

ICRISAT Genebank Review 2014

Programme: Genebanks CRP	
Genebank reviewed: ICRISAT	Site visit Dates: 24 Nov 2014 - 28 Nov 2014
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	Center and Crop Trust responses: 12 Apr 2016
Place: Hyderabad, India	
Genebank Manager	Hari H. D. Upadhyaya
Review Panel	Theo van Hintum
	Clarice J. Coyne
	Shyam K. Sharma
Crop Trust staff	Charlotte Lusty
	Matija Obreza
	Janet Muir



RESEARCH
PROGRAM FOR
Managing and
Sustaining Crop
Collections



ICRISAT 2014 Genebank Review: recommendations and responses

	Recommendation	Responses by ICRISAT	Responses by Crop Trust
1. Strengthening the conservation facility	The Review Panel observed that the shortage of storage space is a limiting factor despite the conservative acquisition policy that is applied, and therefore recommends that at least one additional Long Term Storage (LTS) Module and one Medium Term Storage (MTS) Module be added to the Genebank.	Agree. Subsequent to recommendation 9, the genebank foresee large collections assembled from the regional collections and distribution centers in Africa The genebank needs additional support for establishing the facilities in the form of constructing three new medium-term cold rooms and converting one medium-term cold room in to LTS so that all LTS rooms are at one place for greater security. The existing cold room facilities also need an upgrade so that shelves in MTS and LTS can be moved easily for operational efficiency.	The Crop Trust supports the recommendation. ICRISAT is in the process of building the recommended modules as part of the 2016 workplan.
2. Safety backup of vegetatively maintained accessions	The Review Panel recommends that safety backup be established for all the vegetatively maintained accessions at Patancheru e.g. through seed production in conducive location(s) or a second live plant site.	Agree. The genebank will explore alternate sites for regenerating unadapted germplasm and also collaborate with other CGIAR Centre genebanks in safety backup of vegetatively maintained accessions. To achieve this we will also deploy appropriate staff or student to the task of obtaining seed from these mostly wild relative material through manipulation of day length and or temperature. We will also assess what vegetative material is already maintained at other centres. Duplication of vegetative material at other locations might be problematic as obtaining permission to transfer vegetative material between countries is very difficult. However ICRISAT will consider duplication on site to avoid the possibility of losing germplasm through disease/accident/or damage due to other factors.	The Crop Trust supports the recommendation and ICRISAT's proposal to regenerate the non-adapted germplasm in better suited sites. Safety duplication in a separate location is necessary and ICRISAT should explore fully the range of options.
3. Genebank documentation	The Review Panel observed that the genebank documentation system, though solid and meeting the basic requirements, is too limited in its functionality, and therefore recommends to improve the internal data management system by redesigning or replacing it.	Agree. The genebank implements the recommendation with support from internal units as well as from the GCDT documentation specialists and global partners. Since GRIN-Global is the GCDT-preferred system, ICRISAT is in the process of migrating to Grin-Global.	The Crop Trust supports the recommendation and the action that ICRISAT is taking.

	Recommendation	Responses by ICRISAT	Responses by Crop Trust
4. Genebank website	The Review Panel considers the current visibility of the Genebank and its data on the web highly unsatisfactory and therefore recommends to increase the visibility, improve the quality of presentation and functionality of the Genebank on the ICRISAT website.	Agree. The ICRISAT management endorses the recommendation enhancing visibility of Genebank in terms of quality and presentation on the ICRISAT website. ICRISAT has recently updated its website and initiated a program to ensure data are appropriately managed to ensure accessibility to all interested stakeholders. The Genebank is a central asset for ICRISAT and management of its data is a priority for the Institute-wide data management upgrade to be completed in 2016.	The Crop Trust agrees with the recommendation and the response of ICRISAT.
5. Collecting and providing information about collections	The Review Panel considers it of the highest importance that information generated in breeding activities and other scientific research, which use material distributed by the Genebank, is provided to the Genebank, with support from the ICRISAT management, and made publicly available through the Genebank website and other means.	Agree. A major risk to genebank and plant genetic resource conservation generally is the lack of adequate evidence of their value. Therefore having breeders' and other users feedback to the genebank is critical. As per the response to recommendation 4, ICRISAT is investing in an upgrade to data management. This recommendation that public access be made for data and information generated from material distributed by the Genebank is part of the TORs for the data management upgrade at ICRISAT.	The Crop Trust agrees with the recommendation but is aware of the difficulty of gathering data generated by breeders and users. This needs a more robust approach to collaboration than is currently the case. We hope to take some firm steps on this as part of the Genebanks Platform together with the Genetic Gain Platform.
6. Quality management and risk assessment	Given the combined importance and vulnerability of PGR, the RP recommends implementation of a quality management system for the Genebank under the guidance of the Crop Trust.	Agree. The genebank already has comprehensive documentation on protocols and procedures. However there is a relatively urgent need to revisit risk assessment and define and implement mitigation strategies. A quality management system (QMS) will be implemented with suggestions and support from the Trust.	The Crop Trust agrees with the recommendation and is happy that ICRISAT has already made steps in this direction with help from Janny van Beem. We are looking to the minimum components of QMS being in place by the end of 2016.
7. Succession planning	The Review Panel recommends that a formal succession plan is developed and implemented for all key positions within the Genebank staff, and suggests consideration of alternatives for the current organization structure.	Agree. A succession plan is being developed and implemented for genebank in accordance with the policies and procedures of ICRISAT. A new organization structure for Genebank will be developed keeping in view the critical operations and future challenges of the Genebank. ICRISAT expects to internationally recruit a new Head of the	The Crop Trust agrees with the recommendation and the response of ICRISAT. We look forward to understanding more about the new structure.

	Recommendation	Responses by ICRISAT	Responses by Crop Trust
		ICRISAT Genebank in 2016 so that the new recruit has adequate overlap with the current Genebank Head for smooth succession. For other positions also adequate overlap proposed for smooth succession.	
8. Crop advisory committees	The RP recommends the formation of internal Crop Advisory Committees for the six ICRISAT mandate crops (sorghum, pearl millet, pigeonpea, chickpea, small millets and groundnut) or aggregations thereof, to meet annually to discuss planned characterization and evaluation plans, acquisition of new genetic resources, and other PGR related issues.	Disagree. The genebank is not working in isolation and establishing internal advisory committees is not seen as advisable as it would make genebank management even more difficult as it attempts to respond to various divergent demands. There is also the danger that these advisory committee would attempt to move beyond advice to management. Such advisory committee (ICRISAT internal) would also be open to criticism because they were not representative of the broader role that the genebank plays for the world, not just ICRISAT or even the CGIAR in these crops. Under a recently implemented Organizational structure, the Genebank is now part of a Global Program on Genetic Gains and so closely linked to the full breeding pipeline for all mandate crops.	The Crop Trust encourages ICRISAT to make a firmer commitment to this recommendation. The reviewers are recommending more formal feedback mechanisms to address an apparent disconnect between the genebank and the breeders. This relates also to R#5. Whether an internal crop advisory group is the way to go is clearly an issue for ICRISAT to decide, and if not to explore what other formal mechanisms might work. No doubt an organizational restructuring may help to address the issue. In either case, it is important for the genebank to recognise this apparent weakness and make steps to address it.
9. Regional genebanks	To assure the conservation of the unique African germplasm collected by the Regional Genebanks, the Review Panel recommends that this germplasm along with associated passport and phenotypic data be transferred to LTS in Patancheru as the highest priority.	Agree. The genebank at Patancheru has already developed a plan in consultation with the ICRISAT Regional Collection & Distribution Centers. This involves national plant quarantine clearances, regeneration and documentation needs. The genebank seeks targeted funding support for implementing the task.	The Crop Trust supports strongly this recommendation and urges ICRISAT to take immediate action to ensure these collections are transferred to LTS in Patancheru without further delay. ICRISAT has funding available for these collections and should use it to achieve these aims.

	Recommendation	Responses by ICRISAT	Responses by Crop Trust
10. Regional genebanks	The Review Panel feels that the presented vision regarding the operation of the regional genebanks is weak. The activities that form part of the vision (collecting, characterising, introducing and promoting) are recognized as being of the highest importance and should be supported fully. The long-term establishment and sustainability of Regional Genebanks needs to be carefully considered in the context of existing national and regional capacity.	Agree. The genebank has considered the recommendation, along with ICRISAT management, for developing necessary upgradation (physical infrastructure, operational procedures and HR) plans and rationalizing operations in Africa of these “Regional Genebanks”. A plan for their future will be developed. A key initial decision is to refer to these facilities as ‘ICRISAT Regional Collection & Distribution Centers’ with appropriate investment in and plan for their roles in supporting the ICRISAT Genebank based at Patancheru. The African-based facilities will be an integral part of the ICRISAT genebank system and efforts made using a common database and protocols.	The Crop Trust agrees strongly with the recommendation and continues to work with ICRISAT to clarify the role of these stations. It is important that progress is made on this question before the new Platform program is initiated.
11. ICRISAT-ICAR/NBPGR collaboration	The Review Panel appreciates the ICRISAT-ICAR/NBPGR collaboration in the smooth functioning of the Genebank and thinks that the good relationship should be maintained during the transition in ICRISAT senior management, and further strengthened through investing in infrastructure that may be of use to both parties.	Agree. The genebank is fully aware of the essential requirement of ICRISAT’s collaboration with ICAR-NBPGR and the need for it to be further strengthened. The recent impasse on exchange of germplasm samples has been overcome to a large extent. New facilities including PCR-based diagnostic facilities in the Plant Quarantine Laboratory will be established with additional support from the Trust.	The Crop Trust agrees with the recommendation and acknowledges ICRISAT’s success in nurturing a close and trusting collaboration with ICAR/NBPGR. We recognise that this work never ceases and are glad to see that there very practical actions, such as buying the PCR equipment, that are benefiting the partnership.

External Review of the ICRISAT Genetic Resources Programme Commissioned by the Global Crop Diversity Trust

Theo van Hintum¹, Clarice J. Coyne² and Shyam K. Sharma³

November 24 - 28, 2014, Hyderabad, India



¹ Centre for Genetic Resources, The Netherlands (CGN),
Wageningen University and Research Centre, The Netherlands



² United States Department of Agriculture,
Agricultural Research Service, Pullman, WA, USA



³ CSIR-Institute of Himalayan Bioresource Technology, Palampur-176 061, India



Table of Contents

Abbreviations and Acronyms	4
Executive Summary	5
List of Recommendations	6
Background	8
<i>Aim of this review</i>	8
<i>Review methodology</i>	8
Review of Gene Bank Operations	10
<i>General observations</i>	10
<i>Specific observations and recommendations</i>	11
<i>Strengthening the conservation facility</i>	11
<i>Safety backup of vegetatively maintained accessions</i>	11
<i>Genebank documentation and website</i>	11
<i>Collecting and providing information about collections</i>	12
<i>Quality management and risk assessment</i>	12
<i>Succession planning</i>	13
<i>Crop advisory committees</i>	13
<i>Regional genebanks</i>	13
<i>ICRISAT-ICAR/NBPGR Collaboration</i>	14
<i>Concluding remarks</i>	15
Annexes	166
Annex 1: Terms of Reference to the Review Panel	166
Annex 2: Biopics of the Review Panel members	19
Annex 3: Schedule for Review Panel	211
Annex 4: List of people the Review Panel met at ICRISAT (24-28 November 2014)	244
Annex 5: List of documents provided to the Review Panel	255

Abbreviations and Acronyms

CG	CGIAR
CGIAR	Consultative Group on International Agricultural Research
CGN	Centre for Genetic Resources, The Netherlands
Crop Trust	Global Crop Diversity Trust
CRP	CGIAR Research Program
DSR	Directorate of Sorghum Research
FAO	Food and Agriculture Organization of the United Nations
GCDT	Global Crop Diversity Trust
ICAR	Indian Council of Agricultural Research
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ITPGRFA	International Treaty on Plant Genetic Resources for Food and Agriculture
LTS	Long Term Storage
MTS	Medium Term Storage
NBPGR	National Board of Plant Genetic Resources
PGR	Plant Genetic Resources
RP	Review Panel (as commissioned by the Trust)
QMS	Quality management system

Executive Summary

The Consultative Group on International Agricultural Research includes eleven genebanks in its CGIAR Research Programme (CRP). Responsibility for the Genebank CRP resides with the Global Crop Diversity Trust, which commissioned a Review Panel* to assess the efficiency and effectiveness of the gene bank operation at ICRISAT for the conservation and use of collections of sorghum, pearl millet, pigeonpea, chickpea, groundnut and small millets.

Prior to visiting the Genebank at ICRISAT the Review Panel secured end-user feedback on the collections by approaching 71 randomly selected users from the last three years and receiving feedback from 31 of these. This feedback was generally very positive, praising the high quality of the seeds and responsive handling of requests. The criticism very frequently concerned the delays in receiving the material, lack of data and low amount of seeds.

The Review Panel spent five working days at ICRISAT (24-28 November 2014) specifically reviewing: 1) the operations and activities of the genebank; 2) the roles, services and use of the gene bank, and the linkages with users and partners both within and outside the CGIAR; 3) the status of the gene bank and individual collections within it, in the context of a global system for long-term conservation and use of the crop(s) in question; 4) any outcomes or impact specific to the provision of the long-term grant with Crop Trust; 5) the general appropriateness of current expenditures for the routine operations of the gene bank with reference to the Costing Study estimates.

The Review Panel decided on a series of actionable recommendations relating to the genebank:

- operation (five recommendations regarding strengthening the conservation facility, safety backup of vegetatively maintained accessions, improving genebank documentation and website and collecting additional information about collections);
- organisation (one recommendation regarding improvement of quality management and risk assessment); and
- strategy (five recommendations regarding succession planning, the establishment of crop advisory committees, the position of the regional genebanks and the ICRISAT-ICAR/NBPGR collaboration).

Beyond the recommendations above, the Review Panel notes the generally very high satisfaction of users of the collections, the overall effectiveness of the gene bank operation, the high standard of agronomy and the role of the gene bank's knowledgeable leader.

The Review Panel acknowledges the high level of preparation by genebank staff and the general support to the review process, including the arrangements for touring the facilities at ICRISAT and the field sites, the scheduling of meetings. Finally, the Review Panel recognises the excellent interaction with the staff members of the Crop Trust (Charlotte Lusty, Matija Obreza and Janet Muir), prior to the visit and on site.

*Theo van Hintum, Clarice Coyne and Shyam K. Sharma

November 2014

List of Recommendations

Operation

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| 1 | Strengthening the conservation facility | The Review Panel observed that the shortage of storage space is a limiting factor despite the conservative acquisition policy that is applied, and therefore recommends that at least one additional Long Term Storage (LTS) Module and one Medium Term Storage (MTS) Module be added to the Genebank. |
| 2 | Safety backup of vegetatively maintained accessions | The Review Panel recommends that safety backup be established for all the vegetatively maintained accessions at Patancheru e.g. through seed production in conducive location(s) or a second live plant site. |
| 3 | Genebank documentation | The Review Panel observed that the genebank documentation system, though solid and meeting the basic requirements, is too limited in its functionality, and therefore recommends to improve the internal data management system by redesigning or replacing it. |
| 4 | Genebank website | The Review Panel considers the current visibility of the Genebank and its data on the web highly unsatisfactory and therefore recommends to increase the visibility, improve the quality of presentation and functionality of the Genebank on the ICRISAT website. |
| 5 | Collecting and providing information about collections | The Review Panel considers it of the highest importance that information generated in breeding activities and other scientific research, which use material distributed by the Genebank, is provided to the Genebank, with support from the ICRISAT management, and made publicly available through the Genebank website and other means. |
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Organization

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| 6 | Quality management and risk assessment | Given the combined importance and vulnerability of PGR, the RP recommends implementation of a quality management system for the Genebank under the guidance of the Crop Trust. |
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Strategy

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| 7 | Succession planning | The Review Panel recommends that a formal succession plan is developed and implemented for all key positions within the Genebank staff, and suggests consideration of alternatives for the current organization structure. |
| 8 | Crop advisory committees | The RP recommends the formation of internal Crop Advisory Committees for the six ICRISAT mandate crops (sorghum, pearl millet, pigeonpea, chickpea, small millets and groundnut) or aggregations thereof, to meet annually to discuss planned characterization and evaluation plans, acquisition of new genetic |

resources, and other PGR related issues.

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| 9 | Regional genebanks | To assure the conservation of the unique African germplasm collected by the Regional Genebanks, the Review Panel recommends that this germplasm along with associated passport and phenotypic data be transferred to LTS in Patancheru as the highest priority. |
| 10 | Regional genebanks | The Review Panel feels that the presented vision regarding the operation of the regional genebanks is weak. The activities that form part of the vision (collecting, characterising, introducing and promoting) are recognized as being of the highest importance and should be supported fully. The long-term establishment and sustainability of Regional Genebanks needs to be carefully considered in the context of existing national and regional capacity. |
| 11 | ICRISAT-ICAR/NBPGR collaboration | The Review Panel appreciates the ICRISAT-ICAR/NBPGR collaboration in the smooth functioning of the Genebank and thinks that the good relationship should be maintained during the transition in ICRISAT senior management, and further strengthened through investing in infrastructure that may be of use to both parties. |
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Background

ICRISAT's Genebank is located in the campus at Patancheru, India, and hosts 122,986 accessions obtained or collected from 144 countries, including the world's largest genetic holdings of sorghum (39,197), pearl millet (22,888), chickpea (20,602), pigeonpea (13,771) groundnut (15,446) and small millets (11,082). 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)¹.

ICRISAT, and its Genebank, can only function thanks to the support from all levels of the Indian Government, including the productive collaboration with ICAR/NBPGR. This support and collaboration is not a prerequisite, and should continue to be highly valued.

In 2012 a CGIAR Research Programme (CRP) for the management of the CGIAR 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, secure, reliable and sustainable over the long-term and is supportive of and consistent with the ITPGRFA". The Crop Trust has accepted the responsibility of managing this CRP, as part of its role in managing the endowment which provides long-term funding to the CGIAR genebanks.

This review of the ICRISAT Genebank has been undertaken in the context of the monitoring mechanism of the CRP, but also of the longer-term objective of ensuring sustainable genebank operations in the CGIAR.

Aim of this review

This review aims to assess the efficiency and effectiveness of the genebank operation as a whole, and the status of the ICRISAT genebank within the context of the global system for the conservation and use of the crops in question, i.e., sorghum, pearl millet, pigeonpea, chickpea, groundnut and minor millets. The terms of reference of the review included the following elements (for the complete text see 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;
- 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.

Review methodology

¹ See article 15 of the IT-PGRFA (<http://www.planttreaty.org/content/texts-treaty-official-versions>) and the actual agreement between FAO and ICRISAT (<http://www.planttreaty.org/sites/default/files/ICRISAT.pdf>).

A Review Panel (RP) was created consisting of three scientists with expertise in the fields of genebank management, legume genetics, Indian genetic resources management system, genebank documentation and bioinformatics, research collaboration and research management (for the panels biodata see Annex 2). With active support from the Crop Trust and ICRISAT, the RP studied a large number of documents (see Annex 5), and approached a number of Genebank users. On this basis, a review visit to the Genebank facilities was made from November 24 to 28, 2014 (for the program see Annex 3, and for the people met see Annex 4). During this review visit the panel was accompanied by three Trust staff members, Charlotte Lusty (Facilitator to the RP), Matija Obreza (Information System Manager) and Janet Muir (Finance Director), who respectively reviewed the Genebank's documentation system and the financial affairs related to the CRP. On the last day of the visit the preliminary conclusions were presented to Genebank staff and ICRISAT senior management. A report was drafted which, after a fact-check by the Crop Trust, was sent to ICRISAT management for an official response, to which in turn the Crop Trust responded. These institutional responses are also provided in this report.

Review of Gene Bank Operations

General observations

The Review Panel (RP) came to the general conclusion that the Genetic Resources Unit of ICRISAT (Genebank) operates a genebank with high standards.

The RP was given full access to all relevant documents, and experienced an open atmosphere in preparation of and during the visit.

In preparation of the review, the RP approached 71 users of the ICRISAT genebank, based on a random selection of users made from a list of users of the last three years provided by the Genebank. Responses of 31 of these users from 17 countries were received, and most of them were highly positive. Most replies indicated the high quality of seed material, clean and with high germination. Also noted was the responsive handling of the requests that were often rather unspecific such as 'material suitable for our environment'.

The most frequent criticism related to the extensive delays in receiving the material. In some cases it took over a year between request and receipt. As a result often the material could no longer be used as the experiment had finished or the student had already graduated. The cause of the delay appeared to be caused mainly by a one-off freeze in movement while negotiations were under way with the Indian National Biodiversity Authority (NBA), but also other paperwork seems to be part of the problem frequently. The issue of the NBA seems to have been resolved and genebank material can now be cleared much faster than before. The movement of breeding material is still affected, but that is outside the scope of this review.

Another point of criticism related to the low amounts of seeds supplied, causing a need for multiplication before a proper trial could be conducted. This is an often-heard complaint to genebanks, but generally ignored as genebanks put priority on supplying genetic diversity rather than large quantities of planting material, and small samples are usually sufficient.

A third frequent criticism was the access to evaluation data via the website and data sets not presented on the website. Some users noted that some data were available, while others noted it was not (see recommendations).

During the visit to the Genebank facilities, the RP had an impression of a well-organised and effective operation with dedicated staff. The management procedures, which are very well documented, are of a high standard, and the facilities are in general of high quality. Also the agronomy at the regeneration sites was of high quality. Possible exceptions to the high level of the activities are the lack of storage space and rather weak documentation (see recommendations). This indicated good support for the genebank from the ICRISAT management, an impression that was confirmed by the conversations with all involved.

The RP heard frequently through the week about the value and usefulness of the mini-cores for research and evaluation projects from various partners e.g. internal users, a national program, African regional genebanks, etc. However the information (phenotypic and other data) that must result from this frequent use were not available.

The RP was impressed with the high level of cooperation between the Genebank and ICAR/NBPGR in the effort to expedite the national and international exchange of germplasm at ICRISAT.

The standard of operations of the Regional Genebanks in Africa was outside the mandate of the review, however, it should be noted that it is a point of concern. The role of these genebanks is not very well defined, and it is questionable whether the chosen approach is the right one. Options such as closer collaboration with other CGIAR Centres in the region or prioritisation of the activities could not be explored by the RP, but attention to this situation is needed (see recommendations).

The financial management of the CRP funds was found to be fully appropriate and of no need for concern according to the Crop Trust staff. Therefore, the RP did not further investigate this matter.

The Genebank benefits tremendously from the inputs of the highly respected and experienced Programme Director and Genebank Leader, Dr Hari Upadhyaya.

Finally, the Genebank is an outstanding programme not just of ICRISAT but of the CGIAR as a whole and that should be highlighted as an impactful service of the institution.

Specific observations and recommendations

Strengthening the conservation facility

The RP appreciated that the existing LTS and MTS Modules are being fully utilized to their optimum capacity. Although the Genebank has a conservative acquisition policy, it is likely to receive more germplasm, including new African collections, genetic stocks and elite breeding materials in the future for conservation. There is a need of additional LTS and MTS Modules in the Genebank to cope with this need for conservation capacity. Extra capacity will allow a revision of the current storage protocols, e.g. it would allow storage of more than one seed bag for germination testing in the long-term storage.

Recommendation 1: The Review Panel observed that the shortage of storage space is a limiting factor despite the conservative acquisition policy that is applied, and therefore recommends that at least one additional Long Term Storage (LTS) Module and one Medium Term Storage (MTS) Module be added to the Genebank.

Safety backup of vegetatively maintained accessions

Safety backup of plant genetic resources is a fundamental principle of best practices for conservation of global public goods. Several collections of accessions (e.g. crop wild relatives of peanut and sorghum) are partly maintained vegetatively as they do not produce sufficient seed at Patancheru. These accessions are, however, not safety duplicated. Several strategies could be employed to establish such safety back-up as the risk of losing these accessions can be considerable.

Recommendation 2: The Review panel recommends that safety backup be established for all the vegetatively maintained accessions at Patancheru e.g. through seed production in conducive location(s) or a second live plant site.

Genebank documentation and website

The value of PGR is determined by the information available. The RP noted that the current genebank documentation system and web interface meet the most basic requirements, they allow storage of the basic genebank information (passport, characterisation, inventory and distribution data), and it shows the material on the website. However, they do not go any further than that, evaluation data cannot be

stored, no metadata about the phenotypes are given, data cannot be downloaded, it is not possible to show what accessions are represented by accessions in the mini-cores, nor does it allow on-line ordering or click-wrap SMTA's. The website appearance is not up to date and the information about the collection and how to select or obtain the material is hard to find. This can easily be improved by enhancing the database schema and GIMS software and by careful redesign of the layout and functionality of the website. Adoption of GRIN-Global or publication of the Genebank data via Genesys are also options that can be considered. If the genebank wants to be ready for the approaching developments in terms of linking to genomics and other external data, structural changes will be required. Advice and possibly help of other departments of ICRISAT and external consultants might be necessary.

Recommendation 3: The Review Panel observed that the genebank documentation system, though solid and meeting the basic requirements, is too limited in its functionality and therefore recommends to improve the internal data management system by redesigning or replacing it.

Recommendation 4: The Review Panel considers the current visibility of the Genebank and its data on the web highly unsatisfactory and therefore recommends to increase the visibility, improve the quality of presentation and functionality of the Genebank on the ICRISAT website.

Collecting and providing information about collections

The RP noted that the material of the Genebank is frequently used in and outside ICRISAT, and much information is generated about the Genebank collections (e.g. the tremendous success of the mini-core collections). The RP considers it a missed opportunity that so little of this information is made available for genebank users. This is partly due to the fact that little information is fed back to the genebank, and partly due to the fact that whatever information reaches the genebank is not made accessible on-line. If the distribution of material would be actively followed up, much precious information could be compiled adding to the value of the Genebank collections. For internal users the feeding back of results could be based on the 'CGIAR Principles on the Management of Intellectual Assets', for external users possibly on the provisions in the SMTA regarding the duty to report the findings about the acquired material (art 6.9). Besides collecting and making available phenotypic data (including appropriate metadata) also links to external -omics data relating to genebank material should be provided.

Recommendation 5: The Review Panel considers it of the highest importance that information generated in breeding activities and other scientific research, which use material distributed by the Genebank, is provided to the Genebank, with support from the ICRISAT management, and made publicly available through the Genebank website and other means.

Quality management and risk assessment

The long-term availability of PGR requires high quality operations and elimination of the risks that threaten these operations. In the last decades methods for managing and improving quality of operations have been developed that are based on the principle of 'say what you do', 'do what you say', and 'let someone check it'. Such quality management will be a standard criteria for the eligibility of international collections for long-term funding from the endowment managed by the Crop Trust. With the publication of the ICRISAT Technical Manual no.10 (Managing and Enhancing the Use of Germplasm – Strategies and Methodologies) a major step towards proper quality management has been made. In this document, the Genebank describes in detail its operations in a highly accessible way. Thus the first step of 'say what you do' has largely been made. Under the guidance of the Crop

Trust the follow up steps should also be made resulting in a proper quality management system that will include full risk assessment.

Recommendation 6: Given the combined importance and vulnerability of PGR, the RP recommends implementation of a quality management system for the Genebank under the guidance of the Crop Trust.

Succession planning

While there is an excellent detailed document of SOPs for the day-to-day functioning of the Genebank (Managing and Enhancing the Use of Germplasm – Strategies and Methodologies), still important institutional memory is held by the dedicated and long-term Genebank staff. The RP noted several instances of succession planning are in place for technical support positions, however no formal succession plan exists for key positions in the Genebank, most prominently the Genebank Director. It considers, given the age structure and the nature of the organisation, the creation of such a plan is of increasingly high importance. This will also provide the opportunity to consider changing the organisation structure e.g. engaging crop curators. Spreading the responsibilities in the genebank over more persons, for example on a crop basis, would allow specialisation and closer contact with the different user communities.

Recommendation 7: The Review Panel recommends that a formal succession plan is developed and implemented for all key positions within the Genebank staff, and suggests consideration of alternatives for the current organization structure.

Crop advisory committees

ICRISAT internal users (breeders, physiologists, pathologists, entomologists, genomics specialists) are enthusiastic and engaged users in the evaluation of the genetic resources managed by ICRISAT. In turn, they might have potential new genetic resources, which they have developed, and that may be considered for acquisition. The Genebank manager is eager to acquire designated elite materials and present associated evaluation and other generated data regarding the accessions, while maintaining control of the Genebank resources following a rational acquisition policy. However, in some cases there seems to be a disconnect in communication between these two communities that needs to be bridged to ensure optimal functionality and utility of the Genebank resources. A formal feedback mechanism between the two communities concerning genebank activities and the use of the genebank material would be mutually beneficial both for the Genebank operation and the ICRISAT internal user community. The formation of crop advisory committees would facilitate communication, data exchange and assist on, for example, the decision for storage of new genetic resources such as SSD lines, the choice of material for evaluation, and other issues relevant to both communities.

Recommendation 8: The RP recommends the formation of internal Crop Advisory Committees for the six ICRISAT mandate crops (sorghum, pearl millet, pigeonpea, chickpea, small millets and groundnut) or aggregations thereof, to meet annually to discuss planned characterization and evaluation plans, acquisition of new genetic resources, and other PGR related issues.

Regional genebanks

As a component of the mission of ICRISAT to serve the poor small holder farmers in Africa, the Regional Genebanks play an important role. This role includes serving as plant introduction stations, collecting local landraces and crop wild relatives with national partners and improving access to

centrally maintained ICRISAT germplasm. Furthermore, they provide the possibility to characterize / evaluate PGR in the target environments, and serve a role in demonstrating ICRISAT germplasm to local breeders and farmers. Specific recommendations regarding the function, organization and objectives of the regional genebanks is beyond the scope of this review. However, it is clear that the unique germplasm currently curated in the regional genebanks is of high concern to the global germplasm conservation strategy, and should be conserved and made available on the basis of the standards as applied by international genebanks such as the ICRISAT genebank in Patancheru. Reaching these standards in regional genebanks would probably involve considerable investments, which are unnecessary given the capacity of the international genebank system.

Recommendation 9: To assure the conservation of the unique African germplasm collected by the Regional Genebanks, the Review Panel recommends that this germplasm along with associated passport and phenotypic data be transferred to LTS in Patancheru as the highest priority.

The standard of operations of the Regional Genebanks in Bulawayo (Zimbabwe), Niamey (Niger) and Nairobi (Kenya) is a point of concern. They have facilitated collection of unique germplasm within the region and played a role in the conservation, characterization and evaluation of these resources. Furthermore, they have stimulated the use of these landraces by local breeders and farmers. The national programmes in Africa are still, in many cases, short of infrastructure and technical / backup support including lack of information on the genetic variability in the germplasm and trained staff to support basic genebank operations. It is clear that the Regional Genebanks could play an important role. However, this role with respect to each other and to the Genebank at Patancheru, nor for that matter to national genebanks in Africa, is not very well defined. There is a question whether the approach with very small regional operations is a rational approach. Options such as closer collaboration with other CGIAR Centers in the region, or prioritizing of specific activities could not be explored by the RP, but attention to this situation is needed.

Recommendation 10: The Review Panel feels that the presented vision regarding the operation of the regional genebanks is weak. The activities that form part of the vision (collecting, characterising, introducing and promoting) are recognized as being of the highest importance and should be supported fully. The long-term establishment and sustainability of Regional Genebanks needs to be carefully considered in the context of existing national and regional capacity.

ICRISAT-ICAR/NBPGR Collaboration

The RP appreciated that ICAR/NBPGR is playing an active role in the functioning of the ICRISAT Genebank particularly in facilitating the exchange of the germplasm both within and outside India. NBPGR has established a post-entry quarantine station in the ICRISAT grounds and staff frequently visits the ICRISAT Plant Quarantine Laboratory and may make use of their equipment or facilities. The arrangement has been functioning well for the last 30 years. This should continue and be strengthened, e.g. through the purchase of a PCR-based diagnostic facilities in the Plant Quarantine Laboratory.

Recommendation 11: The Review Panel appreciates the ICRISAT-ICAR/NBPGR collaboration in the smooth functioning of the Genebank and thinks that the good relationship should be maintained during the transition in ICRISAT senior management, and further strengthened through investing in infrastructure that may be of use to both parties.

Concluding remarks

The Review Panel finds that the current Genebank is functioning at high technical and scientific standards and is very good in comparison with other international genebank operations. The users of the ICRISAT genebank are satisfied and appreciation of the genebank is wide spread. However, there are some aspects for further improvement to the quality of the operations. For this reason the Review Panel formulated the eleven recommendations that, with varying urgency, should be implemented over the coming years.

The Review Panel is cognizant that the current genebank staff are already fully engaged running the operation, and does not wish to add further burden to the staff with these new activities. However it believes that the recommendations will be important for the rationalisation and optimization of the current operations.

The Review Panel trusts that implementation of its recommendations will allow the Genebank to move forward into a sustainable and reliable future.

Annexes

Annex 1: Terms of Reference to the Review Panel

Center Genebank 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 Program (CRP) for Managing and Sustaining Crop Collections and 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;
- Review the status of the genebank with respect to performance targets and the feasibility of proposed work plans to reach targets;
- 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;
- 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. The Trust Finance Director will undertake a two-day financial audit, during the review, and will provide any relevant findings to the panel. The overall responsibility to identify and 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:

I. General background and literature review

Reviewers will be provided with the following documents:

- Long-term grant agreement(s)
- Annual technical reports and workplans
- Genebank Costing Study
- Genebank CRP proposal
- Genebank manuals, website and related materials
- Relevant past reviews of the genebank as provided by the Center

- Any other materials given by the Center 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.

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 Center or CRP senior management, researchers and breeders, as well as the full genebank staff. There will also 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.

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 Center staff and management on the last day of the site visit.

The Trust Finance Director will work with the Center financial staff in parallel to the panel review. Initial findings of the financial review will be shared with the panel members in order to inform discussions on general management, the appropriateness of genebank and institutional costs in relation to the Costing Study estimates, and any needs for investment in infrastructure or equipment. If necessary, the Finance Director may provide a recommendation for inclusion in the review report.

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 Center by the Trust. The Trust will 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. Finally, the Center will develop a costed Recommendation Action Plan to address priority recommendations for review and funding by the CropTrust.

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, circulated to the CGIAR genebank managers and presented at the Annual Genebanks Meeting.

Terms of reference of 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 Center, and of future workplans for the Genebank CRP.

- If required, present the aims of the review to the Center 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

Theo van Hintum (Panel Chairman)

Theo has been with the Centre for Genetic Resources, The Netherlands (CGN) since its start in 1986. He started, still a student as database administrator, continued as scientist and later, senior scientist. In this capacity he is currently responsible for the documentation, methodology and science at the CGN and acting as deputy director.

Theo received his BSc in Plant Breeding (with honours), in 1986, from the then called Wageningen Agricultural University. In 1994 he received a PhD from the Swedish University of Agricultural Sciences, with the thesis : 'Drowning in the genepool, managing genetic diversity in genebank collections'.

His career at CGN included a five year period, January 2004 – June 2008, during which he was made available to the CGIAR Generation Challenge Programme (GCP) to act as Sub Programme Leader for Bioinformatics and Crop Information Systems, and in 2005 for a short while as Interim Director.

At CGN his research covered a wide array of topics related to plant genetic resources management. This included the application of new technologies, such as molecular markers or information technology, to genebank management, but also quantitative genetic approaches to the composition of genebank collections, so called core collections, and quantitative studies of genetic erosion. Now he is involved in bridging the gap between the genebank and genomics communities.

Theo is active on several international platforms related to plant genetic resources management, did reviews and consultancies and has published over fifty papers in scientific journals.

Clarice Coyne

Clarice has worked for the USDA National Plant Germplasm System for the last 16 years as curator of the grain legume collection held at Washington State University, Pullman, WA and periodically serves as the acting Research Leader for the unit. Clarice received her B.S. degree from the University of California, Davis in Plant Science and her M.S. and Ph.D. (1995) from the Department of Horticulture at Oregon State University focusing on plant breeding and genetics. Her post-doctoral research was with the USDA grain legume breeding unit studying disease resistance carried over to her work as curator and geneticist with the grain legumes. Current research emphasizes phenotyping and genotyping association mapping populations assembled for agronomic trait discovery from pea, chickpea and lentil core collections. Clarice co-organizes the Genomics of Genebanks workshop annually at the Plant and Animal Genome meeting and recently served on a Crop Wild Relatives panel for pea organized by the Global Crop Diversity Trust. Currently she collaborates with ICARDA on the biofortification of lentil and previously with ICRISAT on chickpea genetic resources linkage project. In 2007 Clarice served on the Center Commissioned External Review panel of ICRISAT's biotechnology, breeding and germplasm efforts. Clarice authored or co-authored 58 peer-review publications, nine book chapters and 17 proceedings papers.

Shyam K Sharma

Prof Shyam Kumar Sharma has worked in different capacities with the Himachal Pradesh Agricultural University (HPAU), Palampur located in the North-western Himalayan region during 1980-2006. I also worked as Director of National Bureau of Plant Genetic Resources (NPBGR), New Delhi during 2006-2010 and Chief Executive Officer of HPAU during 2010- 2013. Presently engaged as Emeritus Scientist with Institute of Himalayan Bioresource Technology, Palampur. Received BSc (Agriculture) from Himachal Pradesh University, Shimla and MSc and Ph D from the Indian Agricultural Research Institute, New Delhi. Completed Post-Doctoral work from Deptt. of Biology, University of Southampton (1983-84), Scottish Crop Research Institute, Dundee (1993-94) and John Innes Centre, Norwich (1994-95, 2003) in UK. His areas of interest are Crop Genetics and Breeding, Biotechnology and Plant Genetic Resources (PGR) and has worked on grain legumes particularly lentils during the last 35 years.

As Director of NPBGR, the national responsibility included planning, organisation, conduct and co-ordination of explorations; undertake introductions, exchange and quarantine of plant genetic

resources; characterize, evaluate, document and conserve crop genetic resources and promote their use in collaboration with other national and/or international organisations; develop information network on plant genetic resources; conduct research, undertake teaching and training; and develop guidelines and create public awareness on plant genetic resources. Supervised National Research Centre on DNA Fingerprinting, which undertakes standardization of experimental protocols for DNA fingerprinting of varieties and germplasm; gene tagging and molecular mapping studies in crop plants; developing bioinformatics tools for exploitation of genomic information for enhanced utilisation of plant genetic resources and carry out HRD activities in related areas. Discharged additional responsibility of Network Co-ordinator, All India Network Project on Under-utilized Crop and supervised 13 centres located in the different parts of the country.

Supervised 14 Post-graduate students and authored or co-authored 97 peer reviewed publications, 21 Manuals/Monographs/Books/Bulletins, 18 Proceedings papers, 31 papers presented in the conferences and delivered 47 invited lectures. Member of several National and International professional Bodies/Committees and visited more than 20 countries.

Annex 3: Schedule for Review Panel

Day	Item
Day 1	<p>Brief presentation by the Review Panel Chair and Q&A to all relevant staff including senior management & General introduction to the Center</p> <p>1000-1030: Assembling at 306 New Sahel Conference Room and Coffee</p> <p>1030-1045: Welcome and Introduction to the Review Team Panel - Dr CLL Gowda (DDG Research)</p> <p>1045-1115: Brief Presentation by the Review Panel Chair and outline of the objectives of the review</p> <p><i>1115-1120: Group Photo</i></p> <p>1120-1135: The genebank within the overall research strategy of ICRISAT - Dr CLL Gowda</p> <p>1135-1215: Overall Conservation and Research Strategy of the genebank – Dr HD Upadhyaya</p> <p>1215-1230: Discussion</p> <p>Present: Dr RK Varshney (RPD-GL), Dr Stefania Grando (RPD-DC), Dr Rajesh Agrawal (ADG), Ms Supriya Bansal (Financial Controller / Head), Mr Sharat Kumar (Director, HR and Operations), Ms Joanna Kane-Potaka (Director-Strategic Marketing & Communication), Noel Ellis, (Director, CRP-GL), Shoba Sivasankar (Director, CRP- DC)</p> <p>Genebank: Dr HD Upadhyaya (Director, Genebank), Dr Rajan Sharma (Senior Scientist - Cereals Pathology & Head, Plant Quarantine Lab), Dr Shivali Sharma (Scientist - Genetic Resources), Dr M Vetriventhan (Scientist - Genetic Resources), Dr Santosh K Pattanashetti (Scientist - Genetic Resources), Mr DVSSR Sastry (Manager - Genebank Seed Laboratory), Mr K Narsimha Reddy (Manager - Germplasm Conservation)</p> <p><i>1230-1330: Lunch break</i></p> <hr/> <p>Tour of the Genebank Facilities in the field and laboratory</p> <p>1330-1530: Tour of genebank field facilities - chickpea, pigeonpea and groundnut characterization and regeneration (HDU/KNR/Mr Sube Singh, Lead Scientific Officer, Genebank), and special facilities (HDU/DVSSRS)</p> <p><i>1530-1545: Coffee Break (Room#12, Bld#305 (GF), Genebank)</i></p> <p>1545-1615: Tour of genebank storage facilities (HDU/DVSSRS/Bijoo Davis, Manager - Electrical and Air Conditioning) and laboratory (HDU/DVSSRS)</p> <hr/> <p>Visit Seed Health Unit</p> <p>1615-1730: Tour of Seed Health Unit/PQL and PEQIA, Germplasm exchange (import and export) – Dr HD Upadhyaya, Dr Rajan Sharma and team</p> <p><i>1830: Cocktails and Dinner</i></p> <hr/>
Day 2	<p>Interaction with internal partners (breeders and other scientists)</p> <p>Meetings in Room#12, Bld#305 (GF), Genebank</p> <p>0900-1000: Breeders – Dr Pooran M Gaur (Principal Scientist, Chickpea Breeding), S Srinivasan (Scientist - Chickpea Breeding), Dr C V Sameer Kumar (Senior Scientist - Pigeonpea Breeding), Dr P Janila (Senior Scientist - Groundnut Breeding), Dr A Ashok Kumar (Senior Scientist - Sorghum Breeding), Dr P Srinivasa Rao (Senior Scientist - Sorghum Breeding), Dr KN Rai (Consultant -HarvestPlus India Biofortification), Dr SK Gupta (Senior Scientist - Pearl Millet Breeding), M Govindaraj (Scientist - Pearl Millet Breeding)</p>

1000-1040: Pathologists, entomologists and crop physiologists - Dr Mamta Sharma (Senior Scientist - Legumes Pathology), Dr Rajan Sharma, Dr Hari Kishan Sudini (Senior Scientist - Groundnut Pathology), Dr S Gopalakrishnan (Senior Scientist – Microbiology), Dr HC Sharma (Principal Scientist – Entomology), Dr GV Ranga Rao (Special Project Scientist – IPM), Dr Vincent Vadez (Principal Scientist - Plant Physiology), Dr Jana Kholova (Scientist - Cereals Physiology)

1040-1100: Coffee Break

1100-1200: Genomics -Dr RK Varshney, Dr RK Saxena (Scientist - Applied Genomics), Dr Manish K Pandey (Scientist - Groundnut Genomics) Dr RK Srivastava, Senior Scientist - Molecular Breeding, Dr SP Deshpande, Scientist - Molecular Breeding and Dr Mahender Thudi, Scientist - Applied Genomics and Genotype Service Laboratory

1200-1300: Lunch Break

Visits to external partners (NBPGR and DSR)

1300-1400: Travel to Rajendranagar (Dr HD Upadhyaya and Dr Rajan Sharma to accompany the Review Team)

1400-1500: Visit to NBPGR – Dr SK Chakrabarty and Team

1500-1530: Coffee Break

1530-1630: Visit to DSR – Dr JV Patil and team

1630:1730: Travel to ICRISAT Campus

Day 3 Visits to field facilities and labs

0900-1030: Tour of genebank field facilities - sorghum characterization and regeneration (HDU/VM/Mr Shailesh Kumar Singh, Scientific Officer, Genebank) and Field Genebank (HDU/VM/SP/ KNR/SKS/)

1030-1100: Coffee break

1100-1200: Visit to be Center of Excellence in Genomics (CEG) - Dr RK Varshney and team

1200-1300: Lunch break

Telephone interviews with Regional Genebanks in Nairobi, Bulawayo and Niamey

1300-1500: Discussion and calls with the regional genebanks

1500-1530: Coffee Break

1530-1630: Continued discussions on regional genebanks

Day 4 Genebank Risk Assessment & Quality Management

0900-0930: Implementation and impact of the QMS.

0930-1000: Overview of risk measures.

1000-1030: Coffee Break

Genebank Data Management

1030-1130: Data management issues – databases

1130-1200: Data integration and uploading

1200-1230: Data Security and utilization

1230-1330: Lunch Break

Financial and Administration

1330-1430: Financial reporting

1430-1530: Issues concerning the management of the grant and the Crop Trust

1530-1600: Coffee Break

1600-1700: Any remaining issues

Day 5 Preparations for presentation of recommendations

0900-1030: Reviewers work on their presentation

1030-1100: Coffee Break

Presentation and discussion of draft recommendations

1100-1230: Presentation of preliminary recommendations to genebank staff

1230-1330: Lunch Break

1330-1430: Presentation of preliminary recommendations to senior management

1430-1500: Coffee Break

Annex 4: List of people the Review Panel met at ICRISAT (24-28 November 2014)

Senior management (Days 1 & 5)

CLL Gowda (DDG)
Vincent Vadez (Plant Physiology)
Noel Ellis (Director - CRP Grain Legumes)
Rajesh Agrawal (Finance Director)
Supriya Bansal (Financial Controller)
Sharat Kumar (HR Director)
Joanna Kane-Potaka (Strategic Market. & Comm.)
Rajeev Varshney (Head of Legume Genomics)
Stefania Grando (Head of Dryland Cereals)

Genetic Resources Centre (Days 1-5)

Hari Upadhyaya (Director Genebank)
Shivali Sharma (Scientist)
DVSSR Sastry (Manager of Seed Lab)
Narsimha Reddy (Pigeonpea Field)
M. Vetriventhan (Sorghum Field)
Santosh Pattanashetti
Shailesh Kumar Singh (Sorghum Field)
Bijoo Davis (Electrical & AC)
K. Chandrashekhar (Electrical & AC)

Germplasm Health Unit (Days 1 & 2)

Rajan Sharma (also Cereals Pathology)

Biosciences (Days 2 & 3)

Rajiv Saxena
Manish Pandey
R.K. Srivastava
S.P. Deshpande
Mahender Thudi
Anu Chitkeneni
Henabindu Kudape (Chickpea genomics)
Manish Pandey (Groundnut)
A. Rathore (Biometrics)

Physiology/pathology (Day 2)

GV Ranga Rao (IPM)
Jana Kholova (Cereals Physiology)
Mamta Sharma (Legumes Pathology)
Rajan Sharma (Cereals Pathology)
Vincent Vadez (Physiology)

Breeders (Day 2)

Pooran M. Gaur (Chickpea)
Sameer Kumar (Pigeonpea)
P Janila (Groundnut)
Ashok Kumar (Sorghum)
SK Gupta (Pearl millet)
M. Govindaraj (Pearl millet)

NBPGR-Rajendranagar (Day 2)

B. Sarathbabu
V. Kamala
N. Sivaraj
K. Rameash
Pranusha
Babu Abraham
Sukesh
Gunasekaran
Svrendar

Regional collections (Day 3)

Ganga Rao (Nairobi)
Moses Siambi (Nairobi)
Eric Manyasa (Nairobi)
Sakile Kudita (Bulawayo)
Kizito Mazvimav (Bulawayo)
Falalou (Niamey)
George (Bamako)

Documentation & Communications (Day 4)

Themma Reddy
PJ Modi

Directorate of Sorghum Research (Day 2)

P. Sanjana Reddy (Senior Scientist)
A.V. Umakanth (Principle Scientist)
KBRS Visarada (Genetics and Cytogenetics)
Aruna. C (Plant breeding)
N.I.K. Dar (Plant pathology)
V.R. Bhagwal (Entomology)
Sujay Rakshit (Plant breeding)
M. Elangoran (Plant genetic resources)
S.S. Rao (Plant physiology)

Annex 5: List of documents provided to the Review Panel

1. 2007-2011 reports - Annual reports on sorghum and pearl millet collections in the Hyderabad genebank submitted to the Crop Trust as part of the long term agreement.
2. 2011-2013 reports - Annual technical reports submitted via the Online Reporting Tool for each of the six crop collections in Hyderabad.
3. ICRISAT Summary Report 2011-2013 - Summary prepared by the Crop Trust of all the technical report submissions from the four ICRISAT localities: Hyderabad, Niamey, Bulawayo and Nairobi.
4. Crop strategies – Global crop conservation strategies for chickpea, sorghum, pearl millet and finger millet.
5. ICRISAT long term agreement with the Crop Trust
6. Genebanks CRP proposal - is the CGIAR Program proposal 2012-2016, prepared and lead by the Crop Trust on behalf of the CGIAR.
7. ICRISAT Genebank Manual - documents downloaded from the ICRISAT web site containing the operations manual.
8. Upadhyaya, HD, Pundir RPS, Dwivedi SL and Gowda CLL. 2009. Mini core collections for efficient utilization of plant genetic resources in crop improvement programs. Information Bulletin No. 78. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 52pp.
9. "Report of ICRISAT genebank activities and future plans" prepared by Hari Upadhyaya and team and provided at the time of the site visit.
10. "Current status and strategies to strengthen ICRISAT regional genebanks" prepared by Hari Upadhyaya and team and provided at the time of the site visit.
11. Upadhyaya, HD and Laxmipathi Gowda, CL. 2009. Managing and enhancing the use of germplasm – strategies and methodologies. Technical Manual no. 10. Patancheru 502 324 Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. 236pp.