IRRI

Genebank Review Report 2023

CROP TRUST

Global Genebank Partnership

Genebank Review Report

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Review team

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1 Summary of Review Findings and Recommendations

The IRRI genebank was the first to conclude the first 5-year cycle of a long term partnership agreement (LPA) with the Crop Trust. This was a recognition of the high standards of their routine operations that led to meeting the performance targets. The IRRI genebank continues to maintain the performance targets based upon a high level of quality operations. This is due to the commitment, passion, knowledge, and skills of the staff who work together well to ensure secure conservation of the collection. Some other strengths for the IRRI genebank recognized by the reviewers are:

- Commitment to excellence demonstrated by achievement and maintenance of genebank performance standards.
- Steady state routine operations have been attained with continuous innovation and experimentation to increase efficiency and effectiveness in conservation and use.
- Leader in *ex situ* conservation techniques with innovative, pioneering use of modern technology and tools.
- Impressive adoption of QMS with strong, comprehensive, and detailed SOPs.
- Great facilities with opportunities for expansion to meet the IRRI Fit-for-Future Genebank aspirations.
- Opportunities to improve seed handling workflows.
- Opportunity to share gold standard expertise with other genebanks and NARS.
- Opportunities to offer greater leadership in the global system for the conservation & use of rice genetic resources.

The review identified areas for improvement in the essential operations, in the engagement with users, enhanced collaboration with NARS in the region, and in the long term planning for the Fit-for Future genebank at IRRI. A list of the recommendations from the reviewers is given in Table 1. A summary of the updates from the last review is given in Table 2.

Table 1. List of recommendations

ID	New Recommendations	Proposed activities to address recommendations	Response of the genebank	Response of the Crop Trust
1	Make improvements in QMS to enhance efficiency, security, and reduce risk for routine operations (Sections 2, 3, and 4)	Update of all SOPs to ensure current activities are correctly reflected in each building/work area.	Updating all SOPs is an annual event, and most SOPs are up to date. Wherever there are gaps in SOPs as identified by reviewers, we will work to further update it.	We agree with the recommendation and commend IRRI for its proactive approach in addressing this issue.
		Update SOPs/workflows to include integration of automation for activities, such as viability testing, verification of identity, and characterization	These procedures are still in the exploratory/research phase. Once validated they will be incorporated into the SOPs	We agree with the recommendation and welcome IRRI's commitment to addressing this issue.
		For sections in common between different SOPs, align to have the same level of detail or alternatively, one section developed in the most appropriate SOP to be referred to in all the others	This is noted. SOPs will be updated accordingly.	We agree with the recommendation and welcome IRRI's commitment to addressing this issue.
		All SOPs need to have detailed equipment registers including all maintenance and calibration schedules, suppliers of these services, and management of spare parts	This is noted. SOPs will be updated accordingly.	We agree with the recommendation and welcome IRRI's commitment to addressing this issue.
		Address recommended improvements in security of collections and facilities that are given in Section 2.2.	The comments are noted and improvements will be made. We believe some of the recommendations are in line with current practice and these points are to be highlighted in the SOPs.	We agree with the recommendation and welcome IRRI's commitment to addressing this issue.
		Develop a longer-term succession and staffing plan that considers staff changes in key positions but also the need to adapt staffing skills to meet the long-term changes due to greater efficiency	This is agreed.	We agree with the recommendation.
		Develop long-term replacement schedule for equipment to reduce risk of unavailability or loss of key equipment	We agree with this recommendation. However, it has to be noted that implementation requires availability of assured funding.	We agree with the recommendation and acknowledge the need for additional funding. We also presume that this requires high-

ID	New Recommendations	Proposed activities to address recommendations	Response of the genebank	Response of the Crop Trust
				level support from IRRI management.
		SHU to use QR codes on all samples being tested to provide improved chain of custody and sample tracking and reduce potential human error in entering data.	This will be relayed to SHU and included in the 2024 SHU workplan from the Genebank Initiative (GI) funds.	We agree with the recommendation and commend the strong linkages between the genebank and SHU.
		Routinely monitor the number of samples in the accessioning process and if needed, revise the protocol to advance these samples into the collection, maybe by revising the minimum quantity required (especially for the wild species) or have the option to archive	We will review this recommendation carefully and in discussion with WP leaders in GI.	We agree with the recommendation and welcome IRRI's commitment to addressing this issue.
2	Enhance user feedback to monitor and address issues in seed, data, service provision, and facilitate end use of germplasm (Section 6.1)	Expand questions on quality of service and seeds received on an online acknowledgement/feedback form and use the feedback from users to improve services or address any seed quality issues that are identified by users.	This is a good suggestion. We have an option in GRIN-Global for users to give feedback voluntarily. The current system SHU uses could be improved to collect this feedback as routine procedure. We will work with SHU to implement this from GI funds.	We agree with the recommendation and welcome IRRI's commitment to addressing this issue.
		Initiate a routine user survey every five to ten years and include the modifications in the survey identified from the Jamora and Ramaiah (2022) paper	Agreed, this our plan as well.	We agree with the recommendation and welcome IRRI's commitment to addressing this issue.
3	Improve the efficiency and security of the seed handling workflow to reduce risk to genetic integrity and longevity of seeds in storage (Section	Refurbishment of seed processing room (current and/or new work areas) with controlled conditions of 20°C and 20% RH to undertake seed processing, cleaning, rouging, and subsampling to reduce potential loss in longevity of germplasm	We agree that the seed processing should be refurbished in the new area. Further, we reviewed the current practices with past staff and SQM experts, and conducted additional testing. All these point out that current practice is adequate to achieve the desired longevity and to provide a healthy work environment to staff. However, we shall continue to monitor and gather additional data before revising the current protocol. It has to be noted refurbishment needs additional resources.	We agree with the recommendation and welcome IRRI's commitment to addressing this issue.

ID	New Recommendations	Proposed activities to address recommendations	Response of the genebank	Response of the Crop Trust
	2.1.1, 2.1.2, 2.2, and 4)	Refurbishment of seed drying room or area (current and/or new work areas) with controlled conditions of 15°C/15%RH with capacity for seed drying, seed packing and distribution activities to maintain seed under best practice standards	We consulted in-house experts regarding this and other facility related recommendations. It seems the best practice would be to convert the existing (non-functional) drying room as coldstore. A new dryer (with dual source of power i.e., solar and electricity) should be built/purchased placed in the new area to make our operations seamless. However, this would require funding support.	We agree with the recommendation and glad to see IRRI taking steps. We acknowledge the need for additional funding and high-level support from IRRI management.to implement this.
		Streamline seed handling process to reduce the double handling of seed during cleaning/rouging and movements into/out of drying room environments that has controlled temperature and relative humidity that meets international standards	Agreed. Once we fully shift operations to new areas this can be achieved.	We agree with the recommendation and commend IRRI for its proactive approach in addressing this issue.
		Review historical data on seed viability tests to compare observed versus expected losses in viability over time. Use the information to review the current monitoring periods with the view to extend monitoring periods and improve efficiency and cost effectiveness	In the past, IRRI has looked in depth at historical seed viability data and monitoring intervals have been decided on the basis of historical data. However, we do plan to further review this in light of new data.	This recommendation has been modified taking into account IRRI's response. We support the need to review historical data for improved efficiency and commend IRRI for its proactive approach in addressing this issue.
		Review the protocol on the viability testing of regenerated seed samples that are non-active. If there are active samples that meet quantity, viability, and seed health criteria, reconsider the need to viability testing of non-active samples to improve efficiency and cost effectiveness.	Our procedure is in line with the recommendation. If an active sample that meets the criteria is available that accession is not regenerated. Viability of accessions from previous crop years are still being monitored as they can still be used as a source of planting materials and seeds for distribution within IRRI for as long as viability is not below 80%. This is implemented in GRIMS.	This recommendation has been modified taking into account IRRI's response. We support the need to review protocols for improved efficiency and commend IRRI for its proactive approach in addressing this issue.
4	Ensure the long term safety duplication of accessions with	Clear process for safety backup of two vegetatively propagated accessions developed	We agree.	We agree with the recommendation.

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	increased security of key processes (Section 2.2)	Update the SOP to clarify the protocol for monitoring viability for safety duplicate samples	We do not routinely monitor the viability of samples sent for safety backup but we do have a set of check varieties that was sent to SGSV (2020) and NLGRP (2021). There are several pouches containing 12 accessions per pouch, packed in a separate box. After every 10 years one pouch will be sent to IRRI for viability testing. These accessions will be the representative samples of the stored materials. Viability testing of the sample at IRRI is carried out as a proxy for the safety duplicate and when that sample loses viability then the duplicate should be considered for retrieval. A large batch of duplicates was brought back from USDA during the time of the Platform and a study was done on viability of the duplicates to test this practice.	We accept the explanation and support the recommendation to update the SOP for clarification.
		Update the SOP to clarify the placement of documents in each box for shipping to safety duplicate site	First box contains all documents and the complete list of materials in the shipment. In addition, each box contains the list of accessions inside.	We accept the explanation and support the recommendation to update the SOP for clarification.
		Develop a more detailed description on withdrawal from safety duplicate sites in a separate section for a post-deposit action	Accepted.	We agree with the recommendation.
5	Revise routine characterization of accessions to focus on relevant subset of phenotypic traits and profiles of genotype (Section 2.1.1 and 5)	Focus characterization on a minimum subset of descriptor traits determined in consultation with key publications and users to identify key traits to facilitate end use.	Accepted.	We agree with the recommendation.
		Continue to identify trait specific and core subsets and promote to user to enhance use of the collection	We do identify subsets and make this information available in Genesys. We shall continue to build on this and the Use Module of GI supports this activity.	We agree with the recommendation and commend IRRI for its proactive approach in addressing this issue.
		Reduce reliance on aging reference seed samples and streamline authentication/verification process with the use of a subset of characterization traits to validate accessions through sample	In addition to the seed files, we are also using remnant seeds of the planted material and revisit characterization data of previous years to validate the accessions for verification. Our AI tool will further help us in this activity.	We agree with the recommendation and commend IRRI for its proactive approach in addressing this issue.

ID	New Recommendations	Proposed activities to address recommendations	Response of the genebank	Response of the Crop Trust
		processing activities and under multiplication/regeneration		
		Use taxonomy SNP chip used for routine baseline genotypic characterization, with an initial focus on all new acquisitions and key sets of germplasm	We agree with this recommendation. This would also need additional resources. It costs >4$/sample.	We agree with the recommendation and acknowledge the need for additional funding. We hope that IRRI can use the review findings to build a business case for raising additional funds.
		Expand the taxonomic SNP chip to include markers that will enable genotypic characterization and evaluation of genetic integrity and diversity within and across species in partnership within IRRI or external partners, potentially to be used as an international standard for genotyping accessions with a future focus to identify duplication in genebanks, create diversity sets, and identify specific traits for end users.	We agree with this recommendation. We have already completed this activity for all the wild species accessions. However, the cultivated species, which are the bulk of our collection, have not been included due to lack of funding. This would also need additional resources as it costs >10$/sample.	We agree with the recommendation and acknowledge the need for additional funding. We hope that IRRI can use the review findings to build a business case for raising additional funds.
6	Modify the regeneration of accession of wild species and temperate japonica to secure genetic integrity and the quality of seed produced (Section 2.1)	For the wild species high density method, adjust the spacing between plants to increase airflow to potentially reduce pest/disease incidence, and improve control of outbreaks	Spacing was already adjusted for 2023WS. From 35 plants per tray, 16 plants per tray were grown. Total of 4 trays with 64 plants per accession are now implemented in regeneration of accession using the high density planting method. Recent publications show that in order to maintain the genetic diversity of rice, the population size for reproduction and regeneration should be between 60 and 140.https://doi.org/10.1038/s41598-023-29514-y	We agree with the recommendation and commend IRRI for its proactive approach in addressing this issue.
		Fully evaluate the use of the shipping containers for regeneration of wild species and temperate japonica accessions, including monitoring the energy use, overall cost, and seed quantity/quality, to determine cost effectiveness, efficiency and allow for modification.	We agree to this. This is a new system and we are in the process of collecting data to evaluate its effectiveness.	We agree with the recommendation and welcome IRRI's commitment to addressing this issue.

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7	Increase security and reduce inefficiencies in operating across multiple data management platforms and facilitate effective end use through one public interface (Section 2.3.1 and 2.3.2)	Consider the use a single web portal (Genesys) for public accessibility & ordering, as well as reporting to Genebank Initiative and the Crop Trust since this platform contains passport and characterization data	Having one portal may be advantageous. However, this has to be carefully reviewed and the decision has to be taken consulting various stakeholders including GI and Crop Trust.	We agree with the recommendation and glad to see IRRI taking steps.
		Determine functionality required from GRIN-Global Community Edition for transition from GRIMS and set deadline for migration to GGCE if suitable.	This exercise has been done. We have worked closely with the COP for this. Current version of GGCE may not be able to fully cater to our needs so we have to learn the programming language used to develop GGCE to be able to build the tools needed by IRG.	We strongly endorse the need to set a deadline for GGCE migration and welcome IRRI's effort in finding solutions.
		Plan to move to a single data system to manage genebank workflows, remove duplication of data, and improve efficiency in data management.	IRIS schema is part of the genebank's database structure, that is why we call the database IRIS-GRIMS. GRIMS (the system) connects to IRIS for more germplasm information and for tracing genealogy which are needed in creating new germplasm and generating new GIDs. There are IRIS stand-alone functionalities that are very useful in data mining. Although developers are trying to re-create them in EBS, nothing has been included yet in the UI as of this time (e.g., pedigree tree, coefficient of parentage matrix, mendelgram). EBS does not generate numeric GIDs, instead they use character type seed codes and germplasm codes. Different accessions of similar names are considered one germplasm, which is totally different from how genebank accessions are managed.	This recommendation has been modified taking into account IRRI's response. The issue is related to GGCE migration. We support the recommendation to streamline data and systems for improved efficiency.
		Continue to engage with the GGCE COP to discuss functionality of GGCE that would be applicable to IRRI genebank	We are involved in data management COP and engaged with various stakeholders for this.	We agree with the recommendation and welcome IRRI's continued engagement in the data management COP.

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		Review and update all SOPs to reflect frequency of backups, and frequency of updates to data systems	Frequency and schedule of backups of other data system (GG) is indicated in a separate document on the procedure on creating backups (GRIN-Global Backup Procedure). The link to this document is included in the SOP (Section XXI). Frequency of updates for Genesys and GLIS is in Section VII.	We agree with the recommendation and commend IRRI for its proactive approach in addressing this issue.
		For AI/automation innovation, develop a clear roadmap with a decision framework on development testing, and integration into routine operations to increase efficiency and maintain cost sustainability	Agreed. This is a new area and we are in the testing/pilot phase. Once validated they will be made part of SOP.	We agree with the recommendation and commend IRRI for its proactive approach in addressing this issue.
8	Incorporate AI and automation into routine operation as appropriate to enhance efficiency, security, and cost sustainability (Section 4.2, 7)	Revise process for the use of imaging/scanning of seed and panicles to remove duplication of effort to improve resource use efficiency with increased automation and with the future aim of using AI to capture valuable traits from images if feasible	We agree that more automation options have to be explored to improve resource use efficiency.	We agree with the recommendation and commend IRRI for its proactive approach in addressing this issue.
		Accommodate a new initial dryer and a dryer/holding room in refurbished building, before shifting routine seed handling operations from current workspace.	Agreed. This is in line with our plan and as explained before. Additional resources are needed to implement.	We agree with the recommendation and acknowledge the need for additional funding. We hope that IRRI can use the review findings to build a business case for raising additional funds.
9	Ensure secure and cost effective conservation facilities for the long term (Section 4.2 and 5)	Address future need to expand space for MTS that will accommodate active collection in one cold room and the archived bulks in a separate cold room	As explained earlier we plan to expand the non-functional drying room into a cold room. This will expand our capacity considerably.	We agree with the recommendation and commend IRRI for its proactive approach in addressing this issue.
		Address future need to expand LTS capacity (into new room maybe) to accommodate >50 year growth in base collection and to serve as a black box safety duplication site for national programs	We agree that there is a need to expand the capacity of LTS.	We agree with the recommendation and commend IRRI for its proactive approach in addressing this issue.

ID	New Recommendations	Proposed activities to address recommendations	Response of the genebank	Response of the Crop Trust
		Reference the institutional and genebank long-term strategic plan in the introduction	Business plan will be improved.	We agree with the recommendation and also updated the business plan template.
10	Improve the Business plan to present the case for continued long-term support (Section 8)	IRRI organizational chart be included	This will be included	We agree with the recommendation and also updated the business plan template.
		Elaborate on what it means for the genebank to be Fit-for-Future	This will be included	We agree with the recommendation and also updated the business plan template.
		Include discussion from longer term analysis of past genebank performance trends	This will be included	We agree with the recommendation and also updated the business plan template.
		Focus on innovations to facilitate end use	This will be included	We agree with the recommendation and also updated the business plan template.
		Include Table with intended outcomes, specific outputs with milestones (include both current scenario and aspirational scenarios) and timeframes for delivery over 5 years	This will be included	We agree with the recommendation and also updated the business plan template.
11	Ensure the cost sustainability of the routine operations at IRRI (Section 5.1)	Consider new funding opportunities to be able to cover increased costs of essential operations and complementary activities of the genebank that are not covered by the LPA.	It has to be noted that IRRI has recently invested a significant amount (>2 M USD) to improve the overall genebank infrastructure including the offices, coldstore, and screenhouses. IRRI's full-cost recovery (FCR) is based on actual costs and is based on a financial audit and is approved by the board. It is regularly reviewed and updated to reflect the actual costs. The chargebacks are a mechanism for paying for actual services provided to the genebank. They are not an overhead.	This recommendation has been modified taking into account IRRI's response. We appreciate the effort to clarify FCR charges and commend the recent investments to improve genebank infrastructure. The recommendation applies to the overarching need to raise additional funds for the genebank to ensure the long-term security of the collection and sustainability of operations.

ID	New Recommendations	Proposed activities to address recommendations	Response of the genebank	Response of the Crop Trust
			Overall, the costs of essential operations have increased for reasons other than FCR. The reasons include: inflation, significant increase in staff costs (due to salary increases, promotions, etc.), increase in cost of inputs, electricity, fuel, labor, etc., and growth in size of collection. Further, given that the LPA was based on 2016 costing study there is a need to review the costs. We recommend undertaking another costing study and for the revised costs to be considered by the Crop Trust for the LPA.	
12	Expand IRRI contribution to the global system, in collaboration with AfricaRice (Section 6)	IRRI and AfricaRice work together to mobilize the resources required to update the global strategy, including the survey of conservers and users as well as any follow-up consultation.	Probably, these are not part of essential operations and there is a need to mobilize the resources externally. We agree on the need to work with various stakeholders including Crop Trust to mobilize resources.	We agree with the recommendation and encourage IRRI to take the lead in updating the global rice strategy. We note the need for additional funds to implement the work.
		Continue working with and identifying opportunities with NARS genebanks to contribute to the security and sustainability of the global system	IRRI continues to work with NARS to identify gaps and support them where needed. However, this is not supported by the LPA and we use funds from GI- WP4 to work with NARS. We supported/supporting the BOLD project in Madagascar and Vietnam. In 2019 we worked with several countries from SEA and few from SA and identified the needs and developed a plan to improve their capacity. We developed at least three proposals and submitted them to different agencies to get funding.	We strongly endorse the recommendation to continue working with and identifying opportunities with NARS.
		Continue collaboration with AfricaRice on the unique attributes of germplasm and conservation processes within both centers to improve efficiency of germplasm conservation, maintenance, and distribution within the global system	This is happening under the Genebank Initiative.	We agree with the recommendation and commend IRRI for its proactive approach in addressing this issue.

Table 2. Updates since the last genebank review

*3=fully or mostly addressed, 2=partly addressed, 1=not addressed; 0=dropped/not applicable.

Rec# ID	Previous Recommendations	Status*	Reviewers Comments
1	Find alternative site(s) for temperate japonicas and any other unadapted varieties.	2	This is still recognized as an urgent need so two other alternatives are being tested, such as a student study on the use of the phytotron (costly) and the use of the shipping container greenhouses
2	Review practice of maintaining and monitoring multiple seed generations in the active collection (pros, cons, cost-effectiveness).	2	This is still a priority issue for IRRI, especially as space in the storage units is limited. There is some effort being made to reduce the packets conserved per accession in the MTS but this needs to be considered further.
3	Improve the protocol for breaking dormancy in *O. glaberrima.*	3	SOP has been updated
4	Undertake a comprehensive analysis of the state of the wild species collection: quantity of seed in storage (MTS and LTS), viability testing; accessions with expected genetic bottlenecks or contamination, available data, importance for breeding, use over last years, required GRIMS adaptations, and other relevant elements to be able to draw-up a plan for improving the management of the wild species collection.	3	
5	Further develop "Distribution and exchange of rice genetic resources" SOP to add principles and procedures for handling large or repeated requests, and for active follow-up with requesters to monitor satisfaction, address any issues raised (viz seed, data, service), better understand needs, exchange data and develop collaboration**.** Include also the principle of proactive distribution to extend the outreach of the genebank and increase its user community. Remove time-sensitive appendices and provide links to where updated versions can be accessed.	2	There is still a need to revise the user survey to be more informative to address all the issues highlighted in bold in the recommendation. Also increase “proactive distribution” with more facilitated access.
6	"1. Complete passport data gaps in the information system and upload to Genesys for IRRI-held accessions in the Bioversity Collecting Missions database. 2. Correct errors in data uploaded to Genesys including entry for subtaxa fields 3. Prepare a workplan for pursuing options to fill other passport data gaps (i.e. checking websites, contacting donor institutions, etc.)"	3	Routine continuous improvement ongoing as needed
7	Investigate data management tools that will allow prediction of 'peaks' or 'dips' in operations and thus facilitate oversight and forward planning of resources and budget.	1	Dashboard addressed internal need to visualize status of operations but tool for planning has not been done and there is still a need to consider the application of this assessment to IRRI collection management

Rec# ID	Previous Recommendations	Status*	Reviewers Comments
8	Increase visibility of genebank on IRRI website and develop a workplan for enhancing public access to information on the IRRI genebank and to IRRI-generated evaluation data.	3	Dashboard active on GRIN-Global
9	"1. Increase staff resources dedicated to conservation research and scientific research related to IRRI's role as a center of excellence 2. Prioritize genebank operational constraints for conservation research."	2	Research on specific conservation operational needs is being done as part of improvements in processes and there are funds available from the Genebank Initiative.
10	Enhance genebank teamwork in processing wild species.	3	

2 Assessment of genebank activities to sustain essential operations.

2.1 Availability of germplasm

The reviewers observed that availability of germplasm at IRRI is high, and that the collection is being routinely monitored for seed viability, seed heath, with regeneration of germplasm undertaken when monitoring criteria were met. Acquisition into the genebank involved a two-step process whereby new germplasm was registered into the GRIMS system and seed quantity, viability and health testing undertaken. If all minimum criteria were met, germplasm was then accessioned and conserved into the MTS, LTS, national and international safety duplication. If minimum criteria were not met, germplasm was held in the MTS until criteria are met through seed multiplication and retesting for viability and seed health.

The reviewers commend IRRI on the high level of availability of germplasm, with little to no backlogs associated with germplasm availability reported during the site visit. However, it was observed that there was a backlog of samples that had not yet met accessioning criteria, with some material having been there for 10 years due to difficulty in multiplication of sufficient seed to meet minimum criteria. The Acquisition SOP describes the protocol for replanting and when there is no longer a need for replanting, the samples are registered and stored with accession numbers, and all databases are updated. That would indicate there could be samples backlogged in this process. The reviewers recommend monitoring the level of this accessioning backlog routinely and revise of the protocol to ensure the advancement of these samples into the collection, maybe by revising the minimum quantity required (especially for the wild species) or have the option to archive.

2.1.1 Monitoring of genetic integrity

IRRI has undertaken genotypic verification of all wild species accessions using SNP chip (20 markers) for taxonomic verification to the sub species level. This has enabled them to identify and correct taxonomy in the passport data and improve the management of those accessions using more appropriate wild species protocols. The plan is to utilize the SNP chip to verify taxonomic classification in all new accessions and the reviewers assume this new process will be described fully in the Acquisition SOP. The reviewers understood that all wild species are currently being genetically characterized using DArTseq to assess diversity within and across these species.

The reviewers observed identity validation checks on recently multiplied/regenerated germplasm using physical seed files. These seed files are used four times during seed processing to validate and for final authentication. Digital images are being recorded for panicles following multiplication/regeneration, including RGB imaging of multiple heads, and document scanner scans of single heads glued to card, as well as seeds scans, however, these are not yet being used for validation. The high throughput seed sorter is used extensively for accessions meeting set criteria (more uniform species/morphologies) based on set identity recipes for each accession. Following processing through the seed sorter, the seed lots are additionally manually cleaned and validated/authenticated.

IRRI undertakes characterization trials for germplasm annually, with the objective to record 52 rice descriptors. It is not clear which descriptors are taken routinely since the Characterization SOP list 64

descriptors based upon the 2007 publication, Descriptors for Wild and Cultivated Rice. To date, no accessions have all 52 traits recorded, with most having fewer than half the traits recorded. This is a significant backlog. The genebank manager detailed plans to collect all 52 traits on every accession regardless of the number of traits already recorded. This could be a worthwhile goal to develop a large comprehensive database for characterization but given that they have annually characterized about 1,700 accessions, it will take nearly 80 years to complete the characterization for the entire collection, assuming that they are able to record all 52 traits in one season for each accession. Obviously, this is not easy given the range of traits measured. The reviewers do not believe this to be an efficient or effective use of resources and instead recommend that the number of traits recorded moving forward are reduced to include a subset of key genebank validation traits and end user traits to facilitate uptake of germplasm. Annex I of the 2007 Descriptor has a list of 21 traits that were considered highly differentiating. Annex I was expanded on in "Key access and utilization descriptors for rice genetic resources[1]" with 25 traits identified. Both lists of descriptors could serve as a source for the subset. Reducing the number of traits measured to the most informative could allow for at least a doubling of the number of accessions characterized each year.

The reviewers were told the characterization traits were not used to validate accessions during growth under regeneration, and that the residual seed stocks from previous regenerations or the original seed file are used to verify identity prior to sowing and at the reproductive stage as described in the Regeneration SOP 6.6.3.5, 6.14.4 and 6.15.5. Some of the traits are used to remove off-types during the vegetative stages but only based on observation of variation (6.14.4). The Acquisition SOP refers to the use of 'mini-characterization' using a minimum crop descriptor list. The approach and subsets of traits used could be considered as a baseline for the identification and use of a set of minimum traits for validation.

IRRI uses QR codes, scanners, and electronic devices to track activities through all genebank processes, with all processes highly integrated into their main documentation system GRIMS with a strong chain of custody observed. Some processes were observed to be highly repetitive and duplicated, with inefficiencies observed in use of staff resources.

The reviewers observed several opportunities for improvement and recommend IRRI:

- Review the number of characterization traits recorded in consultation with publications (2007 Descriptors for Wild and Cultivated Rice and Key access and utilization descriptors for rice genetic resources) and users to identify key traits for validation of identity within genebank processes, and key traits to facilitate end use.
- Improve integrity verification through use of the characterization traits subset to validate accessions under multiplication/regeneration, and through sample processing activities to remove reliance on seed files alone.
- Update SOPs to reflect use of characterization data for validation of identity during multiplication/regeneration.
- Review seed processing workflow to reduce double/triple handling of seed and reduce excessive seed authentication processes.
- Review process for the use of imaging/scanning of seed and panicles to remove duplication of effort and improve resource use efficiency.
- Recommend the development of a process to use the taxonomic SNP chip to validate the taxonomy of all germplasm entering IRRI genebank.
- Investigate opportunity to extend the SNP chip to include markers that will enable genotypic characterization and evaluation of genetic integrity and diversity within and across species with the view to use this to identify duplication or fill gaps in IRRI genebank collection.

2.1.2 Monitoring of viability

During the site visit, the reviewers observed viability testing being undertaken, with staff recording initial viability upon registration of germplasm, and on all newly multiplied/regenerated seed samples

[1] https://www.genebanks.org/resources/publications/key-access-and-utilization-descriptors-for-rice-genetic-resources/

where sufficient seed is available. Two replicates of 50 seeds are tested using ISTA standard between paper tests as rolled towels in growth cabinets set at specified temperature.

Periodic viability testing is undertaken on MTS every 5 years, and every 10 years for LTS samples. In the MTS, all seed samples are tested including the current active and previous generations. All results are recorded using QR codes into an electronic system and uploaded to GRIMS using scan of QR code on sample, use of QR code to record number of germinated seed. An overall "pass, >85% germination rate" or "fail" is recorded into GRIMS and used as a basis for periodic testing into the future.

IRRI has implemented an additional process during viability testing including RGB imaging to count the germination step of viability testing, with the reviewers observing initial images being taken on day 0 upon set up of the trays. These images are being collected for development of automated AI germination counts.

The reviewers observed the new LemnaTec Germination Scanalyzer installed at IRRI that will be used to undertake seed viability testing with value added seed traits recorded. The Scanalyzer was not fully operational, with the genebank manager having concerns about the throughput of the system not being able to process enough samples annually to meet required testing levels.

The reviewers observed opportunities for improvement and recommend IRRI to:

- Review historical data on seed viability tests to compare observed versus expected losses in viability over time. Use the information to review the current monitoring periods with the view to extend monitoring periods and improve efficiency and cost effectiveness.
- Review the protocol on the viability testing of regenerated seed samples that are non-active. If there are active samples that meet quantity, viability, and seed health criteria, reconsider the need to viability testing of non-active samples to improve efficiency and cost effectiveness.

2.1.3 Monitoring of germplasm health

IRRI undertakes seed health testing on all germplasm it receives through acquisition (after registration prior to accessioning) and following seed multiplication/regeneration events. All newly imported germplasm is screened, with germplasm that passes released to the genebank for registration, and germplasm that fails is destroyed. Genebank seed lots are only tested one time, with the whole seed lot certified following testing as either a pass (clear of pests and pathogens of concern) or fail (presence of pest/pathogen) into GRIMS. Older seed lots from the MTS that have not previously been tested are tested prior to distribution as required. Seed lots that fail the SHU testing are temporarily stored in the MTS in paper envelopes, with seed treatments able to be applied depending on the end user requirements/phytosanitary conditions.

All seed testing is undertaken by the IRRI Seed Health Unit located on the IRRI campus, with two small seed samples provided following final seed verification during seed processing. The packaging of the seed for viability and seed health testing is done at the same time (described in 6.3.7 and 6.3.8 in the Management SOP) and only seed samples with sufficient seed for long term storage and >85% viability are sent to the SHU (6.54 in the Management SOP). The SHU tests for nematodes (funnel test and/or beaker test), seedborne fungi (blotter), and bacteria (via PCR). The reviewers observed that the SHU does not use barcode or QR codes on test samples to track processing, although they did have a QMS in place that was accessible via QR code placed on the benches. All data is recorded into electronic systems, with testing taking approximately two weeks. The SHU uses the EBS system to record data, and the EBS PUID is provided for upload to GRIMS to link the data between systems.

The reviewers recommend that the SHU implement QR codes on all samples being tested to provide improved chain of custody and sample tracking and reduce potential human error in entering data. It is noted that the SHU are investigating implementation of ISO accreditation, which will require implementation of QR codes to their processes.

2.1.4 Ensuring sufficient stocks of germplasm

The reviewers observed that both field and greenhouse/screenhouse facilities were readily available to IRRI for multiplication/regeneration and characterization trials. During the site visit, seedling nurseries were observed with hand sowing of the regeneration plots to be undertaken the following week. The genebank manager reported the high costs to undertake field and greenhouse activities based on IRRI cost recovery mechanisms, which is a concern to the reviewers as this could be unsustainable for the genebank into the future.

The reviewers observed that for cultivated species, 100 seeds were sown in seedling nursery, and transplanted to the field by hand which is labor intensive and requires numerous temporary staff. If there was a low seedling number established, the accession was not transplanted. During the reproductive stage, verification of identity was undertaken using the remnant seed or the seed files. At maturity, panicles were hand harvested and transferred to the threshing area and threshed the same day using mechanical threshers. Field staff reported that a new thresher produced less seed contamination compared to the older, larger threshers. Generally, sufficient seed amounts were produced from each plot to meet minimum seed metrics for conservation. The reviewers observed that a new mechanical seed transplanter had been purchased to reduce the need for manual labor but had yet to be tested or optimized. Obviously, increased mechanization and automation is important for cost efficiency.

The reviewers visited the quarantine screenhouse used for multiplication/regeneration of wild species. Standard multiplication/regeneration SOP for the wild species was 20-30 plants sown into individual pots under drip irrigation to maintain flooded state. Varying yields were obtained using this configuration. The reviewers were concerned that there was an insufficient seed number to maintain genetic integrity of the accessions. There were two accessions maintained as clonal plants as they do not flower but these two accessions are not safety duplicated placing them at risk.

The genebank had implemented a new trial layout for seed production from wild species using high density sowing in smaller seed trays with 100 plants sown. There was a high incidence of pest and disease, with control measures being investigated. Some accessions did not have 100 seedlings established due to low viability or seed availability. An investigation into loss of viability over time compared to 20-30 plants in individual pots was done with results indicating no detrimental effects under high density sowing.

The genebank manager reported difficulty in regenerating some wild species and temperate japonica due to the inability to provide conditions they require for growth and seed set. In the previous review, the identification and establishment of an additional site for the regeneration/multiplication for the temperate japonica accessions was recommended but has still not been addressed. Four shipping containers had been purchased with LED lights and temperature control that were being used to trial both wild species and temperate japonica rice seed production. These initial trials will be used to inform further trials to optimize conditions and seed return. A determination of the value of regeneration in the shipping containers, as a substitute for the identification and use of an additional site, should be based upon cost effectiveness, efficiency, and quality/quantity of the seed produced.

The reviewers observed opportunities for improvement and recommend:

- For the wild species high density method, review the spacing between plants to increase airflow to potentially reduce pest/disease incidence, and improve control of outbreaks.
- Use a subset of characterization trait data (existing and to be taken) to validate identity of accessions during regeneration, multiplication, and characterization activities.
- Continued testing of the use of the shipping containers, including monitoring the energy use and overall cost, to allow for determining cost effectiveness, efficiency, and quality/quantity of the seed produced and guide modification.

2.2 Security of the crop collection and the genebank

IRRI has a clear policy on safety duplication of landraces, traditional varieties, advanced cultivars, and varieties of *O. sativa* and *O. glaberrima* and wild rice and related genera conserved as seeds but does not safety duplicate genetic stocks, genebank accessions that are no longer available or archived, and accessions where the donor has or intends to safety duplicate themselves. These are conserved at two

levels described in an SOP that have resulted in 91% of the collection safety duplicated in SGSV and 92% safety duplicated in USDA NCGRP. There are slightly more accessions currently conserved in Svalbard than Ft Collins, but we assume this will be addressed and does not represent any significant backlog. The proportion conserved at both levels is high and probably only small improvement can be made annually given the number of known accessions with regeneration difficulties. Clear agreements for both sites have been signed and updated as needed.

Review of SOP for safety duplication identified several issues in relation to viability testing and withdrawal of samples where there is a need to clarify or develop processes further. For example, in 6.20, the process for sampling and for setting up germination testing at safety duplication sites is clear but it is not in line with the agreements nor with other parts of the SOP. With USDA NCGRP, Annex 1 agreement has a specific condition (no. 2) that states that USDA NCGRP will not use the material for viability testing. With SGSV, Clause 4.4 in Annex 2 of the agreement states that SGSV will not be responsible for germination tests "unless agreed in writing with Depositor". Viability monitoring for the safety duplicated samples need to be clarified and the SOP updated.

The basis for withdrawal from the safety duplication sites are described in Section 6 and Annex 8 but not the process for withdrawal and return of all or part of the collection. There is a need to develop a clear process for "Withdrawal from duplicate site" and this should also be included as a final process in Annex 9 workflows. This will need to include issues related to shipment back and any import issues for the box return. How will you deal with the documenting this return in GRIMS? The experience of ICARDA should be very helpful in developing the withdraw process.

The main recommended revisions are:

- Clear process for safety backup of two vegetatively propagated accessions developed.
- Clarify the protocol for monitoring viability for safety duplicated samples
- Clarify fully the placement of documents in each box for shipping to safety duplicate site.
- The safety duplication process should include a more detailed description on withdrawal from safety duplicate sites in a separate section for a post-deposit action.

Safety and security of the genebank staff, operations, facilities, and equipment was reviewed onsite and in Section 4, 5 and 9 in the SOP for Management of rice genetic resources (MAN-001) v1.2. Section 4 describes the monitoring, calibration, and maintenance of essential genebank equipment, as well as the location of manuals and information sheets. Section 5 describes occupational health and safety while Section 9 describes safety and security of staff, storage units, infrastructure, and work environment. Much of this is repeated in Section 5 and 6 in the SOP for safety duplication. The reviewers recommend improvements in several areas to ensure security of the collections and genebank, such as:

- More specific details on where spare parts are stored, inventory control, etc.
- Indicate on any formal records on how and how often there are incidents, repair, etc.
- Indicate the frequency that smoke detectors and fire extinguishers maintained or replacement/recharging.
- Describe how the standby generator specifically for genebank in addition to the IRRI one is used to ensure a consistent electricity supply. Is it automatic or manual? Does it have a time lapse to avoid power surges or is this managed in other ways? Who is responsible for maintenance and repair of this generator? Who monitors its operation? Are records kept on issues, maintenance, repairs?
- Indicate if any records are kept on fluctuation in RH and humidity during monitoring and if there are responses/repairs?
- The business continuity plan should include an evacuation plan for the collection itself if threatened, who is responsible for this plan, and how often is it updated.

2.3 Documentation and data availability

2.3.1 Information management system for monitoring and management

During the onsite visit, the reviewers observed the data systems and equipment used for QMS processes. The genebank utilizes QR codes in all areas of activity, and uses scanners, printers, and electronic

devices to record data and upload into their data systems. The genebank has a very strong QMS system around managing data integrity, with no handwritten labels/tags observed through any operation. IRRI has a highly skilled database management team with extensive experience across a wide range of platforms.

The reviewers observed five data management systems in use to provide genebank management, external user interface for searching and requesting, and integration with SHU result data. The reviewers observed GRIMS as the primary internal genebank management software, with functionality very closely aligned to genebank workflows, with QR code capability to scan, track process and print labels allowing ease of use for technicians. GRIMS contained all passport, inventory, characterization, viability, seed health and distribution data, although there is no external functionality to enable users to query or make requests. IRIS is used to generate GIDs for each new accession; however, IRIS is not currently maintained and is at risk of becoming non-functional over time. The genebank has developed capability in GRIMS to generate GIDs, making the continued use of IRIS unnecessary. EBS is used by the Seed Health Unit for test results, and as such, the genebank is required to use EBS to generate the unique ID provided to the SHU. All SHU test results are loaded into GRIMS with the EBS unique ID that is also used to generate phytosanitary certificates if they are required for distribution.

The genebank uses two data systems to provide public accessibility to germplasm data and to make requests. GRIN-Global contains the full passport data and some inventory data, with automated update of passport data frequently from GRIMS to GRIN-Global. Most requests for germplasm are received via GRIN-Global, which is migrated to GRIMS to manage the request. Genesys is also used for public accessibility, holding passport and characterization data, and fulfilling the same functionality for the genebank as GRIN-Global. Requests received via Genesys are migrated to GRIMS to process the request. Genesys is regularly updated as new data becomes available.

In addition to the five systems above, the genebank has been reviewing GRIN-Global Community Edition (GGCE) for several years. The reviewers observed a high level of testing, and active communication with the Crop Trust and the Community of Practice on Data Management (CoP-DM) on Data Management around the functionality that they need to enable a transition from GRIMS to GGCE. To date the full functionality requested has not been endorsed by the GGCE COP, with IRRI reluctant to migrate to GGCE given the lack of alignment to their workflows compared to GRIMS, the lack of restrictive access, and the resulting concerns for their technicians to perform routine operations with GGCE.

The reviewers observed significant inefficiencies across multiple data platforms, limiting the effectiveness and efficiency of data management and public availability. There are opportunities to reduce duplication of data across multiple platforms and facilitate effective end use through one public interface. The reviewers recommend to:

- Consider the use a single web portal (Genesys) for public accessibility and ordering, as well as reporting to Genebank Initiative and the Crop Trust since this platform contains passport and characterization data.
- Determine functionality required from GRIN-Global Community Edition for transition from GRIMS and set deadline for migration to GGCE if suitable.
- Plan to move to a single data system to manage genebank workflows, remove duplication of data, and improve efficiency in data management.
- Continue to engage with the GGCE COP to discuss functionality of GGCE that would be applicable to IRRI genebank.

2.3.2 Security and availability of germplasm data

All IRRI genebank data including passport, inventory and characterization data is stored in GRIMS on an AWS server as the primary data management software, with data updated daily in line with activities undertaken on the day. Regular backup of GRIMS is undertaken with data tables backed up daily Monday to Saturday, and full backups of the database and schema every Sunday.

GRIN-Global is updated with new passport data through automated coding from GRIMS, and is backed up daily, although this is not stated in the IRIS-GRIMS and GRIN-Global data integration SOP. Molecular characterization genotyping data is stored in GIGWA and backed up according to GIGWA standard protocols and linked back to GRIMS via DOI's.

The reviewers identified some opportunities for improvement and recommend that all SOPs are updated to reflect frequency of backups, and frequency of updates to data systems outside of GRIMS.

3 Key Performance Indicators

Table 3. Status on key performance indicators

ID	Indicator*	Status
	Availability of germplasm	
1	% collection, legally, and physically available for distribution (clean, viable, and with sufficient quantity)	94%
	Safety duplication of germplasm	
2	% of the seed collection held in long-term storage at two locations	91%
3	% of the clonal collection held in cryopreservation at two locations	NA
4	% of the clonal collection held in slow growth conditions *in vitro* at two locations	NA
5	% of the field collection, also held in *in vitro* and in cryo	NA
	Documentation and data availability	
6	% collection with passport data available online	100
7	Average crop PDCI >6.0	7.38
	QMS	
8	Number of elements of QMS in place (out of 8)+	6.5

**Refer to Annex 2 for baseline figures. Consider crop disaggregation where relevant.*

+The 8 key QMS elements are: 1-Science & Operations, 2-Policy, 3-Risk, 4-Staff, 5-Equipment, Infrastructure, & Reagents, 6-User satisfaction, 7-Information management, 8-Suppliers & Services. See Figure 1 in Lusty, Charlotte, Janny van Beem, and Fiona R. Hay. 2021. "A Performance Management System for Long-Term Germplasm Conservation in CGIAR Genebanks: Aiming for Quality, Efficiency and Improvement" *Plants* 10, no. 12: 2627. https://doi.org/10.3390/plants10122627

4 Proactive management of collection

The reviewers observed high level quality assurance practices across genebank operations with QR codes, scanners and electronic devices used to track activities through all genebank processes. The reviewers observed staff to have a high level of skill across all activities during the site visit. There is a high level of integration of workflows with the GRIMS database, with high-level quality assurance and control in place across all activities. SOPs are in place for all areas of activity, all of which have been updated and/or reviewed internally by the SOP owners and key staff in the last few years. The reviewers observed that some SOPs had not been updated following the move of some activities to the renovated building and did not always reflect current practices. The SOPs have not been aligned in relation to some of the sections which are in common, such as the sections on Materials, Equipment, and Reagents or Occupational Health and Safety or Infrastructure and Work environment, or IT security so they have all the same level of detail. Alternatively, there could just be one section in the most appropriate SOP that is referred to in each of the others and this might be easier for updating also. This is the approach taken for the Regeneration SOP and the Characterization SOP.

The reviewers observed some opportunities for improvement and recommend:

- Review of all SOPs to ensure current activities reflected in each building.
- Need to generate SOPs/workflows to include integration of automation for activities, such as viability testing.

- For sections in common between different SOPs, these need to be aligned to have the same level of detail or alternatively, there could be one section developed in the most appropriate SOP to be referred to in all the others.
- All SOPs need to have detailed equipment registers including all maintenance and calibration schedules and suppliers of these services.

4.1 Risk management

The IRRI genebank has strong QMS processes and SOPs in place, however some additional risks were observed for the genebank. Most staff contracts end during December 2023, placing the genebank at significant risk of loss of highly skilled staff if contracts are not reviewed in time. The genebank has no succession plan in place following the recent turnover in senior staff, with risks to routine operations if skilled staff cannot be recruited to fill roles quickly.

The genebank does not have a complete register of equipment across all activities showing condition, calibration, and replacement schedules. This schedule is required for forward planning for periodic replacement of equipment prior to end of life.

The genebank relies on the use of the physical seed file for validation of the identity of accession through seed processing, sampling, and regeneration, with potential risk in loss of genetic integrity of accessions due to limited characteristics used.

The biggest risk to germplasm in the genebank is the movement of material between dryer and uncontrolled environmental conditions during routine seed processing activities and the packing process. This movement is potentially causing a loss in longevity through the changes in moisture content of the seed as it moves between drying rooms and uncontrolled environments.

The reviewers identified opportunities for improvement to mitigate these risks and recommend that:

- Develop a detailed equipment register, including the condition, calibration, and maintenance schedule of all items, including a replacement schedule.
- A staff succession plan should be developed to enable capacity training of staff to step into key management and operational roles if the role becomes vacant.
- IRRI genebank review their sample handling processes to minimize the handling of material outside of controlled T/RH environments to reduce potential loss in longevity.
- IRRI consider the modification of suitable controlled environments within the renovated genebank building for seed processing (to 20°C/20%RH), and for packing and distribution (15°C/15%RH) that meet the genebank standards.
- IRRI to utilize other characteristics than just the physical seed file to validate the identity of accessions.

4.2 Efficiency of genebank procedures

The reviewers observed highly efficient and effective processes and procedures in use across most genebank activities in terms of staff, resource use and most facilities. Some inefficient practices and procedures were observed during seed processing which involved double and triple handling of seed and multiple movement to and from controlled drying room environments, and in seed authentication/verification process. It was also observed that seed processing, rouging, and packing was undertaken in environments that did not meet international standards for temperature and humidity, potentially impacting the longevity of the seed.

The reviewers observed that the majority of genebank activities were being undertaken in the newly renovated genebank building, whilst the procedures for seed drying, processing, and packaging were being undertaken in the separate TT Chang building, with the seed needing to be transferred between buildings.

The reviewers observed inefficiencies in the recording of characterization data, with multiple forms of imaging (RGB, scanners) being used to capture panicle and seed images, with duplication of effort. The characterization of crop descriptors was also observed to use significant resources to try and capture the full 52 traits, many of which are not used by end users, and not used by the genebank for quality assurance. It was observed that less than half of the traits had been recorded for majority of the

accessions. The genebank manager planned to grow out every accession to capture all traits at a rate of about 1500 accessions per year, which would take nearly 80 years to achieve and should not be a priority for the genebank.

There are opportunities to improve efficiencies across sample handling, characterization, and use of infrastructure, with the reviewers recommending:

- Revise sample handling process in SOPs to reduce the double handling of seed during cleaning/rouging and reduce movements into and out of controlled drying room environments that meet international standards.
- Revise the imaging of panicles and seed to identify a streamlined process to remove duplication of effort with the future aim of using AI to capture valuable traits from imaging.
- Consider refurbishment of the renovated genebank building to incorporate the initial dryer and seed drying room so all activities can be undertaken in the one building.
- Investigate opportunity to build seed processing room at 20°C/20%RH to undertake seed processing, cleaning, rouging, and subsampling to reduce potential loss in longevity of germplasm.
- Investigate opportunity to build seed drying room 15°C/15%RH with capacity for seed drying, seed packing and distribution activities to maintain seed under best practice standards.

5 Effective enabling environment

5.1 Finances

The budget allocation within the LPA was based upon a costing study of routine operations. This allocation is assumed stable and adequate for the long term given the predictable nature of routine operational cost and gains that can be made in efficiency or reallocation of savings. This is the cost sustainability that is needed to ensure that the conservation of the collection is rational, cost-efficient, and sustainable. The IRRI genebank has made many improvements so far to increase efficiency and make cost savings in the portion of the budget that is directly managed by the genebank. The improvements will ensure that they can continue routine operations within the allocated budget. Unfortunately, some of the changes are also being driven by the need to reduce or reconsider some expenditures for institutional services with full cost recovery, such as the use of greenhouse space and field sites. The reviewers appreciate the need to charge projects for their use of institutional services and facilities with full cost recovery, but this can fluctuate with user demand and is not easy to accommodate in the current funding approach for a predictable annual cost for essential genebank operations, based on the costing study. Increases for the full cost recovery of needed intuitional services could be a risk to the cost sustainability of the genebank. The commitment that is made in the 2018 Business Plan for IRRI complementary funding was:

- IRRI commits to maintaining both facilities and equipment in serviceable order and appropriately calibrated as part of the LPA. It also commits to ensuring that the complement of staff listed is sustained.
- IRRI is committed to providing an agreed basic level of complementary funding as part of the LPA, corresponding at least to the “Low” success in Table 1 (about $3.5 million per year).

It was not clear to the reviewers if this commitment for the complementary funding from IRRI is accounted for or information is shared with Crop Trust in annual reporting. The LPA is a contract related to the funds for the essential operations, but it is not a ‘restricted’ project since it is a long term partnership that recognizes the contribution of both the Crop Trust and IRRI. The Crop Trust funds enable IRRI to meet its global obligations under the ITPGRFA and the FAO in-trust agreements to secure the conservation and use of the international collection. If the annual cost for the essential operations were to increase significantly due to full cost recovery or if the gains in efficiency were not adequately reallocated to cover increased direct cost for the genebank, then there would be a risk to the collection and its quality management. Thus, IRRI will need to consider how it might further cover essential services or facilities cost within the complementary funding commitment.

5.2 Policy

IRRI has no issue with the implementation of the SMTA or other MTA's related to distribution and acquisition. The Distribution SOP has clear details on policy and the decision process. The main issue for the distribution SOP relates to the user feedback form or survey (6.14.2 and Annex 10) that will be discussed in the User Engagement section.

While the scope for the Acquisition SOP is comprehensive, there is no section on collection or genebank initiated acquisition. Although there is a reference to collection from *in situ* in the Scope section, a decision process is not given here but in Section 6.1 so this needs to be aligned. In the Scope section, there is reference to sources for acquisition that is not described in Annex 4. Thus, the reviewers recommend that Annex 4 on "Genebank Acquisition Principles" be further developed and updated.

5.3 Staff management and succession planning

The management of staff, their capacity building, and issues related to health and safety are clear in all the SOPs. There is clarity in the staff responsibilities and management at IRRI and this was evident in the genebank visit. As discussed in the section on Risk Management, the genebank has no succession plan in place following the recent turnover in senior staff, with risks to routine operations if skilled staff cannot be recruited to fill roles quickly. So, while succession is happening and management of these significant changes is being done, there is no formal planning process. As discussed, in the previous section, the reviewers recommend that IRRI develop a longer-term succession and staffing plan that considers changes in key positions but also the need to adapt staffing skills to meet the long-term changes due to greater efficiency.

5.4 Leadership

There were no issues with leadership for the reviewers. While the review team did not get the chance to see IRRI's organizational chart during the review period, IRRI management of the genebank was evident in terms of the participation of the key IRRI management staff in the review and there was no issue in terms of institutional arrangements. The reviewers recommend that the IRRI organizational chart be included in the business plan.

6 Contribution to the global system of crop diversity conservation

6.1 User engagement

The IRRI genebank actively engages with users through distribution of accessions but not in any frequent follow-up with the recipients. The IRRI genebank routinely sends the acknowledgement/feedback form described in Annex 10 of the distribution SOP following dispatch of a request. The form has only one question area related to the quality of the service/seed distributed and a question on the purpose of use. They indicated in the baseline report that there were no complaints, just suggestions for improvement. Since the form is both for acknowledgement and feedback, it is assumed they have a high response rate, but this will be made easier with an online form. Section 6.14.2 in Distribution SOP indicated that in the future a google form will be used to obtain acknowledgement receipt/feedback once the shipment has been dispatched.

Jamora and Ramaiah (2022)[2] reported on a survey of recipients of accessions from 2012-2018. A previous survey was done in 1995. The paper demonstrated the significant direct and indirect use of the accessions received and the importance of accession level information to users. Thus, more frequent routine follow-up with users on their use of the germplasm received is of value to the IRRI genebank and to the Crop Trust to sustain support for long term conservation and to enhance use. The study concluded that improvements could be made in the survey to obtain greater information on the characteristics of the users and the impact of different types of data. A routine follow-up survey of users should be implemented to engage more with users of the genebank to not only better understand their use of past distributions but to gain a better understanding and opportunities to enhance future use.

[2] Jamora, Nelissa and Venuprasad Ramaiah. 2022. Global demand for rice genetic resources. CABI Agriculture and Bioscience 3:26 https://doi.org/10.1186/s43170-022-00095-6

The IRRI genebank described the recent experience it has had with a project in Vietnam that involved the testing of a subset of accessions with researchers and farmers. The identification of trait specific and core subsets and other options to facilitate use of collections is not currently being done by IRRI. The availability and promotion of these subsets has been shown to be of value for users and to significantly enhance user engagement by other international collections (for example ICRISAT). Identification of subsets is also an opportunity to engage with breeders and others within IRRI and outside IRRI through a consultation process.

The reviewers identified areas for improvement and recommend:

- Expand questions on quality of service and seeds received on the planned online acknowledgement/feedback form.
- Develop a process for the implementation and use of the information from users to improve services or address seed quality issues that are identified by users.
- Initiate a routine user survey every five to ten years (such as in 2026 for 2019-2023 recipients) and include the modifications in the survey identified from the Jamora and Ramaiah (2022) paper.
- Identify trait specific and core subsets and promote to user to enhance use of the collection

6.2 Partnership with national genebanks and stakeholders

IRRI has established collaboration with AfricaRice on rice conservation and use globally. A more rational conservation of rice genetic resources was an objective of a 2012 study that identified the optimal strategy for global collaboration. The collaboration has included joint research. The genebank collaboration was to be managed through the global program, GRiSP and the CGIAR Genebank Platform. It identified advantages and efficiencies from the two international collections, but this engagement needs to be managed and utilized to sustain and gain efficiencies globally. With changes in both the management of the IRRI and AfricaRice global engagement (Accelerated Breeding Initiative) and the CGIAR (Genebank Initiative), the reviewers were not clear on the current management of coordination or collaboration. The reviewers suggest that there are still many opportunities for working together on rice conservation that need to be explored.

Current engagement with NARS is limited but there are opportunities for expansion with BOLD and other specific projects. Most of these joint activities have been in capacity building and in expanding use of the collection. One of the future opportunities for IRRI to provide conservation services, for example as secure storage site of black box safety duplicates for national genebank in the region. Several of the national genebanks that were reviewed for the BOLD project have a critical need for safety duplicate services. Given the limitation that IRRI has in long term storage, the reviewers recommend that making space available for the black box storage of national collections, both rice and non-rice seed accessions, should be a key consideration in any expansion plans.

6.3 Germplasm availability in MLS

IRRI has a high level of availability of germplasm in the MLS. Generally, it was clear to the reviewers that routine operations are aimed at ensuring the maintenance of availability of these accessions and the associated information for the long term. The key recommendations for improvement for the various processes are given in the relevant sections in previous sections.

6.4 Contribution to development and implementation of global crop conservation strategy(ies)

IRRI committed to updating the global rice conservation strategy in collaboration with AfricaRice in the 2018 Business Plan. The global conservation strategy was completed in 2010 but was initiated in 2005 at the International Rice Congress with the survey of conservers done in 2007. There is a priority need to update and ensure implementation of the strategy as a key input into enhancing the contribution of IRRI and AfricaRice to the global system for *ex situ* conservation and use. The reviewers recommend IRRI and AfricaRice work together to mobilize the resources required to update the global strategy, including the survey of conservers and users as well as any follow-up consultation. The upcoming International Rice Congress in 2023 would be a good opportunity to hold an initial consultation for planning and to facilitate global engagement.

Some more specific global activities that could benefit IRRI as well as other rice collections globally are:

- Enhance use with user defined subsets.
- Identify internationally agreed set of minimum phenotypic and genotypic characterization traits to enhance global databases, redundancies assessment, and global gap analysis.

7 Next generation conservation

For the IRRI genebank to realize the vision of the genebank within the Fit-For-Future Genetic Resources Unit, it needs to focus on using its data and information to optimize conservation and facilitate end use to ensure it remains relevant to industry and the global community. The reviewers recognize the following opportunities:

1) Consider the infrastructure available now and into the future with a focus on:
    a. Consolidation of the initial dryer and drying room into the main genebank building so that all activities can be undertaken in one building.
    b. Refurbishment of rooms in the main building to incorporate controlled environments for seed processing and subsampling (20°C, 20%RH), and for packing and distribution activities (15°C, 15%RH).
    c. Future capacity of the MTS and LTS needs to be expanded and should consider additional space to provide >50 years growth, and to include additional LTS to serve as black box safety duplication site for other genebanks.
2) Greater use of AI in automation to improve efficiency in capturing and using qualitative and quantitative data during routine genebank operations and to facilitate end use.
3) Consider how to use existing genotypic and phenotypic data to facilitate end use and uptake of germplasm.
4) Consider how existing wild relative and cultivated species genotypic data can be used to identify genetic duplication and to prioritize multiplication/regeneration activities, create diversity sets, identify traits of interest for end users.
5) Investigate the opportunity to collaborate to expand the capacity of the taxonomy SNP chip to be able to assess genotype, genetic diversity and genetic integrity, with the future focus to identify duplication within the genebank and identify traits of industry relevance.
6) Consider IRRI's contribution to the global system – IRRI is in a unique position to take the lead in the implementation of the Global Conservation Strategy for Rice
7) Continue collaboration with AfricaRice on the unique attributes of germplasm and conservation processes within both centers to improve efficiency of germplasm conservation and maintenance (for example, species difficult for IRRI to maintain compared to AfricaRice and vice versa), distribution, and collection of gaps in collections.

8 Assessment of the sustainability of the business plan, long-term grant (LTG), and/or long-term partnership agreement (LPA) with the Crop Trust

An assessment was done by the reviewers of the current LPA template. Thus, the reviewers recommend a modification of the current LPA business plan template based upon the review and recommended changes that have been sent separately to the Crop Trust staff.

In the review of the IRRI draft business plan, it was difficult to appreciate the sustainability given the lack of some key details that had been included in the 2018 business plan. Since this is an update to the business plan from 2018, this business plan should focus on any changes from the previous 5 years or changes in strategic direction. It is more difficult to assess the longer term sustainability without this continuity that the LPA requires. There needs to be more reference to the actions and targets described for the longer term future and include a 5-year workplan with milestones or targets. The presentation by IRRI to the reviewers had many details needed for the modified template.

The reviewers have the following recommendation to improve the IRRI business plan to present the case for continued longer term support:

- Reference the institutional & genebank long-term strategic plan in the introduction
- Include discussion from longer term analysis of past performance trends.
- Focus on innovation to facilitate end use.
- Elaborate on what it means for the genebank to be Fit-for-Future.
- Include table with intended outcomes, specific outputs with milestones (include both current scenario and aspirational scenarios) and timeframes for delivery over 5 years.

Once updated, the reviewers could provide feedback to the revised business plan.

Annex 1 About the genebank review

The Global Crop Diversity Trust (Crop Trust) is commissioning the technical review of international genebanks to help validate the institute's compliance with genebank standards, progress in achieving key performance indicators, and confirm eligibility for long-term partnership agreement. The findings will help identify priority areas for upgrading and improvement to sustain essential genebank operations and ensure the long-term security, conservation, and availability of plant genetic resources.

A roster of experts, with knowledge and experience needed to cover the various aspects of the genebank review, was engaged to conduct the genebank reviews of partners. IRRI was reviewed by two experts, facilitated by Sarada Krishnan (Director of Programs, Crop Trust) and Nelissa Jamora (Agricultural Economist and M&E Manager, Crop Trust). The members of the review panel are:

- *Paula Bramel: Chair of the review panel with experience in conducting genebank reviews with expertise in institutional analysis, diversity assessment, and genebank management.*
- *Sally Norton: Reviewer with over 25 years' experience in ex-situ genebank operations and over 12 years as a genebank manager.*

The Crop Trust staff prepared a baseline questionnaire covering institutional, financial, and technical topics and circulated it to partner genebanks. The completed baseline questionnaires were shared with the review panel to provide background information and help the reviewers prepare for the on-site reviews. A review checklist was also provided to the review panel to facilitate the on-site reviews and ensure consistency and completeness across partner genebanks.

The agenda of the visit is available in the table below. The recommendations are listed in Table 1. The reviewers have prepared this report with their expert assessment and recommendations for improvement. A response was solicited from the partner before finalization by the Crop Trust.

Day	Item
1	Introduction by the review panel, Q&A with key staff, including management General introduction to the genebank and institute Tour of genebank facilities Areas for review: Staff, equipment, supplies, facilities
2	Areas for review: Genebank operations, SOPs Areas for review: Documentation and data management
3	Visit field sites Areas for review: Institutional, complete report tables Additional areas for review and other pending issues
4	TR panel consults and discusses recommendations with genebank staff (optional) Time for the review panel to discuss the completion of the report
5	Formal presentation of recommendations to management Time for the review panel to work on the completion of the report

Annex 2 Genebank performance indicators

Indicators*	Number of accessions
Composition	
1. Number of accessions in total	132,627
2. Number of seed accessions	132,627
3. Number of accessions in *in vitro*	0
4. Number of accessions in cryo conservation	0
5. Number of field bank accessions	2
6. Number of accessions in *in vitro* and in field	0
7. Number of accessions in *in vitro* and in cryo	0
8. Number of accessions in field and in cryo	0
9. Number of accessions stored as seeds, and also in field, cryo, or *in vitro*	0
Availability	
10. Available for immediate distribution	124,595
11. Viability tested	130,909
12. Viability above 85%	129.899
13. Health tested	117,956
14. Adequate seed number	132,304
15. Included in MLS	127,727
16. Regenerated or multiplied in last 5 years (seeds)	10,101
17. Samples subcultured in last 5 years (clonal)	0
18. Samples rejuvenated in the field/greenhouse in last 5 years (clonal)	0
Safety duplication	
19. Conserved in LTS (seeds)	123,966
20. Safety duplicated outside the genebank (first level, seeds)	124,595
21. Safety duplicated at two locations (two levels, seeds)	120,601
22. Safety duplicated at Svalbard (seeds)	122,152
23. Field collection maintained in at least two locations	0
24. Number of clonal accessions held in cryopreservation at two locations	0
25. Number of clonal accessions held in slow growth conditions *in vitro* at two locations	0
26. Number of field bank accessions held, also in *in vitro* and in cryo	0
Distribution	
27. Total distributed internally in last 5 years (within the institute)	39,999
28. Total distributed nationally in last 5 years (outside the institute)	827
29. Total distributed internationally in last 5 years	27,094
30. Number of countries receiving germplasm in last 5 years	
Information	
31. With passport data available in Genesys	132,627
32. With characterization data available in Genesys	104,849
33. Average passport data completeness index	7.38
QMS	
34. Number of SOPs written	8
35. Number of SOPs reviewed and approved	6
36. Staff succession/management plan available and maintained (Y/N)	N
37. Risk management plan available and maintained (Y/N)	Y
38. Equipment and supplies inventory available and maintained (Y/N)	Y
Use	
39. Number of germplasm requests received annually (average last 5 years)	93
40. Regular feedback from genebank users (Y/N)	N

* Consider crop disaggregation where relevant.

Annex 3 Review checklist

*Review Assessment Score
0 = Compliant
1 = Minor issues or gaps identified, not likely to impact genebank/QMS standards but would improve the efficiency/sustainability of operations
2 = Major issues or gaps identified, likely to impact genebank/QMS standards and reduces efficiency/sustainability of operations
3 = Critical issues or gaps identified, impacts genebank/QMS standards and efficiency/sustainability of operations
n/a = Not applicable, not assessed

Area	Factors to consider	*Score
A. Genebank overview		
1-Staff management		
Adequacy of staffing	1. The genebank has adequate skilled staff to perform key genebank operations.	0
Succession planning	2. The genebank takes action to mitigate adverse impacts of staff loss from staff movement (resignation, retirement, promotion).	3
Capacity development	3. Genebank staff capacities are kept up to date, and training is provided as necessary.	0
Overall assessment	4. Overall assessment for staff management.	0
2-Composition of the collection		
Uniqueness and importance	5. The genebank conserves unique and valuable crop collections, including Annex 1 crops (consider crop importance to national country and to global conservation and use).	0
Conservation forms	6. The genebank has multiple forms of conservation (seed, *in vitro*, field, greenhouse, DNA) corresponding to different crop types in the collection.	0
3-Key performance indicators		
KPI: Collection size	7. The genebank has information/trends on the size and composition of its collection.	0
KPI: Availability	8. The genebank has information/trends on the number of accessions that are available for immediate distribution.	0
KPI: Data availability	9. The genebank has information on access, availability, and sharing of germplasm-related data through their websites and/or Genesys.	0
KPI: Data completeness	10. The genebank uses Multi-Crop Passport Descriptors (MCPD) and/or other descriptor lists.	0
4-Supplies, equipment, facilities & infrastructure		
Infrastructure	11. The storage chambers (LTS and MTS) are fit for purpose (i.e., well suited) for their intended (longer term future) use.	2
	12. The seed processing and packing areas are fit for purpose (i.e., well suited) for their intended use.	2
	13. The drying room/chamber is fit for purpose (i.e., well suited) for its intended use.	0
	14. The seed cleaning area (internal/external) is fit for purpose (i.e., well suited) for its intended use.	2
	15. The viability testing area or laboratory is fit for purpose (i.e., well suited) for its intended use.	0
	16. For clonal crops, the in vitro storage chambers are fit for purpose (i.e., well suited) for their intended use.	
	17. Environmental records (light, temp, RH) for storage chambers and drying rooms are maintained and periodically monitored.	0
	18. The genebank facilities have safety measures in place (restricted access, cameras, etc.).	0
	19. The genebank has a replacement plan for infrastructure and equipment.	3
Equipment	20. The genebank maintains a list/inventory of key equipment (computers, balances, threshers, etc.).	0
	21. The number, type and condition of the equipment is adequate to carry out activities in the genebank.	2
	22. Maintenance, calibration and replacement are periodically performed on key equipment.	2
	23. The genebank uses barcoding in the management of genebank operations.	0
Supplies	24. The genebank maintains a list/ inventory of key supplies (jars, envelopes, boxes, etc.).	0
	25. The quantity and types of supplies are adequate to carry out activities in the genebank	0
Field stations and greenhouses	26. The genebank utilizes field stations or greenhouses for regeneration, characterization, evaluation, conservation (for field crops), etc.	1
	27. The field station(s) is fit for purpose (i.e., well suited) for its intended use.	0
	28. The greenhouse is fit for purpose (i.e., well suited) for its intended use.	0
Overall assessment	29. Provide an overall assessment of the adequacy of genebank supplies, equipment, facilities & infrastructure.	2
B. Genebank operations		
Area	**Factors to consider**	
1-Acquisition		
1 Adequacy of procedures	30. The genebank assesses viability and phytosanitary health upon reception of new material.	0
	31. The genebank has post-entry quarantine rules for new materials, prior to introduction into the genebank collection.	0
2 Information management	32. The genebank has a protocol for assigning unique identifiers and accession numbers for new materials, prior to introduction into the genebank collection.	0
	33. Data and information generated during the acquisition procedure are recorded and entered documentation system in a timely manner.	0
3 SOP	34. The genebank has a written acquisition procedure/protocol/policy.	1
Overall assessment	35. Provide an overall assessment of the adequacy of the procedure.	1
2-Conservation: seed processing, storage, and viability testing		

Area	Factors to consider	*Score
1 Adequacy of procedures	36. The genebank follows an established protocol for seed cleaning.	2
	37. The genebank follows an established protocol for seed drying and testing of moisture content.	2
	38. The genebank follows an established protocol for packing samples in containers or envelopes.	2
	39. The genebank periodically conducts viability testing.	1
	40. For long-term storage, samples are stored at a temperature of –18 ± 3 °C. For medium-term storage, samples are stored at a temperature of 5–10°C.	0
2 Information management	41. Samples are properly labeled.	0
	42. Data and information required for and generated during the conservation procedure are recorded and entered into the documentation system in a timely manner.	0
3 SOP	43. The genebank has a written conservation procedure/protocol/policy.	1
KPI: Viability and health testing rates	44. The genebank has information on the viability/vigor and health of the collection.	1
Overall assessment	45. Provide an overall assessment of the adequacy of the procedure.	2
3-Field genebank		
1 Adequacy of procedures	46. The genebank follows an established protocol for field conservation and regularly monitors the quality of plants.	0
2 Information management	47. Samples are properly labeled.	0
	48. Data and information required for and generated in field genebank are recorded and entered into the documentation system in a timely manner.	0
3 SOP	49. The genebank has a written field genebank conservation procedure/protocol/policy.	0
Overall assessment	50. Provide an overall assessment of the adequacy of the procedure.	0
4-In vitro conservation		
1 Adequacy of procedures	51. Light and temperature regimes are adequate for in vitro culture	-
	52. The genebank regularly monitors the quality of the in vitro culture in slow-growth storage, maintenance of long-term genetic stability, and possible contamination	-
2 Information management	53. Samples are properly labelled.	-
	54. Data and information required for and generated during the in vitro conservation procedure are recorded and entered into the documentation system in a timely manner.	-
3 SOP	55. The genebank has a written in vitro conservation procedure/protocol/policy.	-
Overall assessment	56. Provide an overall assessment of the adequacy of the procedure.	-
4-Regeneration and Characterization		
1 Adequacy of procedures	57. Regeneration practices are appropriate to ensure that genetic integrity is maintained (regarding the origin of seed, number of seeds to be planted and harvested, and pollination control)	2
	58. Environmental parameters (e.g., photoperiod and vernalization requirements) of field sites are appropriate for the needs of the target crop(s)	2
	59. Field management activities (land preparation, irrigation, rouging, agrochemical applications) are adequate for regeneration and characterization of genebank accessions	0
	60. The genebank has methods to authenticate the harvested accessions (i.e., accessions are confirmed as being identical to the original material by means of morphological or molecular characterization).	2
2 Information management	61. Characterization data is publicly available, or available upon request.	0
	62. Samples are properly labeled.	0
	63. Data and information required for and generated during regeneration and characterization are recorded and entered into the documentation system in a timely manner.	0
3 SOP	64. The genebank has a written regeneration and characterization procedure/protocol/policy.	2
KPI: Regeneration & characterization rates	65. The genebank has information on the number of samples regenerated and characterized annually.	2
Overall assessment	66. Provide an overall assessment of the adequacy of the procedure.	2
5-Distribution		
1 Adequacy of procedures	67. Prior to distribution, the seed quantity, viability, and phytosanitary status of the samples to be distributed are known/checked.	0
	68. The genebank has an established protocol for the preparation of samples for distribution (i.e., sample size is acceptable, accessions are packed in air-tight properly labeled packets, relevant documentation is included, durable packaging is used, etc.)	0
	69. Samples are distributed in compliance with national laws and relevant international treaties and conventions.	0
2 Information management	70. Samples are properly labeled.	0
	71. Data and information required for and generated from germplasm request to distribution are recorded and entered into the documentation system in a timely manner.	0
	72. If SMTAs are used in distribution, SMTAs are periodically reported to the Secretariat of the ITPGRFA to fulfill the SMTA provider's reporting obligations.	0
3 SOP	73. The genebank has a written distribution procedure/protocol/policy.	0
KPI: Distribution	74. The genebank has information/trends on the distribution of its accessions.	0
KPI: User satisfaction	75. The genebank requests feedback from users to improve the delivery of genebank service.	3

Area	Factors to consider	*Score
Overall assessment	76. Provide an overall assessment of the adequacy of the procedure.	1
6-Safety duplication		
1 Adequacy of procedures	77. Safety duplicate samples are stored nationally, under the same or better conditions than those in the original genebank.	0
	78. Safety duplicate samples are stored internationally, for second-level safety duplication.	0
	79. The size of safety duplicated samples is sufficient to conduct at least three regenerations.	0
2 Information management	80. Samples are properly labeled.	0
	81. Data and information required for and generated during safety duplication are recorded and entered into the documentation system in a timely manner.	0
3 SOP	82. The genebank has a written safety duplication procedure/protocol.	1
KPI: Safety duplication	83. The genebank has information/trends on the percentage of the collection that is safety duplicated in one or more locations or geographically distant sites.	0
Overall assessment	84. Provide an overall assessment of the adequacy of the procedure.	0
C. Genebank management		
Area	**Factors to consider**	***Score**
QMS	85. The genebank implements a system that leads to improvement over time (if applicable, establish which genebank standards and best practices are implemented (awareness of FAO genebank standards and others).	0
Information management	86. Information management system is available and used in the management and monitoring of the collection.	2
	87. Passport and accession-management data are secured by regular data backups.	0
	88. Passport and other relevant data are available and accessible to external users.	0
Germplasm health	89. The genebank (or its health unit) maintains and updates a list of quarantine pests and diseases.	0
	90. Phytosanitary procedures are followed in germplasm transfers (import and export).	0
Risk management	91. The genebank can provide evidence of periodic risk analysis, prevention, response, and mitigation (e.g., natural disasters, human-caused threats, incidences of pests, diseases, cyber security, and biological threats (pandemics).	0
Efficiency of procedures	92. Accessions and seed lots are advanced through the genebank workflows at an adequate pace (i.e., they do not remain “in limbo” for extended amount of time).	2
Overall capacity	93. The genebank's overall capacity (for the longer term) to conserve seeds, clonal crops, and field collections is adequate	2
D. Institutional areas		
Area	**Factors to consider**	***Score**
Finance	94. The institution has a clear policy on overhead charges on projects and/or international collaborations.	0
Procurement processes	95. The institution has an established procurement process.	0
Genebank routine funding	96. The genebank has reliable and continuous funding sources for routine operations (e.g., core vs project funding).	2
Policy	97. The genebank/institution adheres to relevant national, regional, and international policies that impact genebank operations (e.g., awareness and compliance with policies in Nagoya Protocol and communication with the Plant Treaty country focal point).	0
Leadership	98. The genebank has clear leadership, commitment, and vision for improving genebank operations and management.	0
Use	99. The genebank works with farmers and other user groups to promote awareness and use of materials from the genebank.	1
Contribution to the global system	100. The genebank works with national genebanks and other partners on crop conservation-related activities.	2

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