CIMMYT Genebank Review 2019

Programme: Genebank Platform		
Genebank reviewed: CIMMYT	**Site visit dates:**	26-30 August 2019
	Review report date:	29 October 2019
	Center and Crop Trust responses:	16 December 2019
Place: Mexico City and Toluca, Mexico		
Genebank Manager	Tom Payne (wheat) and Denise Costich (maize)	
Review Panel	Theo van Hintum	
	Marisé Borja	
Crop Trust staff	Janny van Beem	

	Observation	Recommendation for clearance	Due date	Responses
1	Minor	Reinforce succession planning, shadowing of staff and transfer of knowledge between staff especially those retiring.	Provide an improved plan for staff succession by end 2019.	CIMMYT: Agreed (Response Action Plan 1.1); some actions by end 2019; full plan by April 2020. Crop Trust: Agrees and happy to see the succession planning is integrated into plans for increasing joint activities between the two collections.
2	Major	Integrate and unify conservation activities for wheat and maize into a single genebank by sharing staff, methodologies, equipment, expertise, etc., including establishing biweekly meetings of all staff	Report outcome by end 2020.	CIMMYT: Partially Agreed. Much scope exists, and we will pursue this, but there are limits to unifying maize and wheat activities; the frequency and participants in meetings will be rationalized (Response Action Plan 1.1) Crop Trust: Considers that more integration of staff and activities can be achieved at least in seed processing, storage and data management as in many other genebanks. The ultimate aim is improved management, efficiency and security – these gains need to be obvious in making changes.
3	Major	Implement barcoding and use of mobile devices in all genebank operations including introductions, regeneration, viability testing and seed health testing. Barcodes and mobile devices should be integrated into the data management system.	Full mainstreaming and integration of barcodes and mobile devices into the data management system by the end of 2021	CIMMYT: Agreed (Response Action Plan 1.1.5 & 4.1) Additional resources may be required to implement EBS integration. Crop Trust: Important recommendation and surprising to see this is not yet in place. RAP 4.2 proposes development of mobile apps for GG, which should be implemented in close collaboration with the GG community.
4	Major	GRIN-Global data should be systematically reviewed and actively curated by	Evidence should be provided of significant	CIMMYT: Partially agreed (Response Action Plan 7.1 (add maize to RAP) &

		performing integrity checks, adding missing data, curating virtual accessions, correcting safety duplication data, and improving passport data completeness.	data quality improvement by end 2020.	14.1). Some data are not and will not be available; also, this task could be expensive and require additional funding, depending on level of ambition. Crop Trust: GG was designed to manage passport and trait data. All existing data should be migrated to GG and then curated with resources available. This, plus corrections where errors occur, virtual accessions remain or data are missing are critical functions of genebank management as undoubtedly CIMMYT agrees. Links to external (Germinate, GOBII) systems may be implemented as Subsets in Genesys.
5	Major	All terms (e.g. "Availability") in the GRIN-Global database should be properly defined (data dictionary), consistently used and understood by all staff. Where necessary, fields should be created to record compliance with critical steps managed by other units (e.g. health tests, SMTA). Reporting scripts should be written to ensure that data queries are able to (1) consistently return reliable up-to-date information and (2) prioritize accessions for viability testing, regeneration and safety duplication.	Evidence should be provided that this has been achieved by the end of 2019.	CIMMYT: Partially agreed, (Response Action Plan 3.2). A dictionary will be created. Development of generic scripts may not be entirely in our hands as GRIN-Global is not CIMMYT software; in any case the due date must be extended at least to December 2020. Resources will be required to enhance GRIN Global search and data query ability, aligned with specifications specified by Genebank Managers and clients. Crop Trust: Consistency in the inputting and retrieval of data is essential. Investment in GG development for the group as a whole provides an opportunity to get this right for CIMMYT as a frontrunner. The recommendation is not asking for enhanced search and data query ability of GRIN-Global, but for relevant reports to be generated from the database. This can be implemented even if GRIN-Global is not CIMMYT software.
6	Minor	CIMMYT staff working in the genebank and associated units should be aware of FAO genebank standards and international policy and standards related to the exchange of germplasm. A formal document should be available to indicate CIMMYT's compliance with such standards.	Compliance document should be available by end of 2020.	CIMMYT: Agreed. (Response Action Plan 2.3) Crop Trust: Agrees
7	Minor	Review and report on options to regenerate teosinte, wheat CWR and winter wheat in alternative locations or outsource the work.	Report on review of regeneration options by end of 2020	CIMMYT: Agreed. (Response Action Plan 1.2, 9.1 & 13.4). Additional resources may be required to implement outsourcing. Crop Trust: Noted that CIMMYT has added wheat CWR to this list. ICARDA is an obvious partner in this activity. Also, necessary to consider whether CIMMYT continues conserving these accession groups or whether a longer-term, formal understanding may be agreed with an institute better placed to regenerate them.

8	Major	Internal redundancy in wheat collection should be addressed and a revised policy on seed lot management developed to ensure number of lots (inventories) is significantly reduced and kept to a manageable number.	Revised policy for managing seed lots and their viability monitoring to be shared by end of 2020	CIMMYT: Agreed (Response Action Plan 11.1, 11.2, 11.3 & 13.3) Crop Trust: Agrees with the recommendation. The 13.3 milestones are not clear on what is intended to be done here
9	Minor	Revise procedures for wheat regeneration to take account of (1) reconsidered threshold for regeneration of CWR, (2) characterisation practices, (3) alternative options for regeneration of winter wheat, CWR, and (4) need to reduce time between harvest and storage.	New procedures should be in place and a documented SOP available by end of 2021.	CIMMYT: Agreed (Response Action Plan 13.5) Crop Trust: Agrees with the recommendation.
10	Major	Review maize regeneration policy, thresholds, management of seed lots and consider what can be done that has not been tried before to substantially improve regeneration success rate. Failing an improvement CIMMYT should consider alternative hosts for the parts of the collection that cannot be regenerated.	Annual reports should continue to be provided on progress on this issue and a final decision made at the end of 2021.	CIMMYT: Agreed (Response Action Plan 10.1, 10.2). Additional resources may be required to implement outsourcing. Crop Trust: Agrees with the recommendation. Activity 10 in the RAP is not clear on the plans, which no doubt needs discussion and thought. However, it would be good to see a timetable by which alternative solutions (radical ones if necessary) will be sought rather than a continuation of the current situation.
11	Minor	Response plans to (1) the alarm system and (2) in the case of an emergency should be revisited and improved in full communication with maintenance staff and all other relevant responsible people.	The revised plan(s) should be submitted by the end of 2019.	CIMMYT: Agreed (Response Action Plan 5.1, 5.2) Crop Trust: Agrees. Although not clear in the RAP, assumes that the emergency response (including the response to the alarm) is included in the stated “Risk Management and Business Continuity Plans.” This should be clarified.
12	Major	Complete an inventory of the wheat accessions that are currently stored in paper or unsealed bags, test their viability and, if necessary, regenerate or replace the accessions in LTS.	Provide a report on the list and status of individual accessions affected before the end of 2019 and complete the activities by end of 2020 with a report indicating whether accession loss has occurred.	CIMMYT: Agreed (Response Action Plan 13.1, viability assessment for accessions currently in paper bags will be completed by April 2020) Crop Trust: Agrees and notes that the inventory is already completed and is pleased to see that the exercise will be completed in June 2020.
13	Major	A unified SOP for wheat and maize viability testing needs to be developed and current processes revised to ensure that; (1) initial viability of an appropriately representative sample is tested for both crops, (2) seed dormancy is addressed and taken into account in determining viability and (3) monitoring intervals are revised based on scientific evidence.	Provide the new SOP by end of 2020.	CIMMYT: Agreed (Response Action Plan 1.1, 9.2 12.1, 12.2). Additional resources may be required to establish a high-throughput viability testing facility. Crop Trust: Agrees and understands that the high throughput of the wheat collection is an important factor in planning viability monitoring.
14	Major	Data entries for viability need to be corrected and data entry processes revised for: (1) date of last viability test (where the date of data upload has been erroneously recorded) and (2) flagged clearly where extrapolated data are recorded and distinguished from actual results.	Database should be corrected by end of 2019.	CIMMYT: Agreed, noting that improved data entry processes will be implemented by mid 2020 (Response Action Plan 4.2.1, 12.2). Additional resources may be required to develop workflow interface tools.

				Crop Trust: Agrees with the recommendation and hopes that these needs are taken into account in plans for developing generic workflow-based tools for GG. Genebanks should utilize EBS workflows and tools (e.g. in the field) where appropriate. Design of genebank-specific tools should be a priority.
15	Major	Ensure SMTAs accompany all accessions introduced into the collection and are electronically available both for acquisition and distribution. Use of easySMTA is recommended.	Changes should be in place by end 2021.	CIMMYT: Agreed (Response Action Plan 2.1, 2.2) Crop Trust: Agrees. Relevant data should be recorded in GRIN-Global.
16	Minor	Confirm with ITPGRFA experts that the AMTA is a legal substitute for the SMTA and that it will withstand scrutiny in a legal situation by end of 2019.	Confirmation and actions in response to be completed by end of 2019	CIMMYT: Agreed, although completion may be delayed to mid 2020, as legal opinions are often a slow, iterative process (Response Action Plan 2.1) Crop Trust: Agrees
17	Major	The acquisition and curation policy for both maize and wheat collections, including the automatic introduction of breeding lines, should be strengthened so that decisions to introduce materials are based upon an agreed scope and strategy and implemented by managers who are given the appropriate authority to implement the policy.	Strengthened acquisition policy to be reported by end of 2020	CIMMYT: Agreed (Response Action Plan 1.3). Crop Trust: Agrees. The resulting policy is of interest to the CGIAR genebank group as a whole.
18	Major	The composition of maize and wheat collections requires critical assessment to reduce over-representation of improved materials (especially for long-term storage and safety duplication).	Revised collection composition and scope should be reported by end of 2020.	CIMMYT: Agreed (Response Action Plan 7.1, 8.1, 11.1, 11.2, 11.3, 11.4, 13.3) Crop Trust: Agrees and glad to see CIMMYT's planned actions on this recommendation.
19	Major	Collections of species other than wheat and maize in storage in CIMMYT's cold rooms should be transferred to genebanks better positioned to actively manage them. Barriers preventing this process from happening should be identified and addressed by the end of 2021.	Transfer of materials should be actioned by the end of 2021	CIMMYT: Partially Agreed (Response Action Plan 11.1, 11.2). We will develop a recommendation and identify barriers preventing the process by end 2021; whether our recommended solution can be implemented may not be entirely within our hands. Crop Trust: We assume this refers to the barley and rye collections. It is not entirely clear how this challenging recommendation is being addressed from the RAP but it is appreciated that CIMMYT's intention is to identify the constraints preventing these collections from being placed elsewhere and will report on this recommendation.

Introduction

Commissioned by the CGIAR Genebank Platform, a review of the CIMMYT Genebank was carried out by Theo van Hintum, head of the Centre for Genetic Resources, The Netherlands (CGN) and Marisé Borja, Associate Professor at the Universidad Complutense de Madrid. The reviewers were supported by Janny van Beem, Quality Management Systems specialist of the Crop Trust. These three will be referred to as 'the review team'; when referring only to the two reviewers, the term 'the reviewers' will be used.

This review aimed to conduct an in-depth assessment of the long-term sustainability of the genebank's routine operations and their eligibility for long-term funding through the Crop Trust's endowment mechanism. The review focused on a wide range of areas, including the validation of the status of the collections and its associated information, staff and risk management and the center's responsiveness to users. In preparation for the visit, the reviewers received a wide spectrum of documents, including the Standard Operating Procedures (SOP) in Spanish and partly translated in English, Platform documents such as the annual reports (from the online reporting tool), a self-assessment by the genebank managers, and the results of user surveys performed by CIMMYT and compiled by the Crop Trust.

On August 26-30, 2019 the review team visited CIMMYTs location at El Batán in Mexico. On arrival at CIMMYT, the review team was welcomed by Tom Payne (Head, Wheat Germplasm Collections & International Wheat Improvement Network) and Denise Costich (Maize Germplasm Bank Head). After a brief tour of the genebank facilities, the review team was also welcomed by Kevin Pixley (Genetic Resources Program Director). Senior management, Martin Kropff (Director General) and Marianne Banziger (Deputy Director General for Research and Partnership), were met on the last day for the presentation of the preliminary findings.

Over four days, the review team interviewed the teams responsible for the different crops and operations, inspected facilities and processes, and met with the technical staff at their workstations. Furthermore, a brief visit to the multiplication site Toluca, c. 2 hours from El Batán, was organized. Most elements of the review were carried out by all three review team members, the visit to Toluca was only done by Dr. Borja, the visit to the legal department, Distribution Unit and International Nurseries only by Dr. van Beem. Dr. Borja and Dr. van Beem also visited the Seed Health Laboratory (SHL).

Intense discussions were held with the heads of the operational teams, i.e., Cristian Zavala (maize) and Efren Rodriguez Carranza (wheat) and most of the other permanent staff members of the genebank, i.e., Hedilberto Velazquez Miranda, Rocio Quiroz Soto, Jesus Perales Escalante, Clara Ivonne Torres Elizalde, Martin Carlos Ordaz Cano, Octavio Frutero Gutierrez, Sergio M. Gonzalez Galindo, Maria del Carmen Corona Martinez, Martin Rodriguez, Alfredo Segundo, J. Alejandro Velazquez, Cesar Sánchez, Alberto Hernández, Alejandro Juárez, Marcial López, Filippo Guzzon. In Toluca the reviewer interacted with Denise Costich, Cristian Zavala, Fernando Delgado and Marcial Lopez, and at the Legal department with Teresa Gresl, the Distribution Unit with Mabel Baños and Marcos Jorge and International Nurseries with Ana Luisa Ordaz. At the SHL, Amos Alakonya, Noemi Valencia Torres and Maria del Carmen Corona gave a tour of the laboratory.

Part audit of SOPs and part technical assessment, this type of review is relatively new to the Platform. Since both reviewers had already reviewed a genebank with this new mandate, this caused no problems. The team was able to readily obtain answers, documents or other evidence from the genebank staff without delay or hesitation. This culture of transparency is an essential first step towards proper quality management. The reviewers gratefully

acknowledge the cooperation and patience of the CIMMYT genebank staff throughout the review.

The audit of the SOPs and the reviewers' assessments of processes in need of improvement are detailed in the attached Review Checklist. There are 19 recommendations, including 16 major observations that need, in several cases, urgent action, plus 22 minor observations. The overall findings were presented to CIMMYT management and the genebank's staff on the final day, to avoid factual mistakes and receive initial feedback.

General remarks

Kevin Pixley referred to the genebank as one of the crown jewels of CIMMYT, and it can be. It contains an invaluable wealth of genetic resources of wheat and tropical maize and has received the global mandate to safeguard these genetic resources and make them available for current and future generations. The genebank is located in a perfect scientific environment with expertise in all aspects of the crops, and with an excellent connection to various user communities.

Like any other genebank, many small issues can and should be improved, and suggestions can be made to make the operation more effective. At the CIMMYT genebank, however, the review team observed a few major problems, especially in wheat, that require immediate action. These were related to the fact that a substantial part of the material in the Long-Term Storage (LTS) facility is stored in paper bags and thus may have lost its viability due to humidity, and that the majority of viability observations were recorded without a proper date, making their use for viability-monitoring impossible. These two issues need to be addressed immediately and with the highest priority, as they concern the safety of the world's most important wheat genetic resources collection. The team can only hope that none or very few accessions have been lost and trusts that further loss can be prevented.

The CIMMYT genebank is a very large and impressive operation. Thanks to the coordination of reviews by the Crop Trust, and especially the quality management component therein, the important shortcomings are now being identified and addressed with the objective of bringing the genebank operation up to an acceptable standard, and ultimately to perfection. The results of this review should be seen in this light: steps toward improvement that would ultimately lead to a secure and future-proof genebank.

Overview of recommendations

Details of observations, recommendations, and proposed actions are given in the attached Review Checklist; the text below offers a broad overview of the recommendations and suggestions on how to address them. The numbering corresponds to that in the Review Checklist.

The review team observed many very positive elements in the genebank program. Clear examples are the balanced composite sampling implemented in maize for the preparation of regeneration and safety backup samples, the large-scale relabeling of maize and repacking of wheat samples, and the training and competency-testing activities for genebank staff. However, this list concerns important points for improvement.

The list of improvements begins with the most urgent issue the review team observed: many wheat samples in the Long-Term Storage are stored in paper bags. The action plan is straight-forward: create a complete inventory of the accessions in paper bags and their viability and attempt to regenerate or find alternative seed sources for these accessions (Recommendation 12). The second most pressing issue, is the entry of wrong dates for wheat germination testing

in the genebank documentation system. For this finding, the action is also clear-cut: the original data files need to be found and the correct data entered in the system. If not found, the correct dates need to be copied from the original germination lab sheets. If these do not exist, a prioritization for new viability testing has to be made and large-scale testing has to be started (Recommendation 14).

Related to these viability tests, the reviewers found that the policy for viability testing and its practical implementation needs to be reconsidered due to the following: lack of initial tests (currently for wheat), imputation of test results for untested samples (currently occurring for maize), unavailability of protocols for dealing with dormancy (needed but unavailable for wheat), unsubstantiated choice of samples for germination testing (only latest seed batches), and unclear intervals between tests (possibly unnecessarily short in the official policy, unclear in reality) (Recommendation 13).

To be able to appropriately select material for viability testing, a proper documentation system has to be in place and populated with proper data. Issues described in the paragraph above prevented this, but also the generally poor state of the documentation and date entry into GRIN-Global made it difficult. We are aware that this has improved considerably over the last years, but now it should and can be made better. To achieve this, the data should be actively curated by performing integrity checks, adding missing data, properly defining terms (data dictionary) and writing reporting scripts (Recommendations 4 and 5). This will make the management of the collection better and reporting more consistent over the years.

Once the data are reliable and complete, analysis of the composition of the collections should be made, especially the wheat collection. It appears that there are many unnecessary seed lots in storage, and more importantly, that there is considerable internal redundancy: material that received a new accession number after a regeneration cycle would thus be *de facto* duplicated in the collection (Recommendation 8). At a higher level, a critical look at the composition of both wheat and maize collections is necessary, to identify gaps and redundancies and set priorities for future acquisition (Recommendations 17 and 18). CIMMYT management should implement a plan to transfer material to other CG centers that it is not actively curating and making available e.g., transferring the responsibility of barley and wild wheats to ICARDA (Recommendation 19).

With regards to the genebank operation, the review team found that the use of bar- or QR-codes is very limited. A much wider application of QR-codes not only in the genebank but also in other CIMMYT units and departments (e.g., SHL) could increase efficiency tremendously and, equally important, avoid errors as a result of writing down and copying numbers (Recommendation 3).

In terms of regeneration, the review team was impressed by the apparent regeneration capacity. There appear to be shortfalls concerning certain maize accessions, teosinte, wheat wild relatives and winter wheats, an issue that might be solved by hiring outside contractors or identifying new locations (Recommendations 7 and 10). Time for harvest to reach storage for wheat samples was outside an acceptable range of six months and should be improved (Recommendation 9). Related to this, the regeneration success of maize has been consistently low despite systematic analyses of the problems. To solve this problem, alternate approaches (methods, locations, contractors) should be considered. A possible alternative to additional attempts at regeneration would be to combine different seed lots to obtain the desired seed number (Recommendation 10).

The genebank building is great and the foyer offers a welcoming and informative area for genebank visitors. However, when tested, the alarm system in the Long-Term Storage room did not result in a response (apart from genebank staff that happened to be present). Furthermore, the review team was not completely satisfied with the current Emergency

Response Plan (what steps are taken in the event of a natural disaster or in the event of an extended power outage (e.g., one month without electricity?) (Recommendation 11). This issue is apparently related to insufficient internal communication at the genebank level and with the maintenance staff. Regular staff meetings to share problems, solutions and successes could improve operations and avoid some of the issues described above.

On the legal side, the review team observed that there was a disconnect between the legal department and the genebank operation. For example, it was very difficult or impossible for the review team to retrieve documentation that establishes CIMMYT's legal right to possess the genebank accessions (Recommendation 15). Also, when acquiring germplasm, an 'Acquisition Material Transfer Agreement' (AMTA) appeared to be in use rather than the SMTA. Reviewers had strong doubts regarding its legality and questioned whether due diligence had been done (e.g., through an extensive consultation process) when creating the material transfer agreement. Such legal issues have become very important in these times of the Nagoya Protocol, and should be given due attention (Recommendation 16). CIMMYT staff should be fully aware of the obligations of the Article 15 agreement under which the collection is managed and the FAO Genebank Standards. The compliance of the genebank operations to such standards should be clearly articulated in a formal document (Recommendation 6).

Finally, several key genebank staff are approaching retirement in the coming one to three years. A succession plan is essential (Recommendation 1). The review team is aware that this has the attention of CIMMYT's senior management but wants to reiterate its importance. In planning the succession of staff lies the possibilities of further integrating the two genebanks, i.e., maize and wheat, allowing better use of each other's expertise (e.g., GRIN-Global) and equipment (e.g., label printer) (Recommendation 2).

In the review checklist (an Excel file) more details are added to this report and an additional number of observations and improvements are provided.

The reviewers hope that these recommendations for improving the operations of the genebank will help the genebank reach the high standards that are appropriate for an operation of such immense importance.

Theo van Hintum and Marisé Borja
October 20th, 2019