

ICRAF Genebank Review 2020

Programme: Genebank Platform	
Genebank reviewed: ICRAF	Site visit Dates: 27 – 30 April 2020
	Review report Date: 29 June 2020
	Center and Crop Trust responses: 30 June 2020
Place: [Nairobi, Kenya] Due to COVID-19 pandemic, the entire review was undertaken virtually.	
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	Observation	Recommendation for clearance	Due date	Responses
1	2 Major observations and 11 Minor observations	All SOPs must be revised to reflect the actual workflow in a step-to-step manner, to remove any ambiguities and improve the consistencies across all the SOPs. They should provide clear quality control points and decision options and state which staff position is responsible for decision-making and ensure deputies are in place for decision-making. They should also include a brief summary table of risk management indicating key responsibilities and mitigation actions to be carried out. Policies and standards governing any processes should be incorporated, annexed or referenced. Staff should be trained in the use of the SOPs.	Complete revisions and staff training by end 2021.	<p><u>ICRAF:</u> All suggestions are very useful, and SOPs will be revised as guided. Staff are already using SOPs as evidenced by their continued revision.</p> <p><u>Crop Trust:</u> Agrees with the recommendation and appreciates ICRAF's response.</p>
2	3 Major observation and 1 Minor observation	ICRAF need to carefully think through an improved regeneration procedure appropriate for each AFT species to ensure genetic integrity of the accessions/provenances. It is suggested to convene a group of experts on tree genetic resources to recommend new guidelines for best practice of AFT species regeneration.	Convene expert consultation as soon as possible.	<p><u>ICRAF:</u> The suggestion of having a group of experts to take this issue forward is most welcome. The challenges with tree regeneration of specific accessions is something that has been raised and discussed previously. The issue was also discussed by tree genetic resources scientists during the development of the ICRAF Genetic Resources Strategy 2013-2017; guidance given was to plant all accessions together to prevent inbreeding depression as then the seeds will certainly not have the vigor of the parent tree an aspect of the biology that is counter-productive. Expert consultation will be held to discuss the issues and this recommendation and refine strategies and guidelines by end of 2021.</p> <p><u>Crop Trust:</u> Agrees with the recommendation and the response. A species by species approach may be required in some cases, but if possible general principles should be established, which could then be applied to individual species.</p>

3	1 Major observation and 8 Minor observations	<p>We recommend that</p> <ul style="list-style-type: none"> (a) Migration into GRIN-Global should be done as soon as possible. (b) Automation of data collection in <u>all</u> genebank operations is undertaken where appropriate through the development of new apps; (c) Barcodes be expanded as soon as possible to <u>all</u> genebank activities to reduce transcription errors in the documentation processes; (d) Tablets are used for <u>all</u> data collection and it is ensured there are sufficient tablets for staff to use; (e) Metadata for Field Genebank sites and for characterization data be uploaded on the documentation system. 	This should be done as soon as possible.	<p><u>ICRAF:</u> Agreed, recommendations will be implemented as guided.</p> <p><u>Crop Trust:</u> Agrees with recommendation and response.</p>
4	3 Major observations and 1 Minor observation	<p>With regard to characterization, we recommend that:</p> <ul style="list-style-type: none"> (a) At least the Field Genebank (FGB) collection should be fully characterized. (b) A minimum descriptor list for high-priority AFT species should be developed urgently. (b) Characterization protocols are well standardized across field sites and that control points are established along the process to validate the data and ensure that they are integrated in the GRU database. 	Plan for the full characterization of FGB to be completed over the next 2 years – with 50% done by the end of first year.	<p><u>ICRAF:</u> Agreed. Recommendations will be implemented totally as guided. However, all the priority species descriptor development may not be achieved in two years' timeframe proposed but will be targeted to be done in 5 years. Currently, we have a descriptor template that is customized for each species data collection.</p> <p><u>Crop Trust:</u> Agrees with the recommendation and appreciates ICRAF's response. It may be possible to outsource the development of some descriptor lists/</p>
5	1 Major observation	We recommend that ICRAF urgently develop a plan to ensure that all seed accessions are brought under long-term storage (LTS) conditions and are accessible at all times.	Plan and agreement should be ready by end of 2020.	<p><u>ICRAF:</u> Indeed, it our ambition to have an LTS facility at ICRAF so that collection is accessible at all times. We had started to fundraise for the LTS facility and had aligned this for the 2019 GIZ Genebank uplifting fund before the changes came in. We hope Trust will support this initiative considering the new structuring of Genebanks GIZ funding.</p>

				<p><u>Crop Trust:</u> Agrees with the recommendation. There are different ways to address the issue – and the first important point will be to determine to what extent there are sufficient seed for two forms of storage. Conversion of the current facility to LTS may be one option if there are not sufficient seeds for most accessions. Requesting other institutes with existing LTS to host the base collection is also a possibility. This may be a point to consider in the upcoming Genebanks Costs and Operations review.</p>
6	1 Major observation	We recommend that the monitoring of the ICRAF MTS genebank storage facility be improved by installing data loggers for continuous monitoring of the storage conditions in storage rooms. Further, an alarm system should be established to warn the Genebank Manager as soon as the storage conditions go below the accepted threshold levels of temperature and relative humidity.	In place by end of 2020.	<p><u>ICRAF:</u> Agreed and an urgent action already being put in place to address the recommendations .</p> <p><u>Crop Trust:</u> Agrees with the recommendation and is glad that action has already been taken by ICRAF.</p>
7	4 Major observations	We recommend that measures are taken urgently for safety backup of all the MTS collection, at least all accessions of prioritized species, between the Kunming Institute of Botany and Kew’s Millennium Seed Bank, under LTS conditions. In this respect, a new duplication agreement with Kew MSB should be developed. Subject to available resources, ICRAF reviews its safety duplication plan to achieve at least 75% duplication of its high-priority species by 2022. It should develop a strategy for safety duplication of the Field Genebank accessions. Further, ICRAF should explore the possibility of safety-duplication at another CGIAR center, e.g. ex-CIAT. ¹	By 2022 75% of high priority species duplicated.	<p><u>ICRAF:</u> For some species, as we tried to explain, safety duplication is limited by the seed numbers in the current collection. This was the consideration made in reducing the Performance Target to one site for safety duplication after the genebank review in 2015. All accession with enough seed numbers will be placed in LTS and safety duplicated at Svalbard. A strategy for the safety duplication of field collection will be developed as guided.</p> <p><u>Crop Trust:</u> It is understood that it is difficult to safety duplicate the collections managed by ICRAF – what may not be entirely clear to the Crop Trust is the extent of the</p>

¹ The Genebank of the *Alliance of Bioversity International and CIAT* in Cali, Colombia.

				collection that has too few viable seeds. From ICRAF's response and reporting it appears to be most of the collection. Given this situation, would it be appropriate to determine some form of equivalency between accessions – that if one accession can't be duplicated, another of the same species/provenance can? ICRAF's clarity about the number of accessions that can be safely duplicated and how would be welcome. The continued effort to safely duplicate field accessions following a process of prioritization is appreciated.
8	1 Major observation	The reviewers noted inconsistent recording of seed availability in the seed accession test database and the ORT. It is recommended that a reassessment of what accession is available be made and corrected both in the GRU database and in the next ORT report.	End of 2020.	<p><u>ICRAF:</u> This discrepancy was explained during the review itself. Reviewers were provided with data updated up to 30 March 2020, whereas the ORT was updated up to 31 Dec. 2019. Data was corrected and shared on follow ups after review. This has now also been corrected in the database and the ORT record will be updated in the 2020 reporting.</p> <p><u>Crop Trust:</u> Agrees with the recommendation. Adoption of GRIN-Global should help improve confidence in these data. It is noted in the checklist that the reviewers are concerned with the threshold for acceptable seed numbers and their viability. Added to this is the need for safety duplication and LTS. It would be useful if ICRAF would consider the number of viable seeds required for these critical components of a genebank and reconsider the number of accessions that are still formally available. It does appear that reporting 76% availability in the online reporting tool is misleading.</p>
9		It is recommended that a cost recovery policy be developed for multiplying seeds for distribution and this will also benefit accessions that are in need to be regenerated.	End of 2021.	<p><u>ICRAF:</u> A useful suggestion. Cost recovery policy for seed multiplication and distribution will be developed.</p>

				<p><u>Crop Trust:</u> Agrees.</p>
10	4 Minor observations	<p>We recommend that the conservation functions of the Field Genebanks (FGB) be clearly demarcated from seed stands, which serve the distribution of large seed quantities, e.g. for revegetation. It is recommended that ICRAF-GRU takes full responsibility for FGB activities and processes. This must be reflected properly in the Field Conservation SOP.</p>	<p>As soon as possible.</p>	<p><u>ICRAF:</u> Many of the FGBs have a dual function: 1. They are conservation sites for these species and 2. They also serve as seed sources for planting that communities/NGOs/researchers request (this actually is a great example of 'use' of our conserved materials. However, the recommendation is taken and the conservation functions of field genebanks will be clearly demarcated from supply from the seed stands and this will be added to SOP.</p> <p><u>Crop Trust:</u> This issue remains a long-standing area of discussion. One of the main points is that if long-term conservation is required for species, then accessions should be prioritized, duplicated, documented, made available, and adequate investment provided, to ensure that they adequately represent the genetic diversity of the genepool. The fact that stands are being actively used is definitely a positive point. What is not clear is that the accessions that are in demand are also those that represent unique diversity and are a priority for conservation investment. Until ICRAF clearly communicates the strategic priorities of unique diversity for long-term conservation and how they will ensure these priorities are represented and conserved long-term in the collection this will remain an issue, and funders and reviewers may remain hard to convince. On the positive side, the possibility of using a more nuanced curation strategy or complementary conservation approaches opens up the opportunity to work on different time scales or levels of conservation.</p>

11	2 Minor observations	We recommend that training of all staff should be given high priority in the genebank, and their training needs including in areas of seed physiology, economic botany, and taxonomy be included in ICRAF's human resource development strategy.	Training plan developed by September 2020.	<p><u>ICRAF:</u> Training will be provided to enhance the capacity of the three staff with seed physiology expertise through internship in other seed laboratories, attend workshops, invite visits by experts to the genebank, as well as online courses. Important to note that the three staff have been supported for such skills development (documented in the staff file but reviewers did not request for this). However, botanist/taxonomist expertise is still needed in the genebank team and will have to be recruited.</p> <p><u>Crop Trust:</u> Agrees with the recommendation and looks forward to hearing the progress on this point. It appears that the reviewers' recommendations are based on perceptions formed through discussion rather than on documented skills attainment. It is still an important note to take account of.</p>
12		We recommend that the role of the ICRAF genebank be highlighted both within and outside of ICRAF through increasing its visibility on the current ICRAF website and in any further development thereof, ensuring that the genebank is recognized as a key asset in the new Alliance strategy of CIFOR and ICRAF, and that the genebank carve itself a role in projects aimed at contributing to the international challenges and initiatives in collaboration with strategic partners.	As soon as possible.	<p><u>ICRAF:</u> Agreed totally and thank you for highlighting this to our SLT during the review meeting; recommendations will be implemented as guided</p> <p><u>Crop Trust:</u> Agrees.</p>

INTRODUCTION

1. This technical review was carried out under exceptional circumstances created by the COVID-19 pandemic. The intended scheduled visit to the ICRAF genebank from 27th April to 1st of May 2020 could not be realized due to travel restrictions and confinement imposed by the pandemic for all concerned by this review. These restrictions meant that it was not possible to carry out a full review. Consequently, the technical review was undertaken virtually by GoToMeeting, facilitated by the Crop Trust. The review team carried out a desk review based on documentations provided by ICRAF's Genetic Resources Unit (GRU) staff and interviews of managers and key technical staff of the genebank.
2. The reviewers recognize that the review was done under difficult situation especially for the GRU staff. We have been very impressed with the enthusiasm and professionalism that genebank staff and management have shown and the unreserved willingness of the GRU team to collaborate with the review team. The genebank team was fast and very prompt to respond to particular requests of the review team, given the fact that the team was scattered across different regions of Kenya (Nairobi, Nakuru and Kisumu). They have been open and engaging and we wish to acknowledge their hard work.
3. The technical review was, thus, focused principally on the standard operating procedures (SOPs) of the genebank operations. The reviewers were provided with current versions (version 2) of seven SOPs on information management, seed conservation, safety duplication, field conservation and regeneration, characterization, distribution and acquisition. In addition, the review team received reports on ICRAF's self-assessment, a user survey (2012-19), the previous ICRAF external review (2015), as well as the Genebank Platform online reporting tool (ORT) report on data validation and summary of reported technical data, ICRAF's Acquisition and Curation Strategy (2017), strategy implementation plan (2018), rationalization strategy (2018), conservation priority species list, and an Invasive Alien Species Policy (2018). Besides these key documents, the reviewers also received several reference documents including ICRAF's annual reports; five QMS audit closure reports; seed accessions' test data; and various documents requested by the reviewers during the review. The reviewers also were able to consult online databases on ICRAF and Genetic Resources Unit (GRU) websites, and Genesys.
4. Several meetings with Crop Trust staff were held before the review week to organize this review process in the given context of the COVID-19 pandemic. The review itself was conducted over 4 days via GoToMeeting. The review started with a presentation of ICRAF's Theme on Tree productivity and diversity by Dr Ramni Jamnadass and a presentation on the genebank by Dr Alice Muchugi. The reviewers held interviews with owners of each of the seven SOPs to discuss their respective SOPs. On the third day, a discussion was held to debate acquisition and curation strategy, when a presentation was made by Dr Alice Muchugi. The implementation of the recommendations of the previous review was additionally discussed. On the fourth day, Dr Anthony Simons, Director General of ICRAF, gave a brief presentation on the on-going institutional changes in ICRAF, and the reviewers provided a feedback on their key findings of the review.

FINDINGS

5. The findings of this review are provided in detail in the attached ICRAF Review Checklist, in which we provide our observations of the operating procedures of the main genebank operations, based on the SOPs reviewed. It is important to emphasize that it was impossible to verify most of the procedures, which are detailed in the SOPs, and what the staff interviewed

said they were doing. Thus, the evidence provided was very scanty and essentially based on the interviews with the genebank staff, cross-checking of various documents provided and specific documents requested by the reviewers as well as some demonstration of online databases.

6. The review team made 12 recommendations (see above) relating to the SOPs, regeneration practices, genebank data and information management system, characterization, storage facilities and safety duplication, including the management of field genebanks, and capacity building of staff.

Overall Impression

7. Our overall impression is that the GRU staff and management team is doing a great job in ensuring that the genebank is fulfilling its objectives. We commend ICRAF management in developing a very clear Acquisition and Curation Strategy as well as a Rationalization Strategy, which provide great clarity about their policies on acquisition, curation, retention and prioritization of agroforestry tree (AFT) species and germplasm. We fully endorse the decision of the genebank management to apply the “dynamic curation” principle in differentiating the level of management according to accession priority, which has already resulted in a rationalization of the collection with more than 800 accessions being archived. We also commend ICRAF in taking measures in strengthening the genebank team by hiring a Database manager and new Plant Pathologist, and establishing a post-entry quarantine facility in the nursery. These measures will greatly improve the capacity of genebank to deal with documentation backlogs and better curate the health of its germplasm. This will ensure the ability of ICRAF in providing high quality disease-free propagules to its customers.
8. However, the reviewers have a serious concern regarding the overall status of the accessions in the MTS collection at ICRAF and their regeneration, which the ICRAF management should address as a matter of high priority. (See details below and **Recommendations 5 and 6**)

Standard Operating Procedures (SOPs)

9. In general, the SOPs are well written, but require some improvement. They contain the key elements of the operations that are required for the respective genebank operations. However, we note that there are many ambiguities and inconsistencies in relation to content in the introduction, definitions and abbreviations, missing items of materials and equipment. We find that they are often written in very general terms and do not reflect the actual work flow in the genebank as discussed with the staff. The SOPs need to be very precise and specific, and should layout the processes in a step-by-step manner. They also need to clearly indicate, which staff are responsible for carrying out specific tasks, and which staff need to take decisions at specific decision points in the work flow. The flow diagrams are very helpful and should be included in all SOPs. We noted discrepancies in some of the flow diagrams, which are indicated in our detailed review of the SOPs. We further note that ICRAF SOP closure reports have been approved for mandatory areas in the operations and processes, but we would suggest that these be revisited in light of the findings of this review. (**Recommendation 1**)

Conservation

10. We are extremely concerned about the long-term security of the entire genebank collection, particularly in relation to, long-term storage, safety duplication and monitoring. The security of the accessions and the storage facilities must be of highest priority for ICRAF’s GRU and cannot be compromised at any costs.

11. The bulk of the accessions are not conserved under optimum condition (which should be under LTS condition- minus 20°C in hermetically sealed containers), which means the seed viability will be decreasing relatively rapidly resulting in large regeneration load. We noted that only 18% of the collection is currently kept under LTS condition. We also note that 25% of the MTS accessions (1630 accessions out of 6474) are known to have less than 85% viability, 243 accessions have 0% viability and 4002 accessions (61%) have no viability information. This leaves only 9.2% of the MTS collection as being under safe conservation standards. Moreover, little, if any, regeneration is being carried out, due to inadequate regeneration protocols for AFT species, which further adds to the overall insecurity of the AFT collection held by ICRAF. In contrast to the previous review, we would recommend ICRAF to ensure that all the seeds accessions are maintained under long-term storage condition and are accessible at all times. We wish to reiterate the recommendation of the last review to urgently renegotiate the duplication arrangement with Kunming Institute of Botany and Kew's Millennium Seed bank to back up the entire MTS collection, at least all accessions of the prioritized species. This may involve transfer of a representative sample of all the accessions held at ICRAF, depending on the number of seeds available. We wish to emphasize that safety duplication is a different function compared to conserving accession under LTS condition. **(Recommendation 5)**
12. Monitoring of the storage facility is currently done twice a day, but not on weekends and holidays. This should be improved by installing data loggers for continuous monitoring and an alarm system needs to be put in place. This is all the more important given that the storage facility at GRU is only under medium-term storage (MTS) conditions (5° C and 15% RH) and, thus, the germplasm is not being conserved at the most optimal condition for safeguarding the materials, and considering that only 18% of the collection are safety-duplicated under Long-Term Storage (LTS) conditions. **(Recommendation 6)**
13. Safety duplication should be the highest priority for the Genebank. We think they need to be more ambitious and not only aim at 50% of safety-duplicated accessions by 2022, but should strive for a higher percentage like 75% for all high-priority species accessions. ICRAF should consider expanding partnerships beyond the current arrangements with MSB and GBOWS-KIB, Kunming, and explore opportunities with another CGIAR center, such as the new genebank facility being built at ex-CIAT. **(Recommendations 5 and 7)**
14. Field Genebank (FGB) collections – We appreciate the efforts made to rationalize the FGB collections and would like to encourage ICRAF to pursue this rationalization to make it much more efficient and manageable. Considering a smaller number of FGBs focusing on top prioritized species. The field conservation SOP covers the procedures for nursery propagation and planting of a field site but does not mention how new accessions/species are assigned to existing FGBs. The reviewers are concerned about the terms and conditions of agreements with countries for the establishment and management of FGBs, which need to be more stringent to ensure the long-term sustainability and security of the site tenure. There is a clear need to demarcate between the genebank for conservation purposes and other functions such as seed multiplication and distribution. **(Recommendation 10)**

Regeneration and Multiplication

15. The reviewers recognize the serious difficulties in regenerating and multiplying accessions of AFT species with orthodox seeds, which have long life histories, are mostly outcrossing and, thus, require large expanse of land and large isolation distances. Their biology makes it difficult to achieve the objectives of regeneration in maintaining the genetic integrity of individual accessions, as defined in the 2014 FAO genebank standards. Regeneration and multiplication of AFT germplasm is, thus, the most challenging and expensive genebank operation. And yet, it is a crucial step in maintaining the genetic integrity and the genotypes of individual

accessions. ICRAF would need to take a pragmatic approach about how to carry out regeneration on a case-by-case basis. It should develop a strategy on how it can reduce the regeneration load, for example by improving the storage conditions of the accessions to increase the seed longevity, thereby reducing the time required for regeneration (**Recommendation 2**). For accessions that are in high demand and with low number of seeds, ICRAF could consider charging a cost recovery for multiplication of these accessions to meet the distribution demand and restocking of these accessions at the same time. There may be huge potential for doing this with bilateral projects that can serve both purposes of regeneration for conservation and distribution.

Characterization/Preliminary Evaluation

16. The review team acknowledges that the ICRAF-GRU has made great efforts in documentation of characterization data, as evidenced by records observed in Genesys and demonstrated to us by the database officer. We noted, though, that there is still a very low percentage of the total accessions that currently having any kind of characterization data (e.g. only 23% of the Seed collection have 1000-seed-weight; 59% of the Field Genebank have DBH, height, crown diameter and flowering and fruiting data available). If we want the collection to be used more widely, it is imperative that all accessions should be characterized at the earliest possible opportunity and this should at least be done for all accessions in the field genebank. We recognize there are impediments to this and we have made recommendations on the SOPs on how to improve the characterization. Further, we suggest that the list of species with existing descriptors be compiled and added to the SOP on characterization and a minimum descriptor list be developed for all priority species to be customized according to individual species/genera. (**Recommendation 4**)

Data Management and Documentation

17. We note that there are too many scattered databases for the various genebank operations. However, we are pleased to note that ICRAF is part of the discussion with other CG centres on the migration of their data and information management system into GRIN-Global. We encourage them to migrate into GRIN-Global as soon as it is feasible to help consolidate the genebank databases. (**Recommendation 3**)
18. We note that barcoding has been initiated and apps developed to automate documentation of some genebank activities. Barcoding should be fully deployed for all activities (e.g. seed moisture content and purity assessments, seed dispatch, and in field genebank collection). This should be implemented as a matter of urgency; it will make the whole genebank operations much more efficient, saving on staff time and resources and ensuring that accuracy of data is provided in the database system. We strongly recommend that tablets/apps are used for all data collection and ensure there are sufficient tablets for staff to use.
19. We are concerned about the proper documentation of maintenance and calibration of the genebank equipment. We appreciate that the GRU has a comprehensive equipment list, but we noted discrepancies on what is said to have been done and what is documented. This could be either a documentation issue or a maintenance/calibration issue.
20. Field genebanks (FGB) are integral parts of the ICRAF Genebank and so their documentation needs to be a visible part of the data management workflow (e.g. meta data for the sites were missing from GRU database) regarding establishment, management, maintenance, health monitoring, harvesting seed, distribution of propagules. For Genebank material distribution by a FGB, SMTAs/MTAs should also be applied and documented.

Distribution

21. The reviewers noted that accessions were available for distribution if they have more than 100 seeds. We consider this number to be extremely low; especially if the accession's viability is taken into consideration. We also observed that there are quite some serious inconsistencies regarding availability between the Excel file provided and the summary data from the ORT as well as across the years. For example, we noted that only 406 accessions had less than 100 seeds and of these 71 accessions were still considered as available, while the rest was labeled historical. (**Recommendation 8**)
22. The user survey report was quite revealing in that it showed that very few have responded and that the great majority were from one country. But generally they showed a very good satisfaction of the genebank services and the materials they provided, which is commended. We note, though, that the great majority (90%) of the respondents were from a single country (Kenya), which is indicative of a limited geographic distribution and, thus, use of the AFT germplasm from ICRAF. ICRAF should encourage a wide distribution of its germplasm. Seed suppliers can be considered strategic partners for the genebank, and it is recommended that the surveys be carried out more regularly with them as they can offer a good extension service for ICRAF genebank, with ICRAF provided them small quantities of seeds for seed multiplication and dissemination by them. The distribution of germplasm sub-sets to improve its use is commended. It is suggested that a software similar to the SoFT (Tropical Forages Selection) software could be used to improve the optimal targeting of right species /accessions for the right site for the right purpose.

Risk Mitigation

23. We are aware of the existence of an institutional Risk Management and Mitigation Document and Business Continuity Plan. It seems that the genebank SOPs are referring to these documents as their First Responder Plan. While this is good, it is recommended to undertake for each SOP a specific risk mitigation assessment and produce at least a brief risk mitigation summary table to be included in every SOP. The risk table should indicate responsibilities and mitigation actions to be carried out for each specific genebank operation. We do recognize that at least the INF MAN SOP has provided such a table already, and this can serve as a model for other SOPs.

Capacity and Competencies

24. It is considered that further expertise would be required to make the ICRAF genebank a centre of excellence for the conservation of AFT germplasm. For many of the AFT species, taxonomy, economic botany and basic seed biology (e.g. seed germination, dormancy breaking, seed longevity) are little known, and research work is needed to particularly unravel seed behavior to improve the seed handling of these species in the genebank. It would be desirable to have a specialist and training on these aspects. It is important to continue to ensure that staff are trained and are kept abreast of latest research on seed physiology, taxonomy etc., so that they can better perform their duties in the genebank. It is also important that they receive training on the use of new equipment, and on using new apps and other new technologies. (**Recommendation 11**)

Policies and Strategies

25. There is need to clearly articulate the objective(s) of the ICRAF genebank and differentiate the core genebank work from what could rather be seen as a "seed unit" and from other "non-genebank" services provided by the GRU. We appreciate the clear priority setting for the conservation of AFT species in the Genebank as defined in the document on Acquisition and

Curation Strategy (2017) on genebank collection and strategies, and we suggest that this implementation plan is pursued.

26. ICRAF should consider recovering costs for provision of larger seed quantities to projects or commercials. The income generated from this would help sustain production costs. An institutional policy for charging for regeneration and multiplication of accessions needs to be developed. (**Recommendation 9**)

Visibility and Communication

27. We are pleased to learn that the institution recognizes that its genebank is the globally most important AFT genebank and already efforts to raise awareness have been done. We think that much more can be done by the institution to give the genebank a higher profile. (**Recommendation 12**) For example:
 - a. A more visible link to the Genebank and its products (e.g. seed list, list of trait-specific subsets, core collection) on the front page of the ICRAF website would undoubtedly be extremely helpful and needs to be re-established. We believe this used to be the case (as per the recommendation of the previous review). The website is a vehicle for greater visibility of the genebank, which will help to improve better use of the germplasm.
 - b. We are aware of the development of a new strategy for aligning the work of CIFOR and ICRAF – this can be a good opportunity for giving increased visibility of the Genebank and promoting it as a strong asset for this new alliance. The CIFOR-ICRAF alliance can also seek ways to better integrate its *ex situ* genebank activities with *in situ* conservation by CIFOR and other CGIAR centres (for example the restoration projects with Alliance of Bioversity International and CIAT).
 - c. With the Bonn challenge of restoring 2 billion Ha of degraded land by 2030 and other global initiatives, such as the *Great Green Wall*, or the *Trillion Tree Campaign*, sourcing of reliable high-quality seeds appropriate for tropical areas will be critical. As a globally important genebank, the ICRAF genebank is uniquely placed as a source provider for seed for these endeavors. This, in itself, can help raise the profile and reputation of ICRAF.

IMPLEMENTATION

28. Given the current state of the COVID-19 pandemic in mid-May 2020, it is extremely challenging to give meaningful target dates for implementing recommendations, especially those that should be more or less immediately implemented. It can be expected that the ICRAF genebank team will face considerable challenges associated with the pandemic over the next 12 months at least.
29. The reviewers thank Dr Alice Muchugi and the Genebank team for their open and frank discussions. We hope the comments and recommendations made will assist them in improving the conservation and utilization of the ICRAF mandate species towards wider use and increasing their impact on agriculture and livelihoods in the tropics.

Ehsan Dulloo & Brigitte L. Maass
23 May 2020

Acronyms and abbreviations

AFT	Agroforestry tree(s) – including multi-purpose trees and shrubs
CIAT	International Center for Agriculture in the Tropics, Colombia; now part of the <i>Alliance of Bioversity International and CIAT</i>
CIFOR	Center for International Forestry Research
DG	Director General
FAO	Food and Agriculture Organization of the United Nations
FGB	Field Genebank
FTE	Full Time Equivalent of staff
GB	Genebank
GBOWS-KIB	Germplasm Bank of Wild Species, Kunming Institute of Botany, China
GHU	Germplasm Health Unit
GRFA	Genetic Resources for Food and Agriculture
GRIN-Global	A scalable version of the Germplasm Resource Information Network
GRU	Genetic Resources Unit
HQ	Headquarters
HR	Human Resources
ICRAF	World Agroforestry Centre, Kenya
ILRI	International Livestock Research Institute, Kenya
IRAD	Institute of Agricultural Research for Development, Cameroon
KEPHIS	Kenya Plant Health Inspectorate Service
LTS	Long-term storage
MoU	Memorandum of Understanding
MSB	Millennium Seed Bank, UK
MTA	Material Transfer Agreement
MTS	Medium-term storage
OFI	Oxford Forestry Institute, UK
ORT	Online reporting tool of the Crop Trust
PEQ	Post-entry quarantine
PGR	Plant Genetic Resources
RH	Relative humidity (of the air; in %)
SDS	Safety duplicate storage
SGSV	Svalbard Global Seed Vault
SMC	Seed moisture content (in %)
SMTA	Standard Material Transfer Agreement
SOP	Standard operating procedure
ZARI	Zambia Agriculture Research Institute