

IITA Genebank Review 2014

Programme: Genebanks CRP	
Genebank reviewed: IITA	Site visit Dates: 24 Mar 2014 - 28 Mar 2014
	Review report Date: 14 May 2014
	Center and Crop Trust responses: 29 Sep 2014
Place: Ibadan, Nigeria	
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RESEARCH
PROGRAM FOR
Managing and
Sustaining Crop
Collections



IITA 2014 Genebank Review: Recommendations and responses

Theme	Recommendation	Responses by IITA	Responses by Crop Trust
1. Human Resource Development	Regarding the provision of external training, the Review Panel believes that a more structured approach to the delivery of training would enable the GRC to better plan staff work commitments and maximize opportunities of income generation. The RP recommends that the GRC develops curricula for two or three, paid short courses and advertises the availability of such training.	We welcome this recommendation. We are happy to develop curricula for training courses in key areas of GRC activities and to advertise these. Further details, along with a proposed budget are given in the Recommendation Action Plan (RAP) Proposal. GRC is committed to be a strong partner for national programs and this includes provision of training courses. Also note that this recommendation is very much in line with the direction of IITA in general and we will work closely with the Capacity Development Office of IITA to successfully develop and carry out these courses.	The Crop Trust supports the recommendation and the response, a clear alignment of opinions, and recognizes that IITA has a special role in this regard due to the capacity needs of the region.
2. Risk Management and QMS	An independent consultant should be appointed to assist the GRC to finalise and implement a QMS and Monitoring and Evaluation System for the seed bank(s) and the in vitro bank operations. This should be achieved within the next year. The QMS of the centre's Germplasm Health Unit (GHU) should be taken into consideration given its pivotal role in the use of the collection.	We welcome the opportunity to gain the advice and input of a consultant with respect to finalising and implementing a QMS system for GRC operations and we will plan to achieve this within a year as described in the RAP. We also note the need for this consultant to focus on the Germplasm Health Unit particularly in areas there is a flow of germplasm and information between GRC and GHU and a need for the QMS approaches in the two Units to be working in harmony. We are happy that the Review Team recognised the considerable progress that has been made in GRC with regard to QMS and that interactions with the consultant should result in a high level QMS system operating at an appropriate level for an international genebank.	The Crop Trust is fully supportive of both recommendation and response and recognises IITA's keen attention to strengthening QMS and the progress that it has already made. Janny van Beem, Crop Trust consultant, will be working directly with IITA staff to work further on the QMS.
3. Germplasm	So as to enhance the utility of the	This recommendation is very welcome and strongly	The Crop Trust supports the

Theme	Recommendation	Responses by IITA	Responses by Crop Trust
Enhancement (Pre-breeding)	genebank, the GRC should strengthen partnerships with respective mandate crop breeding teams to develop intermediate materials – for eventual integration into breeding programs – by hybridizing germplasm accessions that contain desirable traits with breeding lines.	supported. We are already working to develop closer relations with breeding programs, particularly within IITA. We firmly intend to continue and develop this strategy in the context of a changing scenario with respect to CRPs. One focus is on the use of crop wild relatives and we anticipate progress in this area within the next year for some of our mandate crops. Further details are given in the RAP.	recommendation and response. This work should be a focus for the genebank’s research agenda within the Commodity CRPs. There is no precedent for receiving financial support from the Genebanks CRP to support pre-breeding.
4. In vitro conservation and cryopreservation	A full value-for-money assessment for the purchase, installation and running of a liquid nitrogen production plant by GRC should be prepared urgently for review and discussion by IITA management and the Trust.	The support of the Review Team for the full implementation of cryopreservation in cassava and yam is greatly appreciated. We will implement the recommendation, including a survey of liquid nitrogen users inside and outside IITA and discuss the outcome of this analysis both with IITA management and the Trust.	The Crop Trust supports both the recommendation and the response. A fully thought-out assessment is important for such a long-term and unique facility and we appreciate IITA’s approach and the full involvement of IITA management.
5. Seed banks	The RP recommends that the appropriateness of the plastic containers used in Medium Term Storage (MTS) and other possible risks to seed viability loss are assessed and, where necessary, addressed. In addition, the RP recommends a business plan is developed and implemented for the increased rate of plant regeneration so that the percentage of accessions deemed of ‘acceptable viability’ is increased substantially over the next few years.	The comments of the Review Team when they visited the seed bank were much appreciated. We will fully implement this Recommendation. As described in the RAP this will include an experimental component (e.g. assessment of different container types) as well as measures to ensure increased viability in medium term store and increased rate of regeneration in the field. For the latter, a plan of how this will be achieved will be developed and discussed with the Trust.	The Crop Trust supports both recommendation and response
6.1 Safety	IITA should, as a matter of urgency,	We fully accept this Recommendation and are	The Crop Trust supports the

Theme	Recommendation	Responses by IITA	Responses by Crop Trust
Duplication	safety duplicate all its germplasm accessions in the next 2 years.	developing plans for it to be achieved for our seed crops. As detailed in the RAP this will entail transfers to CIAT for legume germplasm and CIMMYT for maize as well further duplication of seed crops at the Global Seed Vault Svalbard. However, it should be noted that the Trust definition of safety duplication for clonal crops entails cryopreservation firstly at GRC with duplication also in cryopreservation at another site. Therefore achievement of this objective is dependent on establishment of routine cryopreservation of yam and cassava in GRC.	recommendation and IITA response for seed crops. We also agree with IITA's response regarding clonal crops; safety duplication of clonal crops will be a long-term project.
6.2 Support to NARES	IITA should inventory the extent of overlap between its germplasm collections and those of its catchment area National Agricultural Research and Extension System (NARES). Following this benchmarking, the centre should as a matter of urgency, acquire and safeguard all unique materials in such NARES that are not already conserved by IITA.	We already work closely with NARS and we are happy to develop the inventory called for in this Recommendation. We will also identify any unique germplasm of IITA mandate crops which is being held in national genebanks of the region and initiate negotiations to acquire this material.	The Crop Trust recognizes that this is an important and ongoing activity. However, it is easier said than done to identify really unique materials in NARES in the region and then to produce enough healthy seed for safety duplication. A lot of work and resources have been devoted to this as part of the Gates-funded regeneration work. There was very limited success in the WCA region, materials were frequently found to be neither unique, nor well documented nor in healthy state. While this doubles the importance of this kind of initiative, it may be more appropriate to pursue joint collecting trips with NARES. In either case, building on the partnership with NARES is essential.
7.1 Characterisation of Germplasm	The GRC should complete as a matter of urgency the characterization of all its germplasm accessions based on internationally agreed upon descriptor	Most of our germplasm accessions are characterised and we will move quickly to complete this task where there are gaps or new additions. The recruitment of a Database Manager will help with ensuring that this	The Crop Trust support both recommendation and response and keenly supports the uploading of data to GeneSys asap.

Theme	Recommendation	Responses by IITA	Responses by Crop Trust
	lists and input the data into a publicly searchable database	information is well collated and comprehensively made available to the international community.	
7.2 Evaluation of Germplasm	The GRC should partner with mandate crop breeding teams to evaluate its germplasm collection for traits that are aligned with breeding objectives in order to develop trait-specific sub-sets	This Recommendation is very much in line with the direction that GRC is moving in. We are already developing close partnerships with breeding programs in IITA and we will continue with this to make sure that germplasm accessions become more attractive to breeders. We also plan to develop trait specific subsets based on FIGS or similar approaches.	The Crop Trust supports both recommendation and response. As with R#3, close collaboration between GRC and colleagues in breeding programmes is essential to ensure that trials are appropriately designed and targeted. This kind of close collaboration was very evident at IITA.
8.1.Germplasm Health Unit (GHU): Relationship with NAQS	To enhance the confidence in the exchange of germplasm, IITA should take responsibility to encourage the national authorities to build up their own capacity to carry out the requisite assays independently. A first step may be the physical presence of NAQS personnel within GHU to carry out these analyses.	<p>Working closely with respective NPPOs, GHU has been successful in exchanging germplasm annually to about 40 to 45 countries. IITA has established good strategy to handle exchange requests and also reserves the right to refuse exchange of germplasm when the requested material is not suitable for exchange.</p> <p><i>NPPO capacity strengthening:</i> We fully agree with this requirement. There is a great need to improve NPPO capacities especially in sub-Saharan Africa. To this effect IITA has been making some efforts: conducting various activities to improve the capacity of NPPOs through specific training courses, workshops, awareness rising and knowledge sharing, equipping labs and collaborative research to enable learning by doing. NPPOs in the following countries have benefited from such programs: Benin, Cameroon, Ghana, Kenya, Mozambique, Nigeria, Tanzania, Zambia and other. Through IAPSC IITA is also involved in advocacy and policy related issues to strengthen NPPO capacities in SSA. IITA will continue to pursue every opportunity to strengthen capacity. However, much greater efforts and engagement of broad range of partners is quite essential to address this recalcitrant</p>	In our opinion, this subject demands more in depth assessment and discussion. IITA has a tremendous amount of experience and knowledge of the capacity of NPPOs in the region and its efforts in building capacity are fully acknowledged. However, building the capacity of the woefully inadequate NPPOs to a level that would enhance confidence in the exchange of germplasm internationally has to be the responsibility of a number of national, regional and international agencies, and not IITA alone. This topic will be the focus of a session at the Annual Genebanks Meeting and we hope that we may incite discussion and action on phytosanitary issues more widely.

Theme	Recommendation	Responses by IITA	Responses by Crop Trust
		<p>problem.</p> <p><i>Physical presence of NAQS personnel within GHU to carry out these analyses:</i> Earlier requests for a similar arrangement by IITA were rejected by NAQS. Moreover, it is our opinion that this arrangement may not add additional value for the following reasons: (i) NAQS, as a regulator, are involved in carrying out inspections as per their mandate; (ii) when necessary, NAQS staff gain access to IITA/GHU labs; and (iii) NAQS post-entry quarantine station is based within Ibadan</p>	
<p>8.2 GHU: Research and Development Capacity</p>	<p>Given the lack of confidence in Nigerian Quarantine, IITA needs to explore other methods to ensure confidence in the international dissemination of germplasm from IITA. The research and development capability of GHU should be strengthened through greater emphasis on cutting edge research for the identification of diseases causative agents and pests and the development of appropriate diagnostic tools to meet international standards or the standards of key recipient such as Colombia.</p>	<p>We agree that conditions in the country matters, however, several other factors also influence the importing country's decision to accept germplasm. To our knowledge no importer ever cited '<i>lack of confidence in Nigerian quarantine</i>' as a reason for not accepting material from IITA/Nigeria.</p> <p><i>Strengthen GHU research capability:</i> We welcome this suggestion. It is necessary to strengthen GHU capability (especially replacement of worn-out equipment) to enable application of contemporary diagnostics, comply with QMS, and develop diagnostics reagents (e.g. antibodies) for internal use and also for sharing with partners, increase number of staff to increase turnaround time, and improve staff skills. This requires substantial funding, which is a major challenge.</p>	<p>The reviewers are recommending that IITA, as an international centre, puts measures in place to ensure that there is confidence worldwide that materials disseminated from IITA will be of no quarantine risk. The Crop Trust supports this recommendation. We also agree with the response that substantial funding will be needed to address the recommendation. This subject of ensuring phytosanitary measures reach appropriate standards and are adequately resourced should be addressed in the wider group of CGIAR genebanks and GHUs.</p>
<p>9 Distribution of germplasm to CRP and other end users</p>	<p>GRC management and breeders should identify which breeders lines and materials are of strategic importance and should be considered for conservation as part of the genebank</p>	<p>We welcome this suggestion and will work together with breeders to implement it.</p>	<p>The Crop Trust supports the recommendation and response and requests that IITA puts together a timeline to implement this recommendation, together with the responses to other</p>

Theme	Recommendation	Responses by IITA	Responses by Crop Trust
	'costed' collection		recommendations as part of the RAP.

External Review of the IITA Genetic Resources Centre Commissioned by the Global Crop Diversity Trust

Hugh W. Pritchard¹ and Chikelu Mba²

May 2014



Image courtesy of IITA



Genetic Resources Centre

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Abbreviations and acronyms

CGIAR	Consultative Group on International Agricultural Research
CIAT	International Centre for Tropical Agriculture (Spanish acronym)
CIMMYT	International Centre for the Improvement of Maize and Wheat (Spanish acronym)
CPD	Continuing professional development
CRP	CGIAR Research Program
GHU	Germplasm Health Unit
GPG2	The Collective Action for the Rehabilitation of Global Public Goods in the CGIAR Genetic Resources System – Phase 2
GRC	IITA's Genetic Resources Centre
IITA	International Institute of Tropical Agriculture
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
LTS	Long term storage
MTS	Medium term storage
NAQS	National Agricultural Quarantine Service
NARES	National Agriculture Research Extension Systems
NACGRAB	National Centre for Genetic Resources and Biotechnology
RP	Review Panel (as commissioned by the Trust)
QMS	Quality management system
SMTA	Standard Material Transfer Agreement
Trust	Global Crop Diversity Trust

Executive Summary

The Consultative Group on International Agricultural Research (CGIAR) includes 11 genebanks in its CGIAR Research Programme (CRP) for Managing and Sustaining Crop Collections. Responsibility for the genebank CRP resides with the Global Crop Diversity Trust (the Trust), which commissioned (see TOR, **Annex 1**) the Review Panel (RP), comprising Hugh W. Pritchard and Chikelu Mba (**Annex 2**), to assess the efficiency and effectiveness of the Genetic Resources Centre (GRC) operation at the International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria, for the conservation and use of the long-term *ex situ* collections. These 'costed' collections are the focus of an agreement between the Trust and IITA signed in December 2007.

Prior to visiting the gene bank at IITA the RP requested end-user feedback on the collections through an on-line survey, comprising 13 questions (**Annex 6**). During the visit, the RP members held discussions with researchers at IITA who were using the yam, cassava, cowpea and maize collections in their plant breeding programmes; and held two phone conversations with staff CGIAR of two CGIAR centres, the International Maize and Wheat Improvement Centre (CIMMYT), Mexico and the International Centre for Tropical Agriculture (CIAT), Cali, Colombia.

Overall, the Review Panel spent five working days at IITA (24-28 March 2014; **Annex 3**) specifically reviewing the:

- 1) operations and activities of the GRC;
- 2) roles, services and use of the gene bank, and the linkages with users and partners both within and outside the CGIAR;
- 3) status of the seed, *in vitro* and field gene banks;
- 4) outcomes or impact specific to the provision of the long-term grant;
- 5) future plans for the strategic scientific development of the Centre.

Out of the full staff complement (**Annex 4**), the RP met a high proportion of the GRC staff during a series of tours, discussions, demonstrations and short lectures that revealed how the seed and vegetatively-propagated crops were handled at the Centre (**Annex 5**).

The RP welcomed the high level of preparation by the GRC staff – who provided numerous hand outs and explained many techniques - and the leadership roles of the GRC's knowledgeable head and deputy head, particularly their empowering style of management and support for continuing professional development (CPD). Beyond the recommendations, the RP notes the overall highly effective and efficient operation of the GRC in many areas. In addition to the scheduling of meetings and the general support, the arrangements for touring the facilities at IITA, the field site at Ikenne and the National Centre for Genetic Resources and Biotechnology (NACGRAB) institute were excellent. Finally, the RP recognise the positive interaction with three members of the Trust (Charlotte Lusty, Amanda Dobson and Cristian Moreno), prior to and during the visit.

The RP decided on 12 actionable recommendations relating to the strategic direction, functionality and effectiveness of the GRC's scientific and gene bank work.

Aims of this review

This review aims to assess the efficiency and effectiveness of the genebank operation as a whole, and the status of the IITA GRC within the context of the global system for the conservation and use of the crops in question, i.e., cassava, yam, banana, cowpea, maize miscellaneous legumes.

The terms of reference of the review included the following elements (**Annex 1**):

- Assess the operations and activities of the genebank;
- Assess the roles, services and use of the genebank, and the linkages with users and partners both within and outside the CGIAR;
- Consider the status of the genebank or individual collections within it, in the context of a global system for long-term conservation and use of the crop(s) in question;
- Assess any outcomes or impact specific to the provision of the long-term grant;
- Provide actionable recommendations related to all of the above.

Review methodology

A Review Panel (RP) consisted of two scientists with expertise in the fields of: biotechnology aspects of the genetic resources of Africa; gene bank management, seed storage, in vitro- and cryopreservation; research collaboration and research management; use of plant genetic resources for food and agriculture; and crop improvement (**Annex 2**). With active support from the Trust and the GRC, the RP studied a large number of documents and considered replies to a survey sent to end users (**Annex 6**). A review visit to the GRC facilities was made from 24-28 March 2014 (**Annex 3**) to meet many of the GRC staff (**Annex 4**). Staff led tours of the facilities (including field sites), provided handouts and made short presentations on all aspects of germplasm handling (**Annex 5**).

During the review visit the panel was accompanied by two Trust staff members, Charlotte Lusty and Amanda Dobson; Cristian Moreno provided support at the Trust.

On the final afternoon of the visit the preliminary conclusions were presented to senior management of IITA and then to the GRC staff.

The report was drafted, checked for factual accuracy and sent to the Trust, who checked for consistency and clarity. Thereafter, the Trust submitted the report to the GRC, IITA and solicited a response. These responses are provided in this report.

Background to IITA and the GRC



IITA was created in 1967 as a non-profit organisation. It is the lead research partner facilitating agricultural solutions for hunger and poverty in the tropics; conducting research that provides solutions to nourish Africa (<http://www.iita.org/>). IITA works with partners in the

private and public sector to enhance crop quality and productivity, reduce producer and consumer risks and promote sustainable livelihoods from agriculture.

IITA is a member of the CGIAR Consortium – a global research partner for a food secure future. IITA's research is organised around four core competencies:

- 1) genetic improvement and biotechnology – improving key tropical foods, including banana and plantain, maize, cassava, soybean, cowpea, yam and tree crops;
- 2) plant production and health – developing ecologically sustainable, economically profitable, and socially acceptable solutions for pest, pathogen and weed control and climate change constraints;
- 3) natural resource management – sustainable intensification of farming systems;
- 4) social science and agribusiness – through gender responsive research, looking at poverty reduction strategies and policy frameworks.

IITA is involved in three themes and seven CGIAR Research Programs (CRPs):

Plant production and plant health

1. **Maize:** MAIZE - Global Alliance for Improving Food Security and the Livelihoods of the Resource-poor in the Developing World.
2. **Grain Legumes:** Leveraging legumes to combat poverty, hunger, malnutrition and environmental degradation

Social science and agribusiness

3. **Policies, Institutions and Markets:** Policies, institutions and markets to strengthen food security and incomes for the rural poor
4. **Agriculture for Nutrition and Health:** Agriculture for improved nutrition and health.

Natural Resource Management

5. **Humidtropics:** Integrated systems for the humid tropics
6. **Water, Land and Ecosystems:** Water, Land and Ecosystems: Improved Natural Resources Management for Food Security and Livelihoods
7. **Climate Change, Agriculture and Food Security:** Climate Change, Agriculture and Food Security

IITA has four regional hubs across sub-Saharan Africa (Fig. 1), located in Dar es Salaam (E. Africa), Lusaka (Southern Africa), Kinshasa (Central Africa) and Ibadan (Western Africa), the site of the IITA headquarters and the Genetic Resources Centre (GRC).

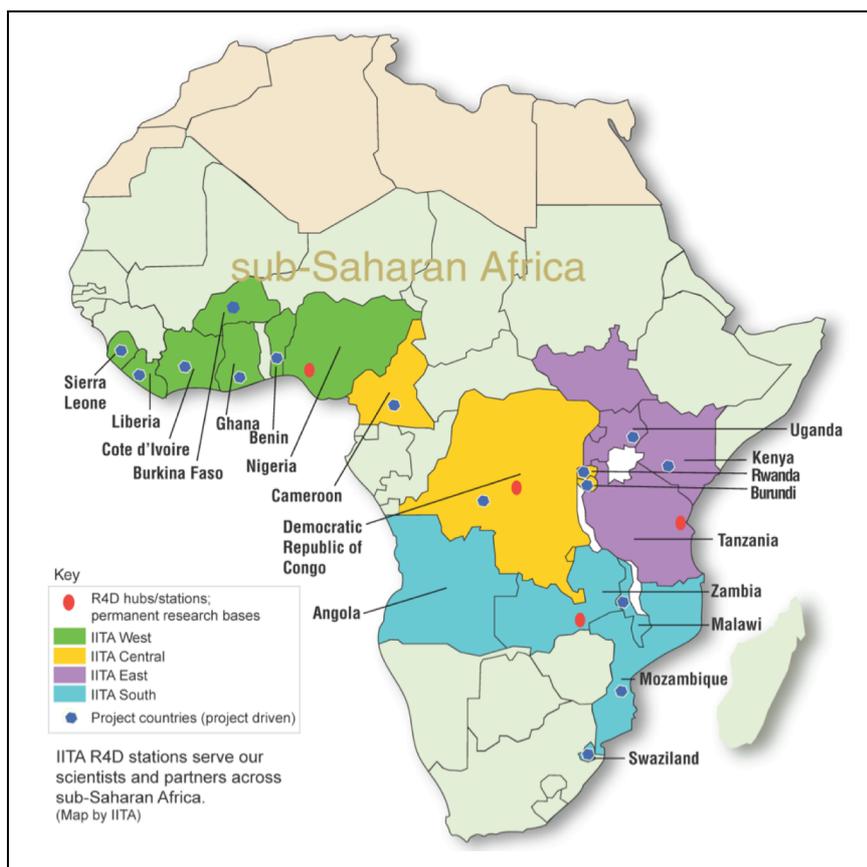


Figure 1. Where IITA operates including four regional hubs in sub-Saharan Africa (courtesy of IITA).

The GRC conserves > 30,000 accessions in its seed bank, *in vitro* bank and field gene bank (Table 1). These accessions are maintained under an agreement with the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA) of the Food and Agriculture Organization of the United Nations (FAO). As part of this agreement, IITA has agreed (a) not to claim legal ownership over the designated germplasm, nor seek any intellectual property rights over germplasm or related information, (b) to manage and administer the designated germplasm in accordance with internationally accepted standards, including ensuring the material is duplicated for safety, and (c) to make small quantities of germplasm and related information freely available for the purpose of scientific research, plant breeding or genetic resource conservation, under a standard Material Transfer Agreement that is used by the CGIAR for all in-trust materials.

In 2012 a CGIAR Research Programme (CRP) for the management of the CG genebanks was approved with the objective to “conserve the diversity of plant genetic resources in CGIAR-held collections and to make this diversity available to breeders and researchers in a manner that meets high international scientific standards, is cost efficient, is secure, reliable and sustainable over the long-term and is supportive of and consistent with the ITPGRFA”. The Trust has accepted the role of managing the funding of CGIAR genebanks.

This review of the GRC, IITA, was undertaken in the context of the monitoring mechanism of both the CRP and the long-term agreement between the Trust and IITA.

Table 1: Accessions in the 'costed' collections of the GRC, IITA in 2013.

Crop	Accessions per facility		
	Seed bank*	<i>In vitro</i> bank	Field gene bank
Cassava		2161	2740
Yam	-	1231	3801
Cocoyam	-	25	-
Banana	-	231	247
Cowpea	13808 LTS; 13913 MTS	-	-
Maize	1468 LTS; 1561 MTS	-	-
Miscellaneous legumes	4207 LTS; 6623 MTS	-	-

*LTS: long term store at -18°C; MTS: medium term store at 5°C.

Review of GRC

(A) General observations

The Review Panel (RP) concluded that the GRC operates three very good gene banks for: seed; *in vitro* material; and plants in the field (Figure 2). Visits to the GRC facilities indicated a well-organised, clean and effective operation. The gene bank documentation is handled with precision, using inventory software. The data are published on the web in an accessible web-site, which is being upgraded. The RP was impressed by the new web site layout and its capability to communicate a broad range of information products (the accessions information, blogs / feeds, publications, etc.).

Another area where the RP was very impressed was the obvious commitment, dedication and enthusiasm of the gene bank's staff and the excellent working relationships with the management team at the GRC. Communications between genebank management and staff are regular and seemed open and effective. As a team, the GRC supports the wider goals of IITA through hosting school children visits, providing tours to VIPs, etc.

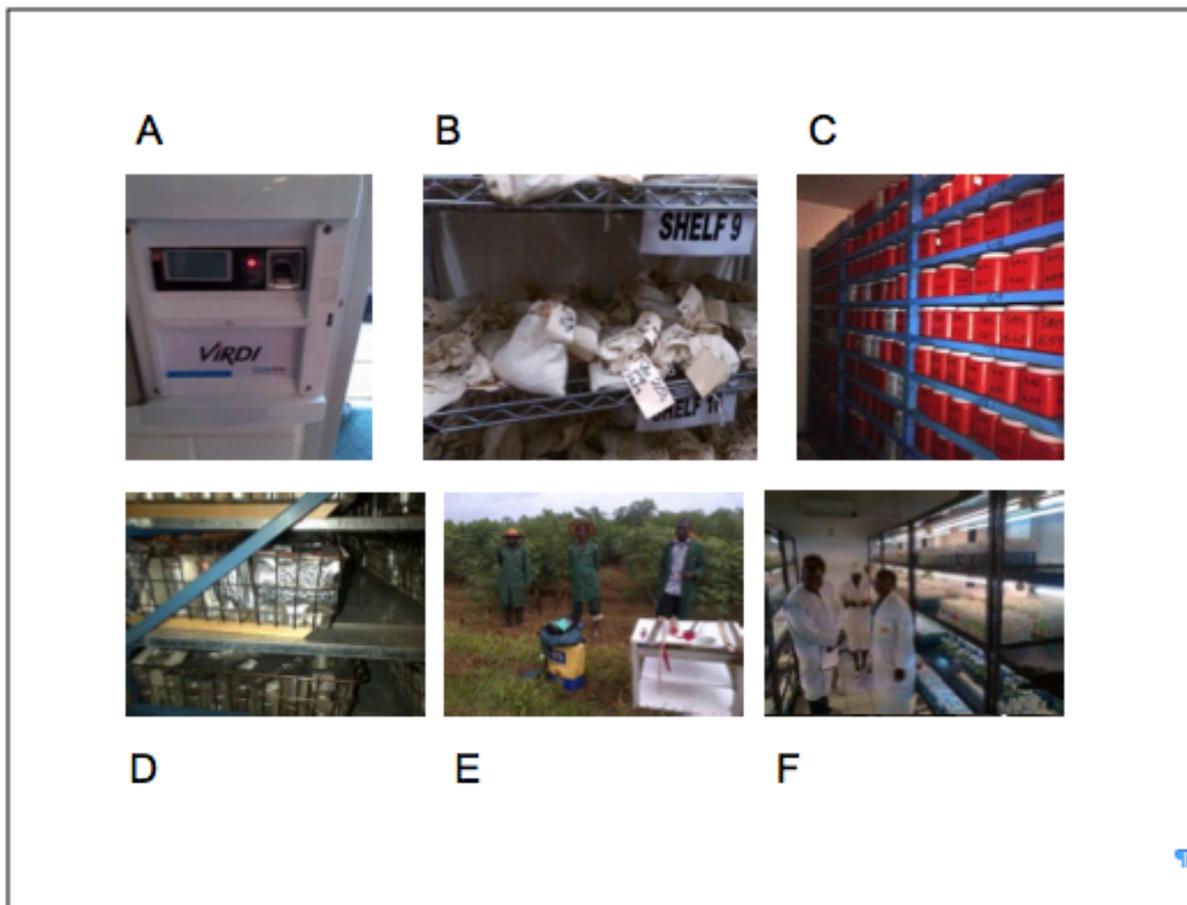


Figure 2: Fingerprint security system for the GRC building (A), the dry room at 17°C, 15% RH (B), the medium term store (MTS) at 5°C (C), the long term store (LTS) at -20°C (D), field staff responsible for growing cassava (E) and one of the tissue culture growth rooms (F).

In preparation for the review, the RP approached a range of end users of the GRC gene banks (Annex 6). Nine replies were received, from users in research institutes and universities. Eight out of nine respondents were of the opinion that the long-term

management and curation of the accessions met international standards; and two had safety duplicated materials at the GRC. Regarding data and documentation, two users noted an inability to access passport data through the internet GRC database. Eight out of nine respondents also confirmed having requested and received germplasm under SMTA, with the germplasm being used mainly for plant breeding; and one noted that 'ordering germplasm resources is very simple'. Two respondents had helped IITA extend crop gene pools and two had collaborated with the GRC on germplasm documentation and cryopreservation. Five users noted strong links with the GRC, on student projects, pollination research, etc. Overall, the replies were positive: 'I like to commend the supportive influence and diligence of the genebank staff' and 'on the whole, working with GRC has been a good experience.'

Finally, whilst many of the recommendations relate to the need for clearer strategies and business cases, the RP recognises that much planning work on the future direction of the GRC is in progress.

(B) Specific observations and recommendations

(1) Human resources development

The RP was impressed by the enthusiasm and professionalism of the GRC staff, which ensured that the tight schedule of visits ran closely to time. Presentations were delivered by staff in the laboratories and a field setting, supported by numerous handouts. Staff raised salient points and the discussion flowed freely, even on potentially contentious issues. Evidence emerged of numerous examples of a strong commitment to continuing staff development; for example, training received at Cornell University (for molecular biology) and at the University of Leuven (for cryobiology; with further skills training in cryo data inventory management anticipated in Japan). The RP commends the genebank management for their empowerment of staff and commitment to CPD.

Annual reports to the Trust show the commitment by staff to support student projects at the under-graduate and post-graduate level, particularly training in specialist techniques; for example, plant tissue culture, quarantine assessments and the weaning of *in vitro* plants into pots. Training by GRC staff has also been delivered in other countries; for example in Guinea, on agronomy and controlled pollination of maize. The current schedule of training is mainly ad hoc, and responsive. The RP see opportunities to be more pro-active in this area, within the country and more widely across the region; engaging with the NARES, the quarantine service, NACGRAB, etc.

Recommendation 1: Regarding the provision of external training, the RP believes that a more structured approach to the delivery of training would enable the GRC to better plan staff work commitments and maximise opportunities of income generation. The RP recommends that the GRC develops curricula for two or three, paid short courses and advertises the availability of such training.

(2) Risk management and QMS

The quality control of the gene bank operations and quality assurance of the seed, *in vitro* and field accessions is fundamentally important to the successful functioning of the GRC. Some elements of these systems can be controlled by the GRC, but often the Centre is

reliant on underpinning by institutional policies (and their implementation). Recently IITA confirmed the position of a full time Safety Officer. Safety sub-committees are also in place, with the GRC sharing a sub-committee with Biosciences. Through its Risk Management Committee, IITA is upgrading its approach to risk management, introducing health screening for staff (of particular importance for field gene bank staff using pesticides) and conducting a Risk Management Survey across the institute. The GRC input to the survey has been forwarded to the Trust. The key elements of the findings were explained to the RP. Of paramount importance was the potential loss of the genetic resources from the gene banks. Fire alarms are linked directly to the Security Office and evacuation procedures are in place. However, there is no emergency plan in place to save the collections (i.e., which ones to save first) under various emergencies, such as flooding, conflict, etc. Another key concern is potential dramatic changes in funding status of the GRC, which should be mitigated through efforts to diversify the funding base.

The RP recognised that at the facility level, significant steps have been taken to secure the collections, such as: purchase of a back-up generator to guarantee the running of the cold stores; installation of a fingerprint system for entry to the building (NB an override to this system in the event of an emergency will be in place soon, which is of particular importance for visitors to the facility); the backing up of data on the IITA system each night.

Evidence was presented of SOPs for both the seed bank and *in vitro* gene bank operations and electronic recording of data is being implemented more widely to reduce transposition errors from hard copy records. Reassurance was also given that staff training records were kept up to date. However, it was agreed that improvements could be made in the formalisation of record keeping in a number of areas, which would enable the GRC to achieve QMS implementation and better monitoring and evaluation.

There are two special challenges that need QA/QC attention: the implementation in the next two years of a liquid nitrogen facility (see comments elsewhere in the report); and the current relationship with the Germplasm Health Unit. The distribution of materials from the gene banks is subject to the tight phytosanitary regulations and the independent acceptance of quality controls at GHU would better enable the transit of material across national boundaries.

Recommendation 2: An independent consultant should be appointed to assist the GRC to finalise and implement a QMS and Monitoring and Evaluation System for the seed bank(s) and the *in vitro* bank operations. This should be achieved within the next year. The QMS of the centre's Germplasm Health Unit (GHU) should be taken into consideration given its pivotal role in the use of the collection.

(3) Germplasm enhancement (pre-breeding)

IITA has traditionally strengthened capacity for the genetic improvement of its mandate crops in its catchment countries of sub-Saharan Africa. The probable single most critical component of this support mechanism has been the continuing provision of early generation breeding materials for trialling – and eventual release of improved varieties – by the counterpart plant breeders of the NARES. The farmers in these countries, more than ever, now require a suite of diverse improved hardy, high yielding, nutritious and input use-efficient crop varieties in order to attain the unprecedented increases in crop production required to avert the projected significant worsening of hunger and poverty as agricultural production

systems are imperilled by erratic extreme weather events, demographic and socioeconomic pressures and other drivers of food insecurity.

Generating these 'smart crop' varieties – that produce more yields with fewer inputs – will require some significant re-orientation of the plant breeding strategies of IITA mandate crops. This extends to gap analysis and acquisition of relevant, new genetic material. Clearly, the progeny of the same sets of 'safe bet' parents can neither be expected to break the seeming yield plateaus nor contain the preferred culinary traits for which farmers stick to their landraces. Significant base broadening of the parental lines is therefore called for. The IITA genebank is a unique repository of an imposing array of heritable diversity that can be leveraged towards the enhancement of the allelic diversity of crop varieties being released in countries. But, the harnessing of these latent potentials in the genebank goes beyond the remit of the conservation, characterization – and even, the evaluation – of the genebank accessions. It requires the identification of putative parents that contain desirable traits and crossing those with elite lines to generate intermediate materials that subsequent introduced into plant breeding. This is pre-breeding, the interface between germplasm conservation and plant breeding. These intermediate materials are notoriously unattractive to plant breeders on account of the required additional investments in time and resources to break linkage drags associated with unintended deleterious alleles. This gap between germplasm conservation and plant breeding must be bridged. CGIAR centers and other crop improvement entities are devising means for achieving this. The Seeds for Discovery project at CIMMYT, for instance, is a model worth studying; it is supported by funds that are distinct from the usual allotments to plant breeding and germplasm conservation.

The GRC and plant breeders are encouraged to seek additional dedicated resources for pre-breeding activities of the centre's mandate crops in order to discover novel sources of traits, and use them as in crosses with parental lines to generate intermediate materials for eventual integration into plant breeding. The extra investments would be worthwhile; the new elite varieties whose pedigrees are traceable directly to the gene bank represent the most eloquent justification for the investment of resources in safeguarding germplasm accessions. The new round of CRPs from 2017 is an opportunity to mainstream this paradigm.

Recommendation 3: So as to enhance the utility of the gene bank, the GRC should strengthen partnerships with respective mandate crop breeding teams to develop intermediate materials – for eventual integration into breeding programs – by hybridizing germplasm accessions that contain desirable traits with breeding lines.

(4) *In vitro* Conservation Unit and cryopreservation

Great progress has been made over the last 20 years in the development of nutrient media for the *in vitro* growth (and slow growth) of plant cells and tissues. This has enabled the wide scale application of *in vitro* technology to the conservation of clonal crops. At the GRC, c. 3600 accessions of IITA mandate crops (i.e., yam, cassava and banana/plantain) are maintained *in vitro* under slow growth conditions (mild osmotic stress, reduced light, 18°C). For each yam and cassava accession, five plantlets are kept *in vitro*; 10 for banana/plantain. The *in vitro* lab arrangement is impressive, logically laid out, with up to date equipment (e.g. six laminar flow cabinets), sufficient (five) growth rooms (running at either 18 or 28°C) and computer-generated bar-coded labels for the tissue culture vessels. Distribution of *in vitro* plantlets has been considerable; 2600 plantlets to 20 countries since 2012. Distribution of material to breeders is essentially funded by them. Innovations are ongoing, including the

introduction of silver nitrate to media to slow down plantlet growth and the development of temporary immersion system (TIS) to enhance the growth rate of plantlets. Challenges remain though, including the 'recalcitrant' response of yam to *in vitro* growth. The RP were pleased to learn of the forthcoming appointment of a post-doctoral scientist to advance knowledge in this area, as this is critical to the next stage of gene bank development for the clonal crops; the commitment of the *in vitro* collection to cryo-storage in liquid nitrogen vapour. Without reliable tissue culture methods, recovery of yam from cryo-store will be difficult. The case for adopting cryopreservation for the conservation of clonal crops was clearly stated in a consultant's report to the GRC in 2013. During the tour of the facilities the RP were informed that consideration is being given currently to purchase a liquid nitrogen production plant. Beyond the needs of the GRC, demand for liquid nitrogen is also anticipated by other groups (molecular, virology) at IITA. Whilst the case for adoption of cryopreservation for clonal crop conservation is scientifically sound, the financial case needs careful consideration. The financial case should include estimates for the cost of commercial production off site and delivery, operational costs (electricity, maintenance, etc.), a share cost model with other units at IITA, etc.

Recommendation 4: A full value-for-money assessment for the purchase, installation and running of a liquid nitrogen production plant by the GRC should be prepared urgently for review and discussion by IITA management and the Trust.

(5) Seed banks (medium term and long term storage)

The number of seed bank accessions at the GRC is extensive, and comprises the following materials in the Multi-Lateral System of the ITPGRFA, under long-term storage conditions: 13808 accessions of cowpea; 4207 of miscellaneous legumes; and 1468 accessions of maize. In total, this amounts to > 19000 seed accessions held under international gene bank conditions. The procedures for seed accession handling were demonstrated to the RP, including: 'pure' seed regeneration in the field; screen house assessment for diseases (backed up by the GHU); threshing, cleaning and a conformity check against the reference collection; drying (15% RH, 17°C) to c. 8% moisture content (checked by a calibrated AgriPro moisture analyser); enclosure under vacuum in heat sealable foil laminate bags; and transfer to the freezer. Germination testing is similar to the International Seed Testing Association guidelines for normal seedling production. The whole process is tightly controlled in terms of inventory and final bar coding.

The broad objective is for all accessions to be of sufficient quantity and quality of seed to meet the conservation needs, including safety duplication (e.g., in international genebanks and in the Svalbard Seed Vault). To meet these objectives, a threshold number of high quality seed is required. Based on information in the 2013 reports, the GRC is holding about 22000 accessions in MTS, of which only c. 7000 are of acceptable viability (i.e. 32%). In contrast, about 60% of the LTS-held accessions are of acceptable viability.

The overall quality of seeds stored in the GRC needs improving and action the reasons for poor viability in MTS and to increase the rate of regeneration of seed lots, taking into account the current limitations of the screen houses (c. 2600 accessions regenerated per year).

Recommendation 5: The RP recommends that the appropriateness of the plastic containers used in MTS and other possible risks to seed viability are assessed and, where necessary, addressed. In addition, the RP recommends a business plan is developed and implemented for the increased rate of plant regeneration so that the percentage of accessions deemed of 'acceptable viability' is increased substantially over the next few years.

(6)

6.1. Safety duplication of germplasm accessions

Safety duplication of germplasm holdings is a critical element of the efficient conservation of plant genetic resources. Of the IITA mandate crops, only cowpea accessions have been fully safety duplicated with more than 90% of the collection being conserved in Svalbard. The extent of safety duplication of the germplasm accessions of the rest of the mandate crops range from 49% to 85%, thus:

- bananas. 51% of all *in vitro* samples at Katholic University, Leuven, Belgium
- cassava. 63% of all *in vitro* samples at the IITA station in Cotonou, Benin Republic
- maize. 49% of the materials in long-term storage at CIMMYT, Mexico
- miscellaneous legumes. 60% of materials under long-term storage at the University of Saskatoon, Canada and at Svalbard.

Whilst the balance of the materials to be safety duplicated represents a significant amount of work, urgent steps in this direction are required.

Recommendation 6.1: IITA should as a matter of urgency safety duplicate all its germplasm accessions in the next 2 years

6.2. Specific support to NARES for safety duplication of germplasm accessions

Most NARES of sub-Saharan Africa have, with the support of governments and other partners, conducted extensive germplasm collection expeditions, established gene banks with the accessions so collected and characterized the holdings to varying degrees. With the passage of time, the diversity of the holdings is being significantly eroded. Some commonly adduced reasons for this sub-optimal situation include inadequate human and material resources, civil strife and natural disasters. While these problems are hardly restricted to sub-Saharan Africa, their scales and frequencies in the sub-region imply a uniquely precarious outlook for the national genebanks and confer a particularly compelling custodial role on IITA.

While it is probable that some germplasm accessions in the national genebanks are safety duplicated in IITA, empirical evidence on the exact scope is absent. An inventory of the extent of duplication of national germplasm accessions at IITA is strongly recommended. This should be followed by a road map and the concomitant securing of the requisite resources to back up at IITA the accessions of its mandate crops held in national genebanks. IITA is uniquely placed to double as a regional genebank. Except for the SADC Plant Genetic Resources Centre in Lusaka, Zambia, there is no other regional genebank in sub-Saharan Africa.

Recommendation 6.2: IITA should inventory the extent of overlap between its germplasm collections and those of its catchment area NARES. Following this benchmarking, the centre

should as a matter of urgency, acquire and safeguard all unique materials in such NARES that are not already conserved by IITA.

(7) Characterisation and evaluation of accessions and availability of data

The significant efforts that have been invested in the management of the center gene bank have resulted in the near complete characterization of all germplasm accessions at IITA. Considering IITA's leadership role, one germplasm accession that has not been characterized is one too many. IITA is therefore encouraged to complete, as a matter of utmost urgency, the characterization of all its germplasm accessions and the provision of the data online. IITA gene bank must remain a de facto model, a status that the non-availability of the totality of this body of information detracts unnecessarily from. The ongoing recruitment of a database specialist is a most salutary development in this regard.

In a similar vein, IITA has begun the evaluation of the core collection of the germplasm holdings of its mandate crops for varied agronomic and yield traits. While some collaboration between the genebank and the plant breeders in this regard is evident – and deserving of commendation – these collaborations should transition to partnerships whereby the parameters to be assayed and the experimental designs are agreed upon and the data collected jointly by the two teams. This will ensure quality assurance, enhance ownership, render the ensuing data more reliable and lead to the development of trait-specific subsets which plant breeders will be most positively disposed to using. This is a win-win situation as the utility of germplasm accessions is demonstrated and the work of the plant breeder is enhanced significantly by this single intervention. There are a myriad of ongoing global efforts to transition to climate smart agriculture – that is underpinned by suitable crop varieties. The evaluation of the germplasm holdings, the provision of the associated data and the identification of subsets of collections that can be harnessed for breeding for traits that enhance the resilience of cropping systems are critical to success in this regard and underscore the critical importance of this activity.

Recommendation 7.1: The GRC should complete as a matter of urgency the characterization of all its germplasm accessions based on internationally agreed upon descriptor lists and input the data into a publicly searchable database.

Recommendation 7.2: The GRC should partner with mandate crop breeding teams to evaluate its germplasm collection for traits that are aligned with breeding objectives in order to develop trait-specific sub-sets.

(8) Germplasm Health Unit

The Germplasm Health Unit (GHU) of the institute, through certification and documentation; seed health testing and field inspection; collaboration in the production of clean planting materials; and research and development activities, facilitate the import and export of germplasm in support of IITA's work. The National Agricultural Quarantine Service (NAQS) of the host country is so poorly resourced that it is unable to carry out the most basic of the requisite plant protection assays prescribed by the International Plant Protection Commission and other relevant normative processes. To prevent a paralyzing styming of IITA's work, the GHU, thanks to the goodwill and sound reputation that IITA has built up, has over the years carried out these assays. With this arrangement, across border germplasm exchange has been smooth, especially within sub-Saharan Africa. However, the increasing difficulties with the transfer of IITA materials outside of the continent (cassava to Colombia)

is grievously impeding inter-centre collaborative activities on this crop and must be addressed.

Akin to the foregoing, the national authorities may not be relied upon to be equipped adequately to deal with the certainty of increasing multiplicity of the biotypes of trans-boundary disease causative agents. To continue to support IITA's work and uphold its reputation as a responsible partner, the research and development component of GHU's work should be increased. IITA is probably the most equipped to identify new variants of disease agents and pests of its mandate crops in the region. It is also the most equipped to develop the diagnostic testing kits.

Recommendation 8.1: To enhance the confidence in the exchange of germplasm, IITA should take responsibility to encourage the national authorities to build up their own capacity to carry out the requisite assays independently. A first step may be the physical presence of NAQS personnel within GHU to carry out these analyses.

Recommendation 8.2: Given the lack of confidence in Nigerian Quarantine, IITA needs to explore other methods to ensure confidence in the international dissemination of germplasm from IITA. The research and development capability of GHU should be strengthened through greater emphasis on cutting edge research for the identification of diseases causative agents and pests and the development of appropriate diagnostic tools to meet international standards or the standards of key recipient countries such as Colombia.

(9) Distribution of germplasm to CRP and other end users

External distribution of germplasm for use in research and breeding programmes is a key role of crop gene banks. The end user survey commissioned mainly generated local replies from within Nigeria. Similarly, the evidence presented in the 2013 annual report indicates very few requests external to the country: none for yam, banana and cassava; 38 seed accessions of maize; 149 seed accessions of cowpea; and 358 seed accessions of miscellaneous legumes. The situation for yam is hampered by the presence of Badnavirus in all but 88 accessions (out of a total of 1231 in the *in vitro* gene bank), which were cleaned in 2013. Availability of the cassava *in vitro* collection is much better, with 1685 of 2164 accessions (78%) with a clean health status and, thus, 'legally and physically available.' In depth discussions with the CRP breeders during the site visits revealed considerable interest in and use of the collections; e.g. Dr. Peter Kulakow (cassava), Dr. Antonio Lopez-Montes (yam) and Mr. Remi Adeleke (cowpea). Some GRC staff are involved directly in CRPs; and the close links between the GRC and the CRPs is commendable. However, the GRC has traditionally neither included breeding lines in the 'costed' collection nor reported such use to the Trust. Other Centre gene banks are including selected breeding materials and genetic stocks in their 'costed' collections.

Recommendation 9: GRC management and breeders should identify, which breeders lines and materials are of strategic importance and should be considered for conservation as part of the gene bank 'costed' collection.

ANNEX 1: Terms of reference for the review

Genetic Resources Centre review – Guidelines and Terms of Reference

The Global Crop Diversity Trust commissions the five-yearly review of the CGIAR Center genebanks in its role as Project Manager of the CGIAR Research Programme (CRP) for Managing and Sustaining Crop Collections and also as donor of long-term grants. This review aims to assess the efficiency and effectiveness of the genebank operation as a whole, and the status of the genebank within the context of the global system for the conservation and use of the crops in question.

The objectives of the review are to:

- Assess the operations and activities of the genebank;
- Assess the roles, services and use of the genebank, and the linkages with users and partners both within and outside the CGIAR;
- Consider the status of the genebank or individual collections within it, in the context of a global system for long-term conservation and use of the crop(s) in question;
- Assess any outcomes or impact specific to the provision of the long-term grant;
- Review the general appropriateness of current expenditures for the routine operations of the genebank with reference to the Costing Study estimates;
- Provide actionable recommendations related to all of the above.

Additional specific areas of focus for the review will be identified in Phase 1 of the review.

In 2010, a comprehensive Costing Study was carried out of the genebank operations, which resulted in the publication of cost estimates for routine operations for each Center crop collection. These now form the basis of the funding allocations of the CRP and also of the Trust's endowment target. The current level of operation and operating costs may be an important consideration of the review if there are significant differences from the Costing Study. This will be clarified during the interactions with the Trust in Phase 1 of the review. The Trust will also undertake a financial audit, during the review, and will provide any relevant findings to the panel. The overall responsibility to resolve financial and budgeting issues will remain with the Trust.

The review will be facilitated by a Trust member of staff, who will provide background information, coordinate the development of the agenda and the execution of the review on site. The Trust facilitator will participate in all review sessions unless requested not to, and will assist the Chair in any aspects of the review and the completion of the final report. However, the Trust will not take part directly in the formulation of the review report and recommendations.

The review will be undertaken in three phases:

Phase I: General background and literature review

Reviewers will be provided with the following documents:

- Long-term grant agreement(s)
- Annual long-term grant reports
- Genebank Costing Study

- Genebank CRP proposal
- Genebank manuals, website and related materials
- Relevant past donor or internal reviews of the genebank as given by the Centre
- Any other materials given by the Centre as background for the review

All review panel members and the genebank manager will be involved in the development of the agenda for the site visit. This is an important process during which specific issues and questions are identified for review and relevant stakeholders and users within and outside the Centre are identified for consultation.

At least one interaction will take place in advance of the site visit between the panel members and Trust staff, either through a visit to the Trust HQ or by conference call.

Phase II: Site visit and review of Centre gene bank

The panel members will conduct a site visit of the genebank following the agreed agenda. Usually the site visit involves interactions between the panel members and Centre of CRP senior management and germplasm users, as well as the full genebank staff. There will be at least one visit to field stations and, if feasible, national partner institutes. The panel members should determine the scale of these interactions in the development of the agenda in Phase I.

Given that discussions during the review are usually intensive, panel members may wish to review together the findings at the end of each day. There may also be a need to make adjustments to the agenda in order to pursue certain issues in greater detail. The draft recommendations will be presented to the Centre staff and management on the last day of the site visit.

Phase III: Completing the report and presenting the recommendations

The review panel will produce a report of no less than 5,000 words in which actionable recommendations are clearly stated and justified. The report should be submitted to the Trust for initial review to ensure that the recommendations are clear and actionable. A response will be solicited from the Centre by the Trust. Specific actions or workplans to respond to individual recommendations may be requested.

The Trust will, finally, provide its own response to the recommendations. In the event of a lack of endorsement by the Center or the Trust to a recommendation, further discussions may be necessary between the Trust, panel members and the Center staff. If necessary, the CGIAR Consortium Office or other bodies may be consulted.

The Trust Executive Board and the CGIAR Consortium Office will review the completed report. The report will also be made available on the Trust web site and circulated to the CGIAR genebank managers and presented at the Annual Genebanks Meeting.

Terms of reference for Review Panel members

The specific responsibilities of the Review Panel Members are to:

- Review background documents and data
- Participate in developing the site visit agenda

- Conduct any background research, ground-truthing or informal consultation concerning the review crops or Center in preparation for the site visit
- Participate in discussions with Trust staff to form an understanding of past interactions and experiences between the Trust and the review Centre, and of future workplans for the Genebank CRP.
- If required, present the aims of the review to the Centre staff
- Participate and/or conduct interviews with participants of the review
- Contribute to the formulation of the review recommendations and the written report
- If required, present the findings and recommendations of the review in subsequent relevant meetings.

In addition, a chair will be appointed by the Trust and will be required to take overall responsibility for:

- Organizing and conducting review presentations and interviews (unless otherwise delegated)
- Leading the panel members in formulating the recommendations and writing the review report
- Ensuring that the feedback from the Trust or review institute is adequately incorporated into the review report
- Ensuring that the formulation of the recommendations is based on principles of scientific and political objectivity, and that the interests or opinions of any one interviewee or panel member do not override this need for objectivity
- Ensuring that the final report is of an acceptable standard to the Trust.

ANNEX 2: Biopics of the Review Panel members

Hugh W. Pritchard (Panel Chairman)

Hugh is Head of Research (Seed Conservation) at the Royal Botanic Gardens, Kew and a member of Kew's Senior Science Group. He has a PhD in plant cryobiology and 30 years' experience in genetic resources preservation, including as a member of the senior management team delivering the Millennium Seed Bank Project / Partnership. His research specialities include seed cryopreservation, germination modelling and stress biology. He has published >180 scientific papers (c. 50% in international peer-reviewed journals), including in the *Proceedings of the National Academy of Sciences* and *Trends in Plant Science*. His research work is multidisciplinary in approach and his research group has global connections, publishing with co-authors from >30 countries (from Brazil to China) in the last 10 years. He has been leader of three Darwin Initiative (UK) projects and currently leads for Kew on two EU Framework 7 projects on 'climate and seed quality' and 'native seed biology'.

In addition to being a publisher of the low temperature science journal *CryoLetters*, he has been chairman of the Society for Low Temperature Biology (2008-11) and a governor at Writtle Agricultural College (partner to the University of Essex; 2008-12). He is chairman of the Seed Storage Committee of the International Seed Testing Association. He holds honorary professorships from the University of Sussex and the Chinese Academy of Sciences, is a fellow of both the Linnean Society and the Society of Biology, UK and is an elected member of the Academy of Sciences of South Africa. He was a Senior International Visiting Professor with the Chinese Academy of Sciences in 2011.

Chikelu Mba

Chike is responsible for the Use of Plant Genetic Resources for Food and Agriculture (PGRFA) in the Seeds and Plant Genetic Resources Team of the Plant Production and Protection Division of the Food and Agriculture Organization of the United Nations (FAO). His work at FAO involves the deployments of combinations of normative and operational interventions to strengthen capacities and foster the requisite enabling environments in member countries for the translation of the potentials of PGRFA into improved productivities in farmers' fields

Prior to joining FAO and relocating to its Rome headquarters in March 2010, he had been:

- Head, Plant Breeding and Genetics Laboratory of the Joint Programme of Nuclear Techniques in Food and Agriculture of FAO and the International Atomic Energy Agency (IAEA) in Vienna and Seibersdorf, Austria from 2003 to 2010;
- Research Fellow and Coordinator, Cassava Biotechnology Network (Latin America and the Caribbean), International Centre for Tropical Agriculture (CIAT), Cali, Colombia. 1998 to 2003; and
- Plant Breeder – Geneticist and Leader, Cassava Program, National Root Crops Research Institute, Umudike, Abia State, Nigeria. 1993 to 1998.

He holds a PhD in Plant Breeding and Genetics and has published extensively on themes relating to plant breeding, molecular genetics, induced mutations and plant genetic resources.

ANNEX 3: Schedule for the Review Panel (24 – 28 March 2014)

Time	Schedule for CRP Genebank Review of IITA Genetic Resources Centre	Venue
	Monday 24 th	
10:00	Welcome and Introductions	
10:15	Meeting with Dr Ylva Hillbur, DDG R4D and Dr Robert Asiedu, Director West African Hub and others)	Vigna room
11:15	Overview of IITA GRC	Vigna room
12:30	Lunch	
13:30	Tour of GRC and discussions with staff	GRC
17:00	Phone/Skype CIMMYT, CIAT	Board room 2
18:00	Wrap up for day	
	Tuesday 25 th	
08:00	Field genebank Ibadan including yam barn; detailed discussions	
	Meeting in field with breeders (Dr Elizabeth Parkes(HarvestPlus cassava breeder, Dr Antonio Lopez-Montes, yam breeder, Dr Abebe Menkir, maize breeder), Remi Adeleke	
12:30	Lunch	
13:30	Germplasm Health Unit (Dr Lava Kumar, Head of GHU)	GHU
15:00	<i>In vitro</i> genebank; detailed discussions	
17:30	Wrap up for day	
	Wednesday 26 th	
08:00	Visit to field site at Ikenne (two hours drive from Ibadan): cassava field bank	Ikenne out Station
12:30	Lunch in Ibadan	
14:30	Visit to NACGRAB (National Centre for Genetic Resources and Biotechnology) Dr Sunday Adeleke, Director and Nigerian Quarantine Services	
18:00	Wrap up for day	
	Thursday 27 th	
08:00	Seedbank including regeneration-labs, screenhouses, field	GRC
10:00	Biosciences Centre (Dr Melaku Gedil, Head of Biosciences, Dr Ranjana Bhattarcharjee, Yam Molecular Geneticist, Dr Ismail Rabbi Cassava Molecular Breeder)	
11:00	Food quality/crop utilisation (Dr Bussie Maziya Dixon, Head of Unit)	
12:00	Call with Bioversity	Board room 2
12:30	Lunch	
14:30	Documentation, inventories, databases (Mr Jim Scott, Head of IT, Ms Andreas Gros, Head of Communications, Ms Flora Hauser, Website Consultant)	Vigna room
16:30	Cryo preservation	
19:00	Dinner	
	Friday 28 th	
08:00	08.00 QMS and Risk Management	
10:00	10.00 Private Session for Review Team	Vigna room
12:30	12.30 Lunch	

14:00	14.00 Feedback Meeting with Dr Hillbur and Dr Asiedu	
17:30	17.30 Final wrap up	
18:30	18.30 Dinner	
	Saturday 29 th	
	Morning free for meeting or personal activity	
14:00	14.00 Departure to Lagos international airport (IITA shuttle)	Departure

ANNEX 4: GRC staff list

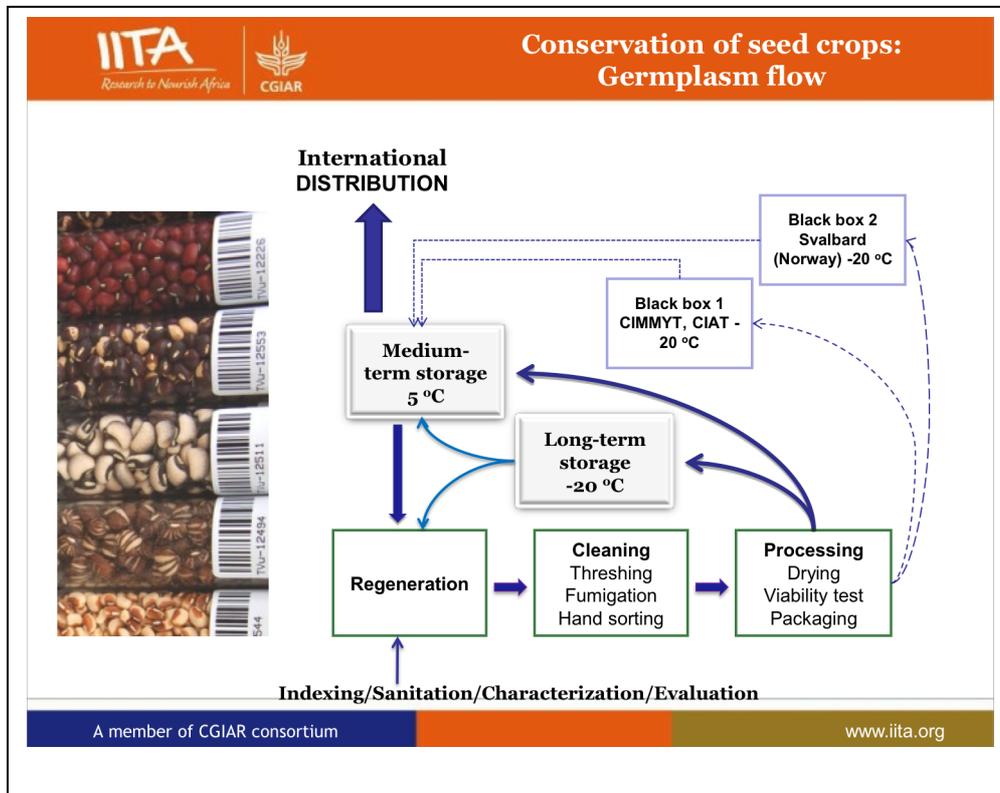
Staff name	Job title	Responsibility
Mrs. Adeyemi Abigael	<i>In vitro</i> Bank Manager	<i>In vitro</i> bank lab. Manager, general supervision and coordination of <i>in vitro</i> lab. activities
Ms. Iwu Emily	Admin. Asst	General Administration of GRC
Mr. Adeyemo Solomon	Research Tech 1	Yam Breeders Line, Acclimatization
Mr. Ogbonna Charles	Research Tech 1	Bank yam and cassava (subculturing & replacement)
Mr. Babalola Olakanmi	Research Technician	Bank Yam, Meristem excision, Indexing sample preparation
Mrs. Obisesan Adebimpe	Research Supervisor	Bank cassava, cryo work, Meristem excision, <i>in vitro</i> items store monitor. (coordination & supervision)
Mr. Okeowo Adetoyose	Research Technician 111	Bank Yam, Data management (coordination & supervision)
Mrs. Ibikunle Oluyemi Ibikunle	Lab Technician	Bank yam and cassava (subculturing & replacement)
Mrs Olagunju Motunrayo	Research Supervisor	Ibadan safe duplication (coordination), assist in data management, meristem excision
Ms. Jekayinoluwa Temitope	Senior Research supervisor	Cassava Breeders Line (coordination & supervision)
Olawoyin Shirley	Research Supervisor	Cassava Breeders Line
Mrs. Peter Omowumi Mary	Research Technician	Plantain/Banana (coordination)
Ms. Udosang Idongesit	Lab Technician	Cassava Breeders Line
Mr. Oyelami Yemi	Senior Research supervisor	Yam Breeders Line (coordination & supervision)
Mrs. Adebayo Bosede	Lab Technician	Plantain/Banana (coordination)
Ms. Haruna Doreen	Lab Technician	Autoclaving, Glassware & general cleaning
Mr. Ajibola Adekola	Lab Technician	Cassava BL
Mrs. Bamkole Busola Rachael	Lab Technician	Yam Breeders Line
Mr. Oyatomi Olaniyi	Seed Bank Mgr	Seed bank Management
Mr. Soyode Folarin	Field Bank Mgr	Coordination of the field bank activities on clonal propagated crops in the field
Mr. Ibanga Boniface	Research Tech 1	General maintenance and supervision of yam field ban
Mr. Faloye Benjamin	Senior Research supervisor	Maize and minor legume regeneration and characterization.

Mr. Lawal Muse	Clerk 1	Store Keeper
Mr. Sanyaolu Kayode	Research Tech 1	Maintenance and supervision of plantain field bank
Mr. Oladepo Adebawale	Field and screen house seed regeneration for virus indexing	
Mr. Ademola Kareem	field worker	field maintenance of cassava
Mr. Alade Omotosho	field worker	field maintenance of cassava
Mr. Yakubu Jimoh	field worker	field maintenance of yam
Mr. Inyang Augustine	field worker	field maintenance of yam
Mr. Belau Folarin	field worker	field maintenance of cassava
Mr.Kofoworola Olatunbosun	Seed desiccation and determination of total and 100 seed weight .	
Mr. Alake Isaac	Research Tech 1	Maize regeneration and Characterization.
Mr.Adeyemo olubiyi	Research Tech 2	Legume Characterization, seed threshing and Driving.
Mr. Saka Afeez	Research Tech 1	Maize regeneration and Characterization
Mr. Oyatomi Opeyemi	Moisture Content determination and seed packaging.	
Mr. Eric Okon	field worker	Yam field data collection
Mr. Ogundalu Adedeji	Maize regeneration and Characterization	
Mr. Makinde Abiodun	Research Tech 1	Cassava field data collection
Mr. Moses Oyajumo	Screen house, insecticide application, data collection and screen house maintenance.	
Mr. Adesokan John	Sorting, Packaging, retrieval from and relocation to the cold stores.	

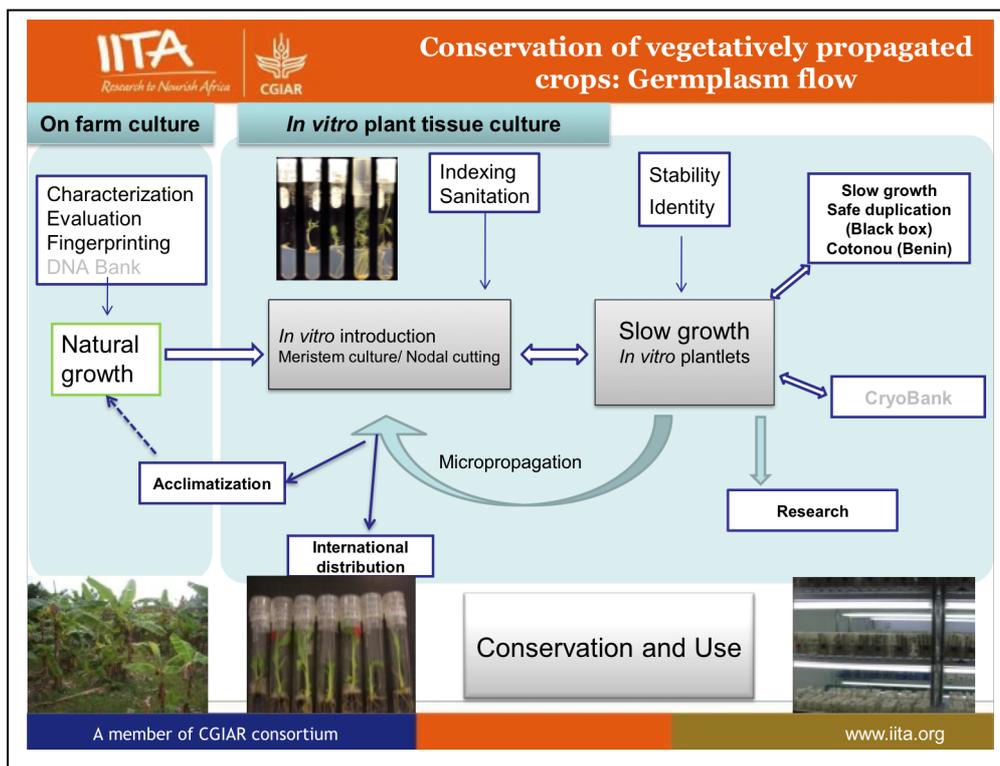
Ms. Amelomen Mary	field worker	Field maintenance
Mr. Olanlokun Amos	Wild vigna regeneration, characterization and seed processing	
Mr. Femi Awodeyi	Seed sorting, Packaging, retrieval from and relocation to the cold stores.	
Ms. Ajao Olaide	Data collection and entry on screen house regeneration.	
Ms. Egwu Ngozi	field worker	field maintenance
Mr. Mfom Victor	Field maintenance	field maintenance
Mr. Akinpelu Ibrahim	Field maintenance and spraying	
Ms. Tokunde Ronke Nafisat	Seed Cleaning, Conformity checking.	
Mr. Aremu Tunde	field worker	Field maintenance
Ms. Shonde Temitope	Research Supervisor	Molecular genotyping of African Yam bean and Cowpea.
Ms. Ojo Confort	Research Supervisor	Molecular genotyping of minor legumes.
Ms. Shitta Suzy	Research Supervisor	Molecular genotyping of African Yam bean and Cowpea.
Mr. Ihenacho Jeffree	Research Supervisor	Supervision of seed processing, inventory update
Mrs. Odesola Kafilat	Research Supervisor	Identification of cowpea from farmer's field and genebank accessions using molecular tools.
Ms. Adetoro Kayayat	Seed Germination and Viability test and inventory updating.	

ANNEX 5: Germplasm flow for the conservation of (A) seed and (B) vegetatively propagated crops at the GRC (courtesy of Michael Abberton, IITA).

(A)



(B)



ANNEX 6: Survey of end users of GRC accessions and services *(survey designed by the Review Panel and summary provided by Cristian Moreno, GCDT)*

Introduction

A survey was conducted between 13-25 of March 2014 to users of germplasm held at the IITA Genebank. A questionnaire was submitted to a total of 51 users through the SurveyMonkey platform. A total of 16 questions were asked, including user information name of user, institution and her/his role as user. Most questions had a field for open comments and no question was compulsory. In addition to the E-mail invitation for answering the survey, users were reminded once before the survey was closed. A total of 9 users filled in the survey. The results are presented below.

User's profile

Most users were affiliated to an university settled in Nigeria (6 out of 9 respondents) or Ghana (1 respondent). There were 2 users from research institutes of France and Japan. The role of users matched on the categories of research (4), education (4) and breeding (3). Note that two users practice breeding and also lecturing.

Part A: Conserving and making available the IITA-held collections

89% of respondents (8 out of 9 users) were of the opinion that the long-term storage, management and curation at IITA are conducted with international standards. Two users had safety duplicated material at IITA and specified:

- "I have duplicated twenty accessions of maize belonging to the TZm group"
- "I have kept the 4 collections safety"

To the question if characterization or evaluation have been done on the safety duplicated germplasm, the latter user reported that basic science and development of the transformation technique on cassava was conducted.

Regarding data and documentation accessibility, 25% of users were able to get information from publicly sources (see Fig. Q7). User's comments on this question were:

- "Passport data on some TZm accessions I collected were readily available online, however, there was no documentation on the IBPGR TZm accessions".
- "Through the internet GRC database"

Q7 Have you been able to access any of the documentation and data on the germplasm collections in the IITA genebank through publicly available information systems?

Answered: 8 Skipped: 3

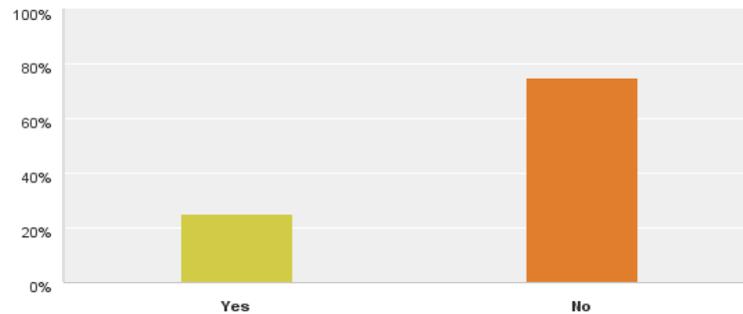


Fig. Q7. Data and documentation accessibility

89% of users confirmed that they have requested and received germplasm from IITA under the International Treaty (see Fig. Q8). Material received includes plantlets of yam and cassava and seeds of African beans and maize. Comments suggest that users were satisfied with the document procedure (SMTA), “although the process might be cumbersome as it takes much efforts to convince some required signatories owing to lack of awareness”. Upon request, “I got quick response from the Genetic Resources Team and seeds that were shipped arrived in good condition”. The germplasm received was used for plant breeding (88%) and multiplication and distribution to farmers (63%).

Q8 Have you requested and received germplasm samples from the IITA genebank in accordance with the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA)?

Answered: 9 Skipped: 2

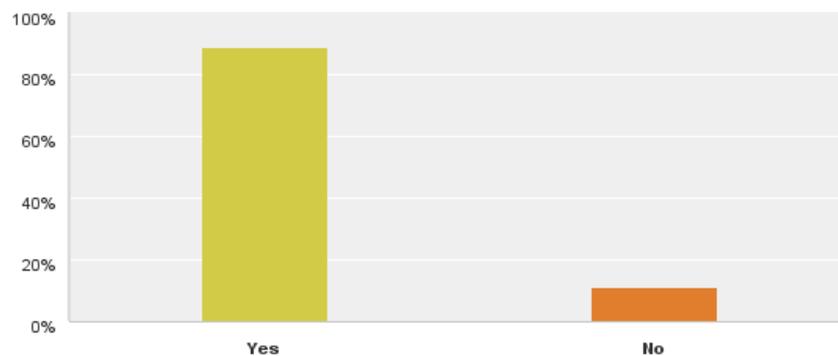


Fig. Q8. Requesting and receiving germplasm from IITA under ITPGRFA

Part B: Furthering the development of a global system for Plant Genetic Resources for Food and Agriculture

Two respondents were involved in helping IITA extend ITPGRFA collections to better cover gene pools. It was explained, "I gave the seeds to about 4 post and undergraduate research purposes".

One user (University of Ibadan, Nigeria) answered that she/he had received training and/or capacity building from IITA genebank staff: "I worked at the Genebank for 6 years before leaving to the university. [...] in the past, with Dr. Ng. training of postgraduate students [was organized] under joint supervision arrangements [with IITA]".

On regard of partnership with IITA genebank, two users confirmed collaboration experience with and commented:

- "I spent a ten-month sabbatical leave in the Genetic Resources Unit under Dr. N.Q. Ng and was involved in germplasm data documentation and the development of core collections for some of IITA's mandate crops".
- "joint research project financed by the Global Crop Diversity trust on cryopreservation of yam germplasm"

Five users (56%) provided examples of strong links with IITA genebank such as joint supervision arrangements of students (in the past...), advice on the use of resources and fieldwork for pollination mechanism, collecting actions for nutrient analysis and joint publications. Remaining users declared either not strong links (3) or skipped the question (1).

Some users (4 out of 6 responses) are aware of promotion of use of the IITA genebank collections. They explained, "[...] many national research institutions and universities utilize IITA collections as a result of awareness created by adequate promotion"; "The online information about IITA genetic resources is adequate to guide a researcher or breeder to access the germplasm. The procedure for ordering germplasm resources is also very simple, requiring few steps"; "I am aware when the institution paid a visit to the organization (user from Obafemi Awolowo University)"; "Yes I am. I also promote the genebank accessions through educating my colleagues and publishing my research results".

Part C: Other comments

- Lawal, Musibau Olajire (Crop Protection Department, Federal University of Agriculture, Abeokuta Ogun State, Nigeria): "I like to commend the supportive influence and diligence of the staff of genebank of the Institute. They pay attention to me at all times. I am currently on my PhD Program in the field of Plant Nematology. I would be willing to share my findings till date and forth in approach to controlling the menace of Root-knot nematodes mitigating large scale soybean production particularly in the tropics".
- Antonia Tetteh (Kwame Nkrumah University of Science and Technology, Kumasi, Ghana): "On the whole, working with IITA Genetic Resources center has been a good experience. On my part, I would benefit from training in seed storage and maintenance so we can exchange material and be partner with regional center for germplasm storage".

**End- user Survey
Genetic Resources Centre, IITA , Nigeria**

Dear Genetic Resources Specialist

The Global Crop Diversity Trust has appointed a panel to review the work of the Genetic Resources Centre at IITA, Nigeria.

In addition to discussions with staff, the Panel would also like to understand what interaction there is between the GRC operations and end-users of the collections, including the transfer of knowledge, delivery of capacity building, etc. With this in mind, the Panel has devised a questionnaire, which I hope you can spare the time to complete.

Please could you provide brief answers to the most relevant questions that relate to your experience of interacting with the GRC?

It would be most helpful if you could return your comments by Thursday 20 March 2014 (extended deadline: 25 March 2014).

Many thanks

Prof Hugh W. Pritchard
Chair of Review Panel
and on behalf of the Global Crop Diversity Trust
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End- user Survey

Genetic Resources Centre, IITA , Nigeria

Name of Respondent

Institutional or company name

Role (breeder, educationalist, etc.,)

PART A: Conserving and making available the IITA-held collections

Q1: *In your experience is the long-term storage, management and curation of the IITA-held collection at international standards (health, regeneration, etc.)?*

.....YES.....No.....

If no, which aspect(s) of the collections management need(s) improving?

.....

Q2: *Have you safely duplicated any plant genetic resource collections in the IITA gene bank?*

.....YES.....NO.....

If yes, please state how many collections and describe the material

.....

Q3: *To your knowledge, have any of the germplasm collections you have deposited in the IITA gene bank been characterised or evaluated?*

If so, please give examples.....

Q4: *Have you been able to access any of the documentation and data on the germplasm collections in the IITA gene bank through publicly available information systems?*

If so, please give examples

Q5: *Have you requested and received germplasm samples from the IITA gene bank in accordance with the International Treaty on Plant Genetic Resources for Food and Agriculture?*

If so, please give examples.....

Q6: *Please indicate how many of germplasm accessions that you received from the IITA gene bank have been used in:*

a) *plant breeding*.....

b) *multiplied and distributed to farmers*.....

PART B: Furthering the development of a global system for Plant Genetic Resources for Food and Agriculture

Q7: *Have you been involved in helping IITA extend its ITPGRFA collections to better cover gene pools?*

If so, please explain how this came about and what your involvement was.....

Q8: *Have you received any training and capacity building at IITA from the genebank staff?*

If so, please give examples.....

Q9: *Have you partnered with the IITA genebank and networks to create a more efficient and effective global conservation system?*

If so, please explain your involvement.....

Q10: *Have you used any other conservation service provided by the IITA genebank?*

If so, please give examples

Q11: *As an end user, have you developed strong links with the IITA genebank?*

Please explain your experience.....

Q12: *As an end user, are you aware of the promotion of use of the IITA gene bank collections?.*

Please explain your experience

PART C: Other comments

Q13: *Please feel free to comment on any additional aspects of interacting with the Genetic Resources Centre at IITA*

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THANK YOU FOR YOUR HELP. IT IS MUCH APPRECIATED.