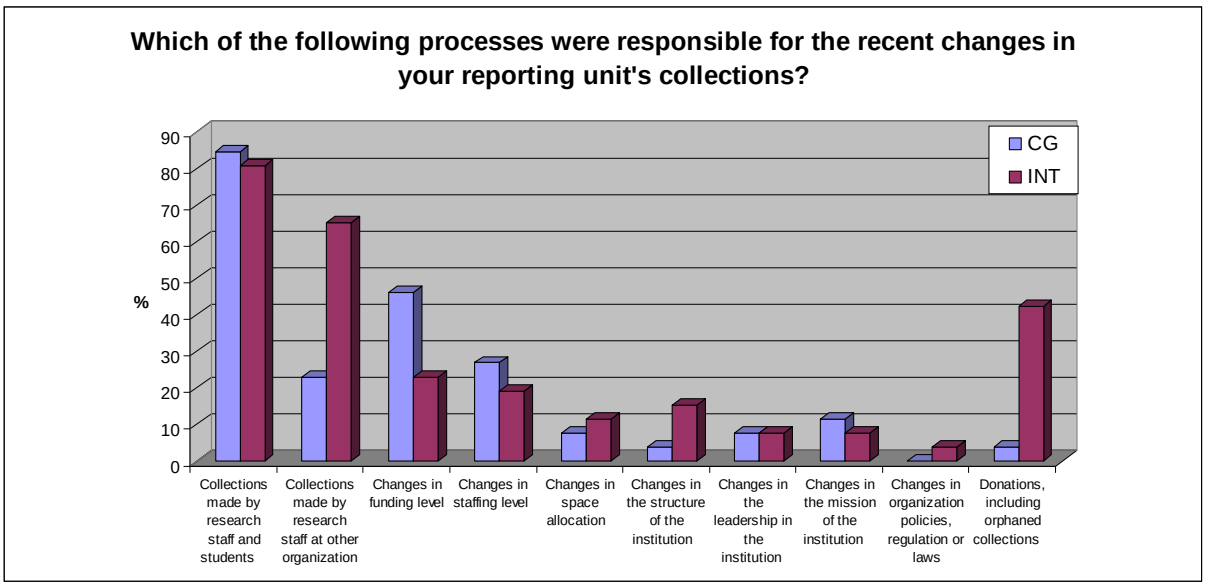


**Figure 2: Processes that were responsible for changes in collection size since 2000.**

## Funding

Significant costs are attached to the characterization and conservation of collections. The average cost for adding a bacterial culture that does not require special treatments for characterization or conservation in a large culture collection has been estimated to be US$ 250-300 by David Smith (WFCC).
However, significant investments in research can result in little long term scientific value if e.g. voucher specimens are not deposited. Follow-up research on erroneous results based on impure cultures can by far exceed the cost of maintaining accessions. The investment in collections might not show immediate effects, but should be considered as a valuable long-term investment with substantial scientific and socio-economic benefits, providing the accessions are used.

Financial constraints put collections at risk. For the surveyed collections with a reduction in size since year 2000 (n=3; 2 CG, 1 INT), the most frequent reasons were changes in staffing followed by changes in funding. This is even more alarming when reviewing the funding structure since 2000. Fifty-five percent of the CGIAR collections are supported through special projects, 15% are funded through both core and projects, and only 30% are core-funded. Almost half of all surveyed CG collections expect erosion or cuts of funding within the next 5 years, from which 23% of the CG collections expect significant funding cuts.

*The short-term nature of development focused project grants is contrary to the long-term commitments of a culture collection. This highlights the need to develop strategies for collections including investment plans to safeguard core collections.*

**Staffing**

Although the survey data show that the permanent staff associated with collections are on average academically less qualified compared to the staff in international repositories, they were generally capable of handling collection maintenance. Alarmingly, about half of all collections reported a decline in staff due to attrition and elimination of positions, and that staff numbers have been reduced through elimination of positions during the last 5 years. Despite this negative trend, the outlook is that most of the CG units expect to add new positions and will be able to fill vacancies as they arise. However, 5 collections warned that further losses in staff positions were forecast.
The biggest challenges related to the current and future staffing of collections were reported to be "retaining qualified staff members" followed by "providing training for basic collection activities".

*There has been a negative trend in the staffing of collections and retention of qualified staff. Collection survival is jeopardized if these negative trends continue.*

**Facilities**

Some units indicated that the space allocated to their collections was not adequate and that renovation of on-site storage facilities, installation and/or construction of higher-density on-site storage facilities was required. However, the majority of units reported that available building space was adequate and therefore that accessions in their collections are being preserved according to scientific standards.

*Not every collection has sufficient space to safely preserve collections. Action plans are needed to solve these issues and to safeguard these collections.*

**Curation and preservation**

The main objective of a collection is the safe long-term conservation of authentic material (biological and genetic resources) for present and future use.

The majority of CGIAR collections are properly labeled, documented and catalogued, but some units (<10%) reported that a significant proportion of their collection was not appropriately cataloged due to sub-optimal availability of characterizing and preservation materials. While many accessions are available their scientific value is diminished by the quality of curation/preservation. Some collections need immediate attention to prevent the integrity of accessions from being lost. This is particularly alarming when it is realized that only a few collections are duplicated and backed-up elsewhere.

*Especially those collections that have unique holdings, but are unable to provide proper preservation, should seek to duplicate their collections. Insect collections cannot always be duplicated and it is recommended that modern technologies, like DNA barcoding, are employed to preserve genetic information in addition to digital images, morphological descriptions and associated ecological data.*

Experimental and biological data are most frequently used to characterize collections, followed by images. The least used methods are molecular sequencing and metabolic profiling (figure 3). These methods are much more advanced and nowadays are irreplaceable tools for applied research and

modern taxonomy which is combining morphological descriptions with molecular based phylogenies. The use of “meta-genomics” further allows access to wider range of microorganisms that are currently not culturable (>95% of all bacteria found in a soil sample can not be grown on artificial media). For meta-genomics DNA from microbe populations is directly isolated from environmental samples like the rhizosphere and can be subsequently screened for sequences of interest. Those sequences can be multiplied through the use of the polymerase chain reaction method and cloned into a genomic library which can then be screened for active biomolecules, e.g. nematocidal proteins.

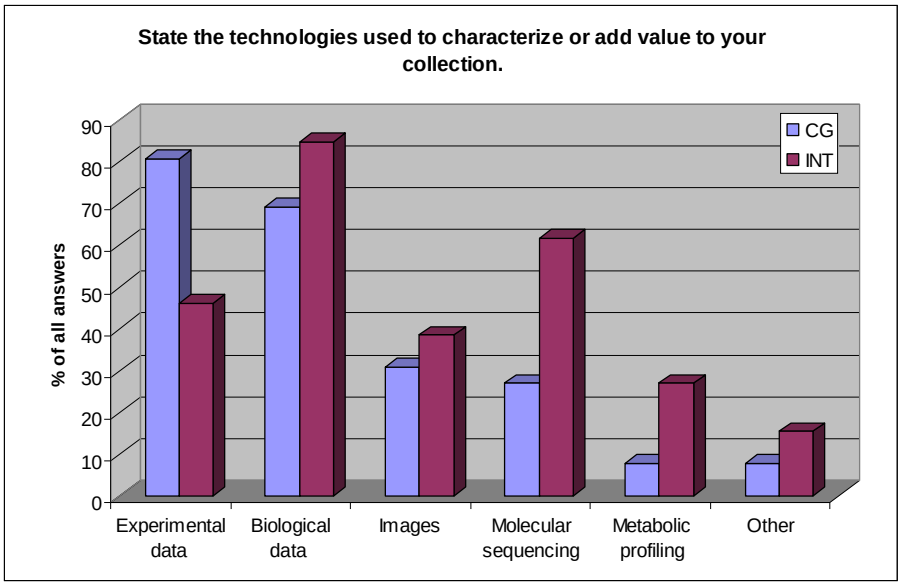


**Figure 3: Technologies used to characterize or add value to collections.**

*Centers should seek to apply more advanced methods of characterization. Especially the meta genomic approach (use of DNA sequence data) allows access to a much wider biodiversity and can relate to ecological function. Sequence data can be made web-accessible which would also increase the awareness of collections.*

Most collections of microbes use slants (60%), followed by cryopreservation (42%) and ampoules (33%). Herbaria are used for 28% and liquid culture for 14% of the CGIAR collections (figure 4). Slants are often used in working collections, but are not suitable for long term preservation. Sub-culturing is laborious and has the risk of genetic drift, instability and contamination. In contrast, international repositories store material predominantly by cryopreservation and lyophilization (freeze drying of cultures). Cryopreservation is the method of choice to safeguard long term storage. Lyophilization also allows for long term storage in ampoules as well as easy storage and distribution. Non-living insects are preserved in liquid (e.g. isopropanol, ethanol), dried stored or frozen. Nematodes can be kept alive in greenhouse populations or preserved dead as slide mounts, unmounted in fixatives in vials or frozen in liquid nitrogen.

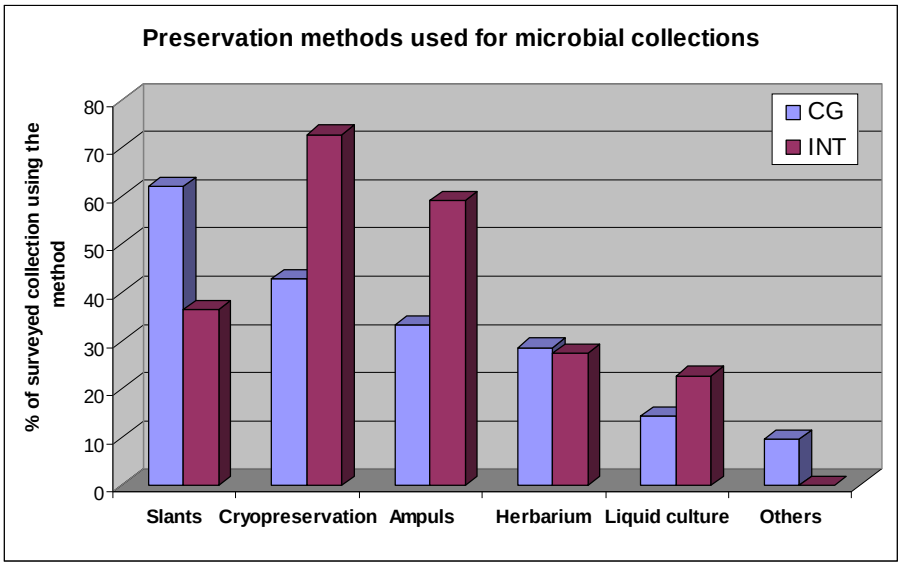


**Figure 4: Preservation methods used for microbial collections.**

*Centers should consider innovations in preservation technologies and as a minimum requirement develop plans to cryopreserve or lyophilize back ups of their core collections where possible.*

*A more detailed and comprehensive analysis is required to assess the efficacy of each preservation method per non plant taxa group to ensure the characteristics of organisms are maintained (i.e. to retain the function which justified their storage in the first instance e.g. pathogenicity, virulence, nutrient cycling etc.).*

The scientific community continuously develops standards for the curation and preservation of collections. The implementation of international recognized standards ensures the provision of authentic material to facilitate scientific research and to allow comparability of results across collections and countries. Organizations who can provide these guidelines or accredit collections are listed in the annex 1.

Only 12 out of 26 CGIAR collections indicated that they actively seek standards to apply to the preservation and documentation of their collection, but specific manuals or protocols were not specified.

From 26 surveyed international repositories, only 15 confirmed that they would seek standards to apply in the preservation and documentation of their collection. 5 stated that ISO standards were adhered to and of those 2 also mentioned that guidelines set out for Biological Resource Centres (BRC) were followed. 2 collections stated that in-house Standard Operating Procedures were used (SOPs) (Figure 5). Two collections did not specify standards used and others mentioned (as entered, unspecified) links to:

- CBS (Centraalbureau voor Schimmelcultures) instructions
- ATCC (American Type Culture Collection) and DSMZ (no specific manual mentioned)
- “Bergey's manual”
- “Current standards for microorganisms” (unspecified)
- Kew Herbarium Techniques Manual and others related to Fungi (unspecified)

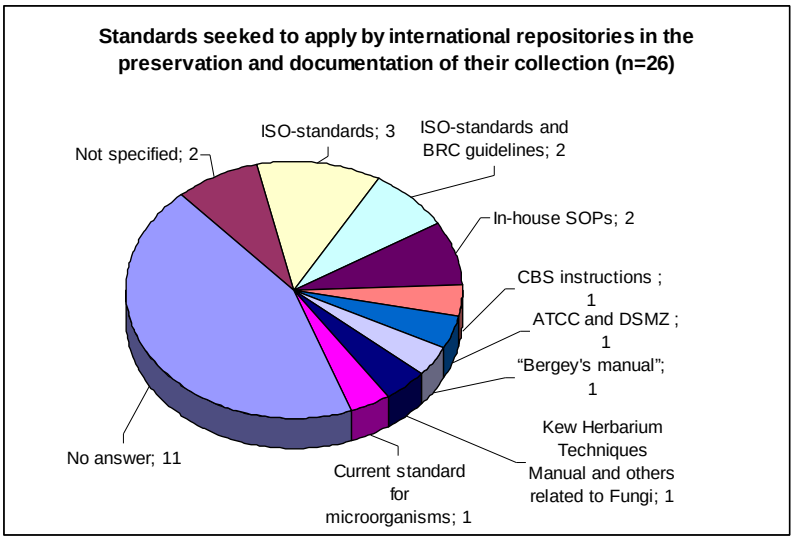


**Figure 5: Standards for preservation and documentation apply by international repositories (n=26)**

*International repositories easily out-compete CG collections in the use of advanced technologies for characterization and preservation and the implementation of quality management systems.*

*Collections can cooperate with projects like QBOL (Quarantine Barcoding of Life) who will provide opportunities for collections to be better characterized through barcoding of specimens and to increase their visibility.*

*There are several organizations and initiatives working together with collections to transfer knowledge and build capacity and who can be approached. Examples are the World Federation of Culture collections i.e. provides trainings for creating and maintaining microbial culture collections. The Belgian coordinated Collections of Micro-organisms (BCCM) are coordinated by a central team at the Belgian Federal Science Policy and experienced in supporting networking and capacity building with a historical focus on Central-Africa.*

## Use and clients

The primary purpose of both, the surveyed CG and the non-CG collections is for basic research (88%), followed by agriculture and food safety (61%), applied research in another disciplines (54%), education (46%), biomedical research (8%) and others (11%).

The type of specialist service provided by the CGIAR institution include long term preservation (70%), consultancy and best practice (58%) and identification (54%) (Figure 6). Unsurprisingly, data mining only features in 15% of collections because only a limited number of collections are accessible on the web and because of the lack of sequence data exist compared to the international repositories.

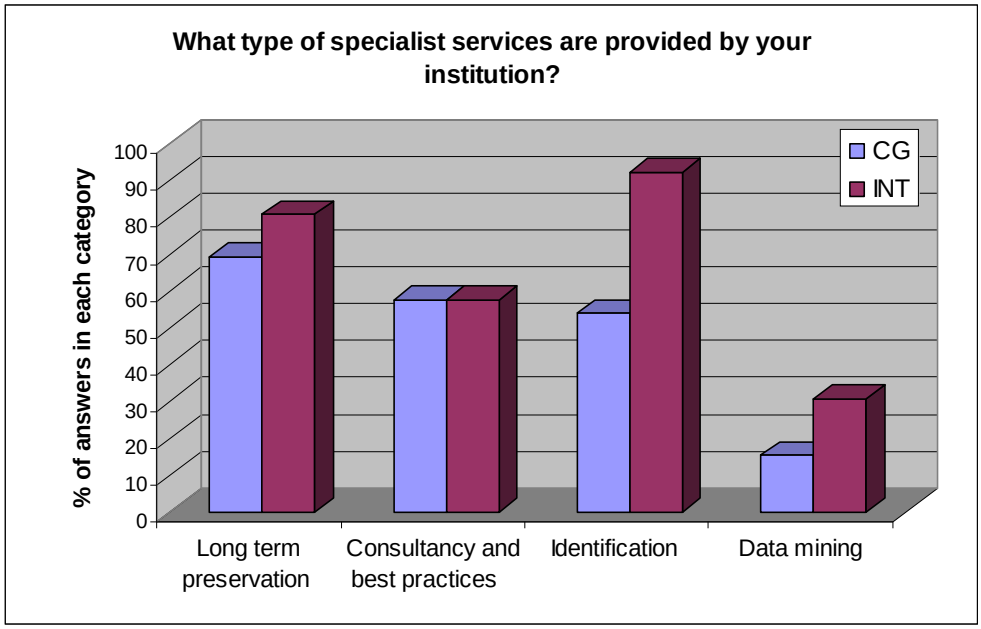


**Figure 6: Types of special services provided by the institutes hosting collections.**

*Providing special services not only increases the profile of an institution but also opens potential income streams. Data-mining tools accessing centralized stored sequence data can be used for commercial prospecting and to maximize the utilization of genetic material for research. Centres with significant holdings should be supported to increase their capacity to provide such services.*

The primary users of the CGIAR collections are intramural research staff (80%), national institutions and researchers and/or students from other countries (70%), researchers from non-profit organizations and intramural students (60%). Only 23% of the primary users are regulatory agencies and as little as 15% are commercial entities who in contrast account for 46% of the primary users of international repositories.

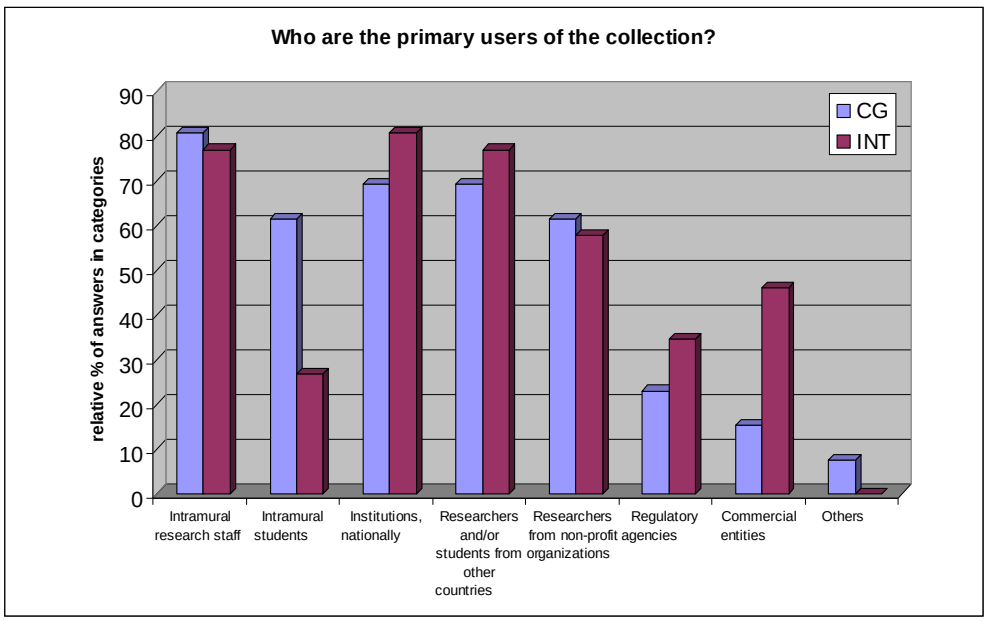


**Figure 7: Primary users of the surveyed CGIAR collections and international repositories**

Microbial and insect collections have a potentially wide range of commercial uses: Some beneficial microorganisms can be commercialized as biofertillizer, e.g. a formulation of Rhizobium inoculum for legumes. Worldwide, 140-170 million tons of nitrogen is fixed by microbes, estimated to be worth equivalent of US $90 billion.
Some other examples for the commercial use of microorganisms in agriculture are bioremediation agents, biopesticides and biological control agents, pathogens to develop diagnostic kits and microorganisms as producers of functional proteins (e.g. enzymes) biochemical compounds. Some insects and nematodes can also be used for biological pest control.

*The CGIAR has a comparative advantage because centres collect in under prospected regions which are not adequately served by others. Some collections might be unique and therefore interesting for commercial bioprospecting. However, selected CGIAR collections would first have to gain visibility (e.g. through a centralized database) and credibility (through working towards implementation of internationally recognized quality standards (OECD - Best practice guidelines, ISO standards, etc.).*

Although commercialization can be used in part to compensate operational costs of collections, CGIAR collections need to retain their goal of supporting agriculture in developing countries.

## Accessibility and documentation

The survey data show that the CGIAR collections are not fully catalogued. 12 of 26 collections have 50% or more of their collection catalogued, 14 are computerized, but only 2 CGIAR-collections have their catalogue computerized and their data accessible on the web.

Furthermore, collections do not apply international standards on documentation, such as recommended by CABRI (Common Access to Biological Resources and Information) guidelines and the OECD – best practice guidelines for BRCs).

*A CGIAR non-plant taxa database?*

*The global visibility of CGIAR non-plant taxa collections is very low. Only one collection was found to be registered in the World Data Centre for Microorganisms (WDCM). Only 2 collections have large parts of their collections catalogued and accessible online. In 1997 a database for the „N-fixing germplasm" within the CGIAR was developed in the framework of the System-wide Genetic Resources Programme SGRP Project "Development of a System-wide Microbial Genetic Resources Database" which was implemented by ICARDA. A database with passport data for almost 9,000 accessions with information on symbiotic effectiveness for about 15% of the accession was compiled and made available on digital media. The data base still exists but is neither web-enabled, nor updated. This is because the SGRP project on nitrogen-fixing organisms stopped and is a good example of how the survival of CGIAR collections is vulnerable to project dependence. A more durable solution would be for the CGIAR to support collections and the first step towards achieving this would be a centralized database of collections and their contents.*

*It is recommended that microbial collections register at the WDCM to increase their visibility.*

## Policies, Treaties and Agreements

During the 1980s, concerns about the global loss of biodiversity grew. In June 1992, the CBD (Convention on Biological Diversity), an international legally binding treaty was adopted and entered into force on 29 December 1993. Three main goals were established: the conservation of biological diversity; the sustainable use of its components; and the fair and equitable sharing of the benefits from the use of genetic resources.

Of special relevance for ex-situ genetic resource collections, is Article 15 stating that the CBD is [*Recognizing the sovereign rights of States over their natural resources, the authority to determine access to genetic resources rests with the national governments and is subject to national legislation*.]

Further [*Contracting Party shall endeavor to create conditions to facilitate access to genetic resources for environmentally sound uses by other Contracting Parties and not to impose restrictions that run counter to the objectives of this Convention.*]

The CBD recognizes national sovereignty over all genetic resources, access to valuable biological resources should be carried out on mutually agreed terms and be subject to the prior informed consent of the country of origin. If a genetic resource is commercially used, the country of origin has the right to benefit from its use. Such benefits are not only cash, but can also be samples of the collection, the participation or training of national researchers, the transfer of biotechnology equipment and know-how etc.

While the International Treaty on Plant Genetic Resources organizes the access to plant genetic resources and benefit sharing in a multilateral system, there is no such international legal framework regulating access and benefit sharing (ABS) for insects and microorganisms. However, guidelines have been developed to help collections, industry and governments to make decisions related to ABS.

- MOSAICC - (Micro-Organisms Sustainable use and Access regulation International Code of Conduct) is a voluntary tool to support the implementation of the Convention on Biological Diversity at the microbial level, in accordance with other relevant rules of international and national laws.

- The Bonn Guidelines ("Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising out of their Utilization") are voluntary guidelines to assist governments in the structuring of national and regional legislation and mechanisms to ensure fair access to genetic resources, and sharing of benefits from these resources.

Historically, material was informally exchanged between collections within the research community. Due to the increased economic importance of products deriving from genetic resources and the national ownership over these resources, the exchange became more formalized in recent years. Collections are expected to use acquisition agreements before acquiring material and MTAs (material transfer agreements) when distributing them.

The System-wide Genetic Resources Programme (SGRP) together with the CGIAR Genetic Resources Policy Committee developed i.e. MTAs for non-plant genetic materials (including micro-organisms, animals, and aquatic and marine material) and guidelines for acquisition and transfer of accessions (CGIAR Centre Policy Instruments, Guidelines and Statements on Genetic Resources, Biotechnology and Intellectual Property Rights - Version II).

Although these guidelines exit, only half of the responding CGIAR units stated that their unit's have a written policy regarding intellectual property rights (IPR) (e.g. through the use of MTAs) for non commercial use (Figure 8a). Other studies also found that the awareness on access and benefit sharing (ABS) issues is still very low.

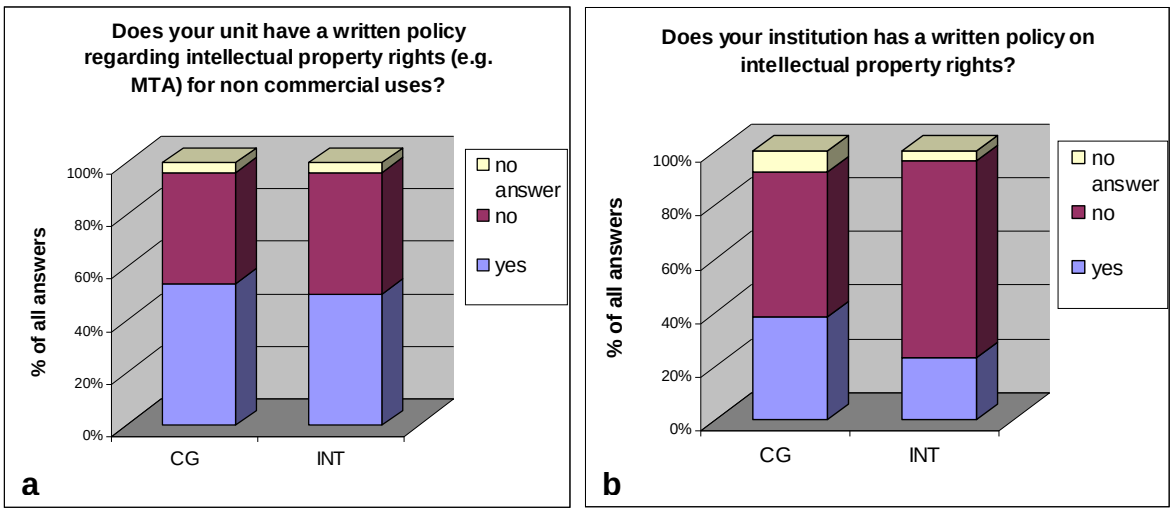


**Figure 8: Policy regarding IPR for non commercial use (a); Institutes policy on IPRs (b)**

Regarding IPRs, only 38% of the CGIAR respondents and 23% for the international repositories reported that their institutes have written policy on IPRs (Figure 8 b).

Collection managers were asked to what degree their unit asserts its ownership of intellectual property rights associated with objects in the collection. The answers from CG and non-CG units are similar and most units stated that users of material are free to publish their observations, but are expected to acknowledge the collection and country origin of material used in any publications.
Furthermore about 40% stated that users must provide copies of all the published material related to the collection. 30% of the CG and 50% from non-CG units don't want material derived from provided specimens to be lent to a third party. 26% indicated that other restrictions apply (Table 2). However, it is unclear if collections use written agreements to assert these points and if or how the compliance is regulated.

**Table 2: Ownership of intellectual property rights associated with objects in the surveyed collection.**

| | CG-collections | International repositories |
|---|---|---|
| All qualified visiting researchers, students, and borrowers of material are free to publish their observations | 65% | 70% |
| Users/borrowers of specimens must provide copies of all published material related to the collection | 42% | 38% |
| All uses of the collection must be acknowledged in publication. | 73% | 65% |
| Material derived from borrowed specimens (e.g., DNA extracts) may not be lent to a third party | 30% | 50% |
| Other restrictions apply to the use of intellectual property associated with the collection's specimens | 26% | 26% |
| Other | 4% | 8% |

*There is a need to inform CGIAR centres and collection managers about the existing access and benefit sharing (ABS) issues. Further the existing CGIAR policy instruments and guidelines need to be promoted*

*Informal exchange (e.g. without MTA) of material acquired after the coming into force of the CBD at the end of 1993 is potentially illegal. A detailed assessment of the country of origin and the time of acquisition and the terms under which the material in collections was acquired and deposited is needed.*

The CGIAR is one of the main producers of agricultural Global Public Goods (GPGs).

The idea behind GPGs is that problems that affect the public are increasingly of global scope (e.g. pests and diseases and climate change) and thus, solutions also need to traverse country borders. A public good is something the public depends on like knowledge, peace, and the absence of pathogens. Ideally, a GPG does not create rivalries (use of that good by some does not cause deleterious effects to others) and is non-excludable (it is impossible to prevent anyone from using that good). The concept of GPGs is linked to the concept of "common heritage of mankind", in which territorial areas and elements of humanity's common heritage (cultural and natural) should be held in trust for future generations and be protected from exploitation by individual nations or corporations.

Global Public Goods in agriculture

Plant genetic resources and associated knowledge are global public goods and the CGIAR centres are safeguarding over 650,000 samples of crop, forage and agroforestry genetic resources as trustees under the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGFA). However, CGIAR scientists also collect and preserve non-crop genetic resources relevant for food and

agriculture. These can be regarded as Global Public Goods. For example, control of invasive species is a global public good because it reduces the negative impacts of invasive species on ecosystems, biodiversity, health and economics.

*In the context of this report, the question is to ask whether the CGIAR is dedicated to manage their non-plant taxa genetic resources as research material, or as a global public goods, which implicates the need for increased visibility, secure long-term preservation, harmonized protocols for curation and preservation and policies to increase access to these resources.*

## Annex 1: Useful linkages:

### *Collection guidelines*

**OECD: Best practices guidelines for BRCs -** The most recent best practices for quality management, biosecurity, building capacity, preservation of biological resources and data management.
http://www.oecd.org/dataoecd/7/13/38777417.pdf

**The UKNCC Biological Resource: Properties, Maintenance and Management.** Provides all the information required to run a biological resource collection. Details techniques used for preservation and characterization of strains and lists the uses and properties of over 5000 micro-organisms. http://www.ukncc.co.uk

**Guidelines for Collection Quality Management Standards and Catalogue production** - CABRI (Common Access to Biological Resources and Information) guidelines.
http://www.cabri.org

**World federation for culture collections (WFCC) Guidelines for the establishment and operation of collections of cultures of microorganisms** - 2nd Edition, June 1999 Revised by the WFCC Executive Board.
http://www.cabri.org/guidelines/micro-organisms/M100Ap1.html

**ISO 9000.** ISO 9000 is a family of standards for quality management systems, maintained by the International Organization for Standardization and is administered by accreditation and certification bodies.
http://www.iso.org/iso/iso_catalogue.htm

**MINE** (Microbial Information Network for Europe). The MINE project developed standards (e.g. Minimal Data Sets) for information related to microorganisms. (Gams, W. et al. 1988. Structuring strain data for storage and retrieval of information on fungi and yeasts in MINE, the Microbial Information Network Europe. Journal of General Microbiology 134, 1667-1689)

**Collecting and preserving Insects and Mites -** Produced by the Agricultural Research Service of the United States Department of Agriculture
Can be accessed online
http://www.ars.usda.gov/SP2UserFiles/ad_hoc/12754100CollectingandPreservingInsectsandMites/collpres.pdf

**Collecting and Preserving. Nematodes - A Manual for Nematology** by. SAFRINET, the Southern African (SADC) LOOP of BioNET-INTERNATIONAL. Compiled by the National Collection of Nematodes Biosystematic Division; ARC – Plant Protection Research Institute Pretoria, South Africa.
http://www.spc.int/pps/SAFRINET/nem-scr.pdf

### *Barcoding*

**CBOL** (Consortium for the Barcode of Life). CBOL is an international initiative devoted to developing DNA barcoding as a global standard for the identification of biological species.
http://www.barcoding.si.edu/

**QBOL** (Quarantine Barcoding of Life). QBOL is a project financed by the 7th Framework Program of the European Union that makes collections harboring plant-pathogenic quarantine organisms available. Informative genes from selected species on the EU Directive and EPPO lists are DNA barcoded from vouchered specimens. In the next 3 year the sequences, together with taxonomic features, will be included in an internet-based database system.
http://www.qbol.org/UK/

### *Databases, federations and information networks*

**WFCC** – (World Federation of Culture Collections). The WFCC is a Multidisciplinary Commission of the International Union of Biological Sciences (IUBS) and a Federation within the International Union of Microbiological Societies (IUMS). The WFCC is concerned with the collection, authentication, maintenance and distribution of cultures of microorganisms and cultured cells. Its aim is to promote and support the establishment of culture collections and related services, to provide liaison and set up an information network between the collections and their users, to organize workshops and conferences, publications and newsletters and work to ensure the long term perpetuation of important collections. http://www.wfcc.info

**WDCM** – (World Data Centre for Microorganisms). The WDCM is a comprehensive worldwide directory of culture collections and holdings, and links to databases on microorganisms, biodiversity, molecular biology and genome projects.
www.wdcm.nig.ac.jp

**ECCO** – (European Culture Collection Organisation). The aim of the organisation is to promote collaboration and exchange of ideas and information about all aspects of culture collection activity.
http://www.eccosite.org

**UKNCC** – (United Kingdom National Culture Collection). The UKNCC co-ordinates the activities, marketing and research of the UK national service collections, with links to strain databases and affiliated collections.
www.ukncc.co.uk/

**MIRCEN** – (UNESCO Microbial Resource Centers). Global network in environmental, applied microbiological and biotechnological research.
http://www.biotech.kth.se/iobb/mircen/activities.htm

**GBRCN** – (Global Biological Resource Centre Network). The aim of the GBRCN is to publicize the benefit of micro-organisms. Provides publicity accreditation quality and authenticity and alleviates bioterrorism suspicion.
http://www.gbrcn.org/

**EMbaRC -** (European Consortium of Microbial Resources Centres). EMbaRC aims at harmonizing the systems for conserving and identifying bacteria and microscopic fungi in the different European countries and also at developing DNA banks and reinforcing biosafety. The goal is also to preserve and valorize microbiological biodiversity.
http://www.embarc.eu/

**Straininfo.net -** The StrainInfo.net Bioportal currently integrates data from 55 Biological Resource Centres (BRCs) into an integrated strain database. A single portal interface, with direct pointers to the relevant information at the collections' websites, and provides both historical traces and geographic distribution of the strains they keep in culture. In addition, this information is automatically linked to related sequences in the public domain and refers to all known scientific publications that deal with the organism.
www.straininfo.net

### *Access and benefit sharing*

**CBD** – (Convention on Biological Diversity). Website of the Convention on Biological Diversity.
www.biodiv.org

**MOSAICC -** (Micro-Organisms Sustainable use and Access regulation International Code of Conduct). MOSAICC is a voluntary Code of Conduct, a tool to support the implementation of the Convention on Biological Diversity at the microbial level, in accordance with other relevant rules of international and national laws.
http://bccm.belspo.be/projects/mosaicc/

**Bonn Guidelines**: The "Bonn Guidelines on Access to Genetic Resources and Fair and Equitable Sharing of the Benefits Arising out of their Utilization" are voluntary guidelines to assist governments in the structuring of national and regional legislation and mechanisms to ensure fair access to genetic resources, and sharing of benefits from these resources.
http://www.cbd.int/abs/bonn.shtml