

ILRI

Genebank Review Report 2025





Global Genebank Partnership Genebank Review Report

Institute name:	International Livestock Research Institute
Genebank manager:	Alemayehu Teressa

Review team

Reviewer 1:	Ehsan Dulloo
Reviewer 2:	Stephanie Greene

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1 Summary of Review Findings and Recommendations

The purpose of this genebank technical review, commissioned by the Global Crop Diversity Trust (Crop Trust), was to undertake an in-depth assessment of the ILRI Forage Genebank located in Addis Ababa, Ethiopia to determine their progress towards eligibility for long term support from the Crop Trust endowment fund. The review follows a previous external review of the ILRI Forage Genebank which was undertaken in 2012 (Greene and Linnington, 2012) to assess the basic operations of the ILRI genebank and to consider the role of the ILRI genebank within a global system for forage conservation. This second review aims to assess progress made on the recommendations of the first review, validate compliance with international genebank standards, monitor progress towards meeting agreed performance standards, institutional and financial commitments and confirm eligibility for possible future endowment funding (See Annex 1 for Terms of the Reference of the review and methodology followed).

The review was carried out from 18th to 25th October 2025 in Addis Ababa by the independent review panel composed of Dr Ehsan Dullo (Chair) and Dr Stephanie Greene (Panel Member), facilitated by two members of the Crop Trust, Dr Sarada Krishnan (Director of Programs) and Dr Nelissa Jamora (M&E Manager). The reviewers are grateful to Janne Bertram and Faith Wambua-Lüdeling of the Crop Trust for their logistic support for this review. We wish also to thank Dr Alemayehu Teressa, Manager of the ILRI Forage Genebank and all his staff for organizing this review and providing all the background documents to enable the review to be undertaken.

A summary of progress made on the recommendations since the 2012 review is provided in Table 1 below. Of the 11 recommendations made at the 2012 genebank review, the great majority has been fully or mostly addressed, while only three have been partially addressed (recommendations on succession planning, reduction of seed lots - which is ongoing and seed viability and germplasm health). Only one recommendation (relating to collection assessment for gaps/redundancy and acquisition priorities) has not been addressed (see Figure 1 and Table 2 below for details).

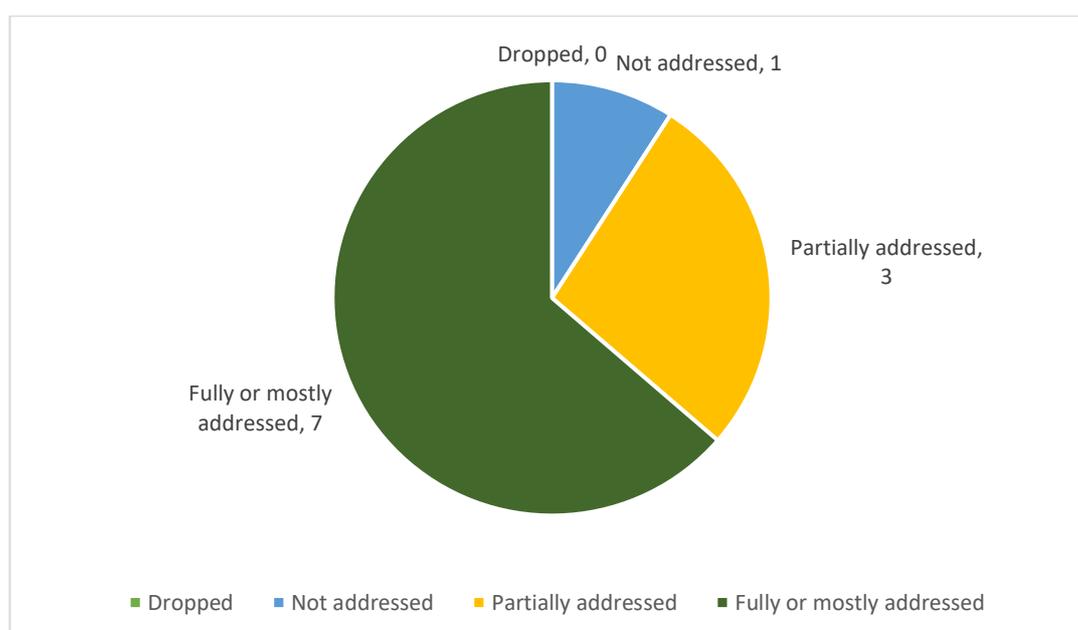


Figure 1: Update on the implementation of the 2012 review recommendations

Table 1. Updates since the last genebank review

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

ID	Previous Recommendations	Status*	Comments
<i>Merging CG Forage Collections</i>	We recommend that the three CG forage collections remain separate since each focuses on germplasm adapted to specific conditions. The three CG genebanks need to maintain close linkages and maximize joint and mutual activities.	3	The 3 centres came together and aligned and harmonized their procedures.
<i>Facilities</i>	The storage area above the cold storage area should be immediately cleared of combustible material. Within a year, short term solutions need to be implemented to 1) eliminate water leakage from the roof into the genebank, and 2) assess the structural integrity of the west end of the building. At the same time, efforts need to focus on exploring options and setting in motion the mechanisms needed to replace the prefabricated building and the cold storage unit bought in 1986. We support efforts to establish reliable sprinkler irrigation at the Debre Zeit field site and tenancy arrangements there with the Ethiopian Government need to be monitored.	3	Fully accomplished with a new building and greenhouse. Irrigation systems have been set up at Addis Ababa and Debre Zeit (Bishoftu)
<i>Human Resources and Succession Planning</i>	Given the scope of Alexandra Jorge's responsibilities, we recommend a staff member be hired and supported jointly by ILRI, to manage the quality assurance in laboratory and gene banking work, including the Nutritional Lab. We highly recommend that the ILRI SOP be completed within one year and that they focus on detailing the local procedures used. A second recommendation is to ensure that succession planning is in place for Asebe Abdena.	2	SOPs have been produced and replacements for retiring/resigning staff have been hired. However, the genebank does not have a succession plan formally in place.
<i>Risk assessment of collection</i>	We would strongly recommend that a risk assessment of the collection be carried out within the first quarter of 2013 looking at all potential risks to the collection no matter how unlikely those risks might be; combinations of risk factors should also be considered. A regular testing regime for safety devices should be in place. We would recommend that crisis management be considered as part of the risk assessment. As a precaution, the most important collections should be labelled in order to allow rapid	3	A risk assessment table has been developed, and all relevant risks have been identified and mitigation actions taken. There are devices in place to monitor temperature and RH in cold rooms, freezers and germination incubators and cameras fitted inside and outside genebank. All these are routinely tested, as are fire alarms. Labelling of important collections is done. There is regular data backups done, on the cloud and hard drive

ID	Previous Recommendations	Status*	Comments
	extraction from storage. Regular data back-up transfers to Nairobi need to be confirmed		
<i>Seed Storage</i>	Considering the age of the oldest cold storage unit, end-of-life planning needs to occur now, to ensure the unit can be replaced when needed. Considering the gains in efficiency that result from increasing seed longevity, we recommend that the ILRI genebank move towards storing all samples (for conservation and distribution) under LTS. In the meantime, we would recommend that consideration be given to lowering the temperature in the two cold rooms currently running at 8°C, to -5°C. We would strongly recommend a reduction in the number of multiple seedlots of each accession. It is essential that ILRI produces a definitive set of data on the storage status of its accessions. Finally, it is strongly recommended that high quality bags are used for all samples.	2	<p>LTS and archive storage is at -20 °C and MTS has been lowered to 5°C. We still strongly recommend moving the whole collection to LTS.</p> <p>The process is ongoing to reduce seed lots through rationalization. The goal of the genebank is to have no more than three seed lots accession.</p> <p>The genebank is now using laminated aluminium foil pouches for seed storage.</p>
<i>Regeneration</i>	Contingent upon ILRI developing a detailed regeneration plan that provides a realistic timeframe for regenerating their backlog (the scale of which needs to be confirmed), we recommend that funding for non-recurrent costs be continued. We encourage ILRI to explore new approaches that will help them to meet their regeneration challenge.	3	The genebank has developed a regeneration plan for 2026-2030.
<i>Database/ Documentation</i>	The genebank is currently investigating the use of MySQL or Grin Global as a new platform. We recommend that within a year this decision be made, and a migration plan developed. Our recommendation is that Grin Global (GG) be used. Recognizing that GG will need to be customized to meet ILRI's specific needs, outside GG expertise needs to be available to facilitate the migration. We also recommend that ILRI explore opportunities to harmonize database and web user interface with the other CG forage genebanks.	3	The genebank shifted completely to Grin Global in 2019 and is now customizing their workflow to GGCE and aim to adopt GGCE by the end of 2026.
<i>Seed Viability and Germplasm Health</i>	We support ILRI's plan to carry out a large retest in 2013 and use these results to provide a third point on a set of decline curves that will allow re-estimation of retesting intervals which may help cut down on testing	2	The retesting of seed viability is well under way and progressing well. The genebank now has data to calculate longevity and has begun to explore the re-estimation of retesting intervals

ID	Previous Recommendations	Status*	Comments
	by lengthening the intervals for a number of species. We recommend that expert advice from the Millennium Seed Bank (Robin Probert) continue to be sought on this project.		
<i>Germplasm Characterization</i>	ILRI needs to explore options for ensuring that characterization data are easily accessible by users and that preferably users can use the data to select desired accessions.	3	All characterization data including subsets are publicly available on Genesys.
<i>Collection assessment for gaps/redundancy and acquisition priorities</i>	We recommend that within 12 months ILRI define formally the scope of the collection, in terms of taxonomic and geographic coverage. The focus should be on meeting user needs and conserving vulnerable germplasm. We feel ILRI should set itself apart from the other forage CG genebanks by focusing on representing forage grasses and legumes found in Africa. Within 24 months, ILRI should conduct a comprehensive examination of the contents of its collection and develop an acquisition strategy to proactively guide collecting/acquisition efforts over the next five years. The genebank should also give serious thought to removing redundancies from the collection.	1	<p>The genebank has done an exercise to categorize accessions into 5 categories based on use criteria. However, it has not done any analysis to identify gaps in collections and address the conservation of threatened and vulnerable forage genetic resources.</p> <p>It is understandable that the genebank has been focusing on performance targets, however efforts should begin to identify and fill gaps in the collection.</p>
<i>Distribution</i>	We recommend that the ILRI genebank focus on activities that will enhance the use of the collection as outlined in the main part of the document including improved dialogue with African user community.	3	There is evidence that the number of requests has been increasing and consequently the number of accessions distributed has increased.

Main Findings and New Recommendations

The main findings and new recommendations of this second review are provided in Table 2. The ILRI Forage Genebank has made excellent progress over the last 12 years, as described above, and is moving steadily towards meeting the performance targets for long term funding support. Among the five performance targets, ILRI Forage Genebank has reached or nearly reached three of the targets on data availability, QMS and capacity building of NARs. The genebank is still struggling to make available clean materials for distribution and for safety duplication, having reached about 50% ‘Availability’ and ‘Safety duplication’ of the collection. However, it is making good progress towards and has developed an achievable 5-year Business Plan 2026-2030 to speed up not only the physical availability but also safety duplication.

The reviewers came up with a total of 17 new recommendations, which have been classified as ‘Critical’, ‘Major’ or ‘Minor’ (Table 2). There are three ‘Critical’ recommendations, which the reviewers wish to highlight as being very important and that will help ILRI to safeguard the maximum genetic diversity of forage accessions in the collection and to achieve its performance

targets quicker. The reviewers consider that all accessions in the collection are critically important and a review of the conservation priorities is needed (recommendation #1). The other two critical recommendations concern the genebank's limitation to produce clean materials that can be made available for distribution (recommendation 7a) and safety duplication (recommendation 8). Further, there are seven 'Major' recommendations which will greatly improve their efficiency if implemented and there are eight 'Minor' recommendations.

Table 2. List of new recommendations

ID	Critical/ Major/ Minor observation	New Recommendations	Proposed activities to address recommendations
1	Critical	It is considered that all accessions in the collection are important. It is recommended that ILRI genebank reviews its categories and prioritize not solely based on use, but on a broader set of criteria. We recommend that the outcome of this review should guide the active management and curation of accessions within the forage genebank collection. Consideration should be given to transferring accessions with no value for forage and fodder to other genebanks.	<ul style="list-style-type: none"> ● Change the names of the categories to high, medium and low priorities according to meaningful criteria relating to value, use, number of requests, uniqueness as well as conservation value.
2	Major	A gap analysis of the collection found in Africa and beyond should be carried out to develop an acquisition strategy to widen the diversity of wild forage species in the collection, particularly from Africa.	<ul style="list-style-type: none"> ● Assess the taxonomic and geographic coverage to identify gaps in collection, as recommended in the previous review ● Use species distribution modelling ● Develop an Acquisition Strategy and Action Plan
3	Minor	It is recommended that a dedicated RH controlled (15-20%) area is demarcated within the genebank building closest to the drying room where seed handling for packing and sealing of seed packets are performed. It is also recommended that, after drying, seeds samples are placed in a moisture-tight container when transported from the drying room to the seed packing area.	<ul style="list-style-type: none"> ● Acquire a trolley and plastic closed containers with silica gel or other desiccating agent for transport of seeds from the drying room to the packaging area. ● Acquire a dehumidifier to control RH when required.
4	Major	It is recommended that the genebank revise their workflow to streamline subsampling and packaging. One option that might be efficient for -20°C storage would be to: a) subpackage after confirmation that the seed-lot has passed quality checks (i.e. viability, seed health), b) subsample the bulk sample (in temporary storage) for LTS, c) safety duplicate, d) future monitor tests and distribution samples, e) store all samples in final location(s). Bulk samples that fail quality check remain in temporary storage until they are successfully regenerated (or cleaned). The SOP needs to be revised to reflect any new workflow.	<ul style="list-style-type: none"> ● Subsample seeds for initial viability and seed health testing. ● If seed viability and health tests do not meet standards, regenerate accessions and discard the original seeds after successful regeneration. ● If quality checks meet genebank standards, prepare seed packets for safety duplication, seed viability monitoring and distribution and transfer to LTS freezers as soon as possible. ● Revise SOP to bring it in line to what is done in practice.

ID	Critical/ Major/ Minor observation	New Recommendations	Proposed activities to address recommendations
5	Major	The reviewers agree that the thresholds of sampling size for MTS and LTS conservation, safety duplication, distribution for forage species and viability test can be reduced, given the difficulties for obtaining adequate number of seeds for certain forage species. However, the normal international standards for these thresholds should continue to be applied for species with normal seed viability and regeneration/multiplication capacity similar to crops.	The thresholds for storage safety duplication, distribution and viability can be set as follows: <ul style="list-style-type: none"> ● Storage threshold: MTS= 1500-4000, LTS=1000 ● Threshold for safety duplication: 300-500 seeds ● Distribution: 30-100 seeds depending on quantity of seeds ● Viability threshold: 50% to 65% depending on species ● Revise SOP accordingly.
6	Major	It is recommended that <ol style="list-style-type: none"> a) The genebank should consider monitoring not only MTS (active) samples, but LTS (base) samples too. Testing efficiency could be gained if active and base samples were stored at the same temperatures (i.e. -20°C), as only one sample need be tested. b) High priority grasses trees and legumes that have not been tested in 20 years should be tested, to identify material at risk of loss due to low viability. Also, lower priority accessions need to be monitored, giving priority to accessions that have not been tested in the last 20 years and known short-lived species. c) Historic viability data should be used to estimate seed longevity of species. Once longevity is known, FAO standards can be followed to determine species-specific monitoring intervals. Because many species are long lived, efficiency gains can be expected with monitoring intervals greater than five years. 	<ul style="list-style-type: none"> ● Carry out seed viability monitoring on both MTS and LTS samples. ● Prioritize testing for grasses and trees with legumes that have not been tested in last 20 years, and known short-lived species ● Estimate the seed longevity of species
7a	Critical	In addition to addressing the difficulties in producing high-quality, disease-free seeds and adequate quantity of seeds, the genebank should consider carrying out regeneration of 'difficult' species in the greenhouse under controlled environmental conditions. The genebank should urgently invest in the restoration of existing greenhouses and the construction of a new greenhouse, with controlled environment conditions. This will enable it to increase the number of successful regenerations for the so-called 'difficult' forage and CWR species.	<ul style="list-style-type: none"> ● Renovate existing greenhouse and shade house to increase the capacity for regeneration in controlled conditions. ● Construct a new state of the art greenhouse with environment control, irrigation to produce healthy disease-free plants and seeds.
7b	Major	The use of insect-proof row covers (https://extension.umd.edu/resource/row-covers/) should be explored to reduce the incidence of pest and insect-mediated disease transmission. It is also suggested that for insect-mediated, cross-pollinated species such as	<ul style="list-style-type: none"> ● Provide additional physical isolation through row covers/isolation cages for regeneration plots in the field to reduce disease incidence and maintain genetic integrity.

ID	Critical/ Major/ Minor observation	New Recommendations	Proposed activities to address recommendations
		<i>Medicago</i> , only a single accession be planted in the field since insects such as bees can move pollen more than 1 km. Alternatively, pollinators could be added to isolation cages to ensure controlled pollination occurs.	
8	Critical	The reviewers recommend that the genebank should aim to safety duplicate all unique seed and field accessions at two locations to meet performance targets, not just Category 1-3. We also support lowering the threshold safety duplicate seed number to 300 seeds per sample. We would encourage the genebank to increase the number of accessions they backup annually, so the collection is secured in 2-3 years.	<ul style="list-style-type: none"> ● Safety duplicate all unique seed and field accessions at 2 locations. ● Reduce safety duplicated sample to 300 seeds per accession.
9	Major	It is recommended that the ILRI Forage Genebank should aim to conserve all accessions under LTS storage conditions (-20°C) as soon as possible and seriously consider making the required capital investment in LTS (-20°C) cold-rooms for long term sustainability.	<ul style="list-style-type: none"> ● Conserve all accessions under LTS storage conditions. ● Consider converting MTS cold-rooms to LTS storage conditions (-20°C) or, if not possible, consider replacing the MTS cold room with LTS cold-rooms.
10	Minor	The genebank has followed through on the 2012 recommendations to rationalize the seed-lots they store. We encourage them to continue their efforts to rationalize seed-lots, targeting no more than three packets per accession. This will help to streamline packet management and save storage space in their coolers	<ul style="list-style-type: none"> ● Rationalize seed-lots targeting less or equal to 3 packets per accession
11	Major	We recommend that the genebank move forward to store seeds of field accessions that produce orthodox seed, in LTS and MTS. Since seed storage is much less costly than field storage, this will save on resources and also help to liberate more field plots for regeneration activities.	<ul style="list-style-type: none"> ● Assess which of the field genebank accessions have orthodox seeds. ● Develop a plan to transfer the field accessions with orthodox seeds to the seed bank. ● Move accessions to seed genebank as feasible.
12	Minor	The reviewers recommend that equipment be regularly maintained, checked and calibrated to ensure it is functioning properly. Maintenance dates should be recorded on equipment tags.	<ul style="list-style-type: none"> ● Develop a timetable for maintenance of all equipment. ● Ensure that the last date of maintenance is clearly marked on a tag attached to all equipment.
13	Minor	The genebank is to be commended for the efforts it has accomplished in setting up the QMS. There are however some minor issues that should be addressed as described in the report, ensuring that: <ol style="list-style-type: none"> a) All SOPs are well aligned to the practices in the genebank. b) The risk table is in accordance with the table in the Red Book of risks. c) Continue to ensure that all heads of units have assigned deputies that can take over when he/she leaves. 	<ul style="list-style-type: none"> ● Align all SOPs to actual practices in the genebank. ● Assign deputies to all head of units. ● Ensure all equipment is properly calibrated and records well documented. ● Make characterization information more easily accessible.

ID	Critical/ Major/ Minor observation	New Recommendations	Proposed activities to address recommendations
		d) Ensure that all equipment is adequately maintained and calibrated regularly and proper records well documented in a visible area. e) Attention is given to making more characterization information easily accessible to users seeking to order accessions and that relevant information on seeds that are dispatched is also provided to users at distribution.	
14	Minor	It is recommended that the genebank develop a Business Continuity Plan and First Responder Plan and that all genebank staff are appropriately trained and responsibilities assigned to specific staff in implementation of these plans.	<ul style="list-style-type: none"> ● Develop a Business and Continuity Plan and First Responder Plan. ● Train staff in implementation of Business and Continuity Plan and First Responder Plan ● Assign responsibilities to staff in the event of disasters.
15	Minor	It is suggested that when seeds are distributed, procedures for seed germination, breaking dormancy, cultural practices, fertilizer applications, pest control etc. be sent with the seed request.	<ul style="list-style-type: none"> ● Growing instructions or fact sheets should be included with seed distribution (could be hardcopy or website link).
16	Minor	The genebank should improve the visibility of its work to its various stakeholders to promote the use of its collection.	<ul style="list-style-type: none"> ● Develop and implement a broad reaching communication strategy.
17	Minor	The genebank should expand its efforts to partner with NARS research centers and universities, farmers and NGOs that are interested in making selections within wild populations of species that can be directly used as forage, fodder or for environmental restoration. This would be in addition to partnerships being made with breeding programs.	<ul style="list-style-type: none"> ● Identify and engage with new potential partners.

2 Assessment of genebank activities to sustain essential operations

2.1 Availability of germplasm

2.1.1 Monitoring of genetic integrity

Collection composition and acquisition:

The ILRI Forage Genebank focuses on the conservation of the genetic resources of tropical and subtropical forage (TSTF). Since the last review in 2012, there has been a slight increase in the total number of accessions conserved in the genebank from 18,850 to the current level of 18,950 accessions, representing 1,884 species of tropical and subtropical legumes (55.5%), grasses (24.5%) and browse forages (20%) from 159 countries around the world. Analysis of the composition of the collection shows that wild species and crop wild relatives (CWR) are the most abundant with 16,822 accessions (88.8% of the total number of accessions), followed by 1,378 traditional cultivars or landraces (7.3%), 569 cultivars and released varieties (3%) and 10

accessions of hybrid and/or breeding materials. In addition, the genebank included 25 unique lines from EMBRAPA collection and 171 new unique progeny accessions of Napier grass into the genebank collection from pre-breeding activity. Despite the wish of the genebank to widen the diversity within the collection, there have been no attempts to acquire new germplasm in recent years, except for donations.

Guided by the global forage strategy, developed in 2015 (Pengelly, 2015), to ensure an efficient and rationalized conservation of TSTF, the ILRI genebank has prioritized its accessions into 5 categories based on the criterion outlined in Maass, Appendix 3, 2019 CIAT-ILRI FGR Report:

- Category 1: Species of known value
- Category 2: Species recognised as high potential
- Category 3: Species that have some potential
- Category 4: Crop wild relatives
- Category 5: Species of known low potential

The genebank strategy has been to focus on consolidating their collection on categories 1 to 3, which together with a number of unassigned accessions (3,811) are considered as their core mandate (13,945 accessions), while categories 4 and 5 (totalling 5,005 accessions) are considered as low priority and have been archived and placed in separate -20°C freezers labelled as “Archived”. However, whenever there is a request for any of the archived accessions, their seeds are made available by the genebank. The reviewers are of the opinion that, although priority should be given to accessions that have current high value and high potential, it is short sighted to consider categories 4 and 5 as being less important, which are genetically diverse and may have high conservation value for future potential needs. The reviewers consider that all accessions in the collection are critically important and a review of the conservation priorities is needed.

RECOMMENDATION 1: It is considered that all accessions in the collection are important. It is recommended that ILRI genebank review its categories and prioritize not solely based on use, but a broader set of criteria. We recommend that the outcome of this review should guide the active management and curation of accessions within the forage genebank collection. Consideration should be given to transferring accessions with no value for forage and fodder to other genebanks. (CRITICAL)

Action:

- **Change the names of the categories to high, medium and low priorities according to meaningful criteria relating to value, use, number of requests, uniqueness as well as conservation value.**
- **Attempt to transfer accessions in Cat 5 that have no potential value as forage or fodder to genebanks that would value the material (i.e. Kew)**

2.1.2 Seed acquisition

Seed acquisition has still not been given any priority, despite the recommendations of the last review in 2012, to carefully identify gaps and redundancies in the collection and develop an acquisition strategy to guide the collection of valuable germplasm before it is lost. The business plan reiterates that there is no plan for direct collecting of germplasm in the coming years, although the genebank is open to receiving and including any potentially unique material that widens the diversity of the collection. However, progress has been made in developing a Standard Operating Procedure (SOP) for Acquisition (*ILRI, 2025. Acquisition of forages at the*

ILRI genebank (ILRI-SOP-ACQ) Version 2.0 revised on 15 July 2025), defining ILRI's acquisition policies and describing the procedures for acquisition.

While the reviewers understand that genebank management is prioritizing all its efforts to achieve the performance targets set by the Crop Trust for obtaining a Long-Term Partnership Agreement (LPA), it would be irresponsible to neglect securing the genetically diverse, often unique, wild forage genetic resources that are threatened by habitat destruction, development, climate change and other drivers in their natural habitats. We, thus, reiterate the previous 2012 recommendation on undertaking a proper gap analysis for their important forage species in collaboration with other stakeholders.

RECOMMENDATION 2: A gap analysis of the collection found in Africa and beyond should be carried out to develop an acquisition strategy to widen the diversity of wild forage species in the collection, particularly from Africa. (MAJOR)

Action:

- **Assess the taxonomic and geographic coverage to identify gaps in collection, as recommended in the previous review**
- **Develop an Acquisition Strategy and Action Plan**

2.1.3 Seed processing - cleaning, drying and packing for storage

The latest version of the SOP on Conservation (ILRI, 2025. *Conservation of forage seeds at the ILRI genebank (ILRI-SOP-CONS v.5)*) clearly describes the current procedures for the reception of seeds in the genebank coming from the field sites after they have been regenerated, threshed and major cleaning done in the field. Once the seed-lots arrive in the genebank the seeds are verified for true to type using reference collection for the accession. Then, more advanced cleaning is performed manually to identify off types or damaged seeds or using seed blower and zigzag seed separator for smaller sized legumes and grasses. There are some inconsistencies between the practice and what is described in the SOP, in the order that drying, viability and seed health testing are done prior to or after drying. During the visit, it was indicated that seeds are then dried in the drying room set at 15°C and 15% RH and seed sampling is done for initial viability and seed health testing after drying. The genebank is well equipped to carry out moisture content monitoring during drying. In the past, the genebank used the oven-method and halogen moisture analyser, both of which are destructive methods, to determine seed moisture content (SMC). They have now switched to a non-destructive method using the Rotronic hygrometer, but this is not reflected in the SOP. The SOP should be updated to reflect the routine use of the Rotronic hygrometer. Any disparities should be addressed, and SOP and practices aligned.

After drying, seeds bags or trays are taken out of the drying room and brought to the bench outside the drying room, in an area where ambient temperature and RH are not controlled for seed bag preparation, packaging and sealing for storage. Sampling for safety duplication and distribution are also done in this area. This may be an issue given that the dried seeds suddenly become exposed to a higher RH environment and can absorb moisture, thereby raising moisture content of the seeds to suboptimal level which could affect seed longevity. However, the air RH in Addis is said to be generally low, but can be quite variable, depending on weather condition. While the risk of raising SMC may be low, it is still prudent to take measures to limit the exposure of dried seeds to high RH in ambient conditions. This can be achieved by either controlling RH in a restricted area where all dried seed handling is done, using a dehumidifier, and/or to carry and keep dried seeds of the accessions in covered plastic containers with silica

gel in them at all times, except when they are being packed, so as minimize any exposure to ambient conditions.

RECOMMENDATION 3: It is recommended that a dedicated RH controlled (15-20%) area is demarcated within the genebank building closest to the drying room where seed handling for packing and sealing of seed packets are performed. It is also recommended that, after drying, seeds samples are placed in a moisture-tight container when transported from the drying room to the seed packing area. (MINOR)

Actions:

- Acquire a trolley and plastic closed containers with silica gel or other desiccating agent for transport of seeds from drying room to packaging area
- Acquire a dehumidifier to control RH when required.

Seed Packing: The procedure followed at ILRI Forage Genebank is as follows:

1. After seed drying, subsamples of the accessions are then taken for initial seed viability tests (100 seeds), and seed health tests (300 seeds, although the Conservation SOP indicates 250 seeds for seed health).
2. The remaining seeds are packed in an Aluminium foil bag and temporarily placed in a third MTS storage room, awaiting the results of the seed viability and seed health tests.
3. If the viability and seed health results meet genebank standards, the seed packets are transferred to an assigned location in the MTS storage room.
4. For accessions not yet stored in LTS, 1000 seeds are subsampled, packed and transferred to designated freezers (LTS).
5. If genebank standards are not met, fresh seeds are regenerated to produce pathogen free enough seeds.

RECOMMENDATION 4: It is recommended that the genebank revise their workflow to streamline subsampling and packaging. One option that might be efficient for -20°C storage would be to:

- a) subpackage after confirmation that the seed-lot has passed quality checks (i.e. viability, seed health),
- b) subsample the bulk sample (in temporary storage) for LTS,
- c) safety duplicate,
- d) future monitor tests and distribution samples,
- e) store all samples in final location(s).

Bulk samples that fail quality check remain in temporary storage until they are successfully regenerated (or cleaned). The SOP needs to be revised to reflect any new workflow. (MAJOR)

Actions:

- Subsample seeds for initial viability and seed health testing.
- If seed viability and health tests do not meet standards, regenerate accessions and discard the original seeds after successful regeneration.
- If quality checks meet genebank standards, prepare seed packets for safety duplication, seed viability monitoring and distribution and transfer to LTS freezers as soon as possible.
- Revise SOP to bring it in line to what is done in practice.

Thresholds for conservation: Considering the difficulties in obtaining adequate quantities of seeds for some forage species and crop wild relatives (see section 2.1.6 below) for which little information on germination and dormancy biology are known, the reviewers agree that the thresholds for conservation can be relaxed, as proposed by the genebank manager in his presentation. For species that have normal germination results comparable to crops, the original FAO standards should apply. It should be pointed out that this would not be in contradiction to the FAO standard 4.3.2, which states that “*The initial germination value should exceed 85 percent for most seeds of cultivated crop species. For some specific accessions and wild and forest species that do not normally reach high levels of germination, a lower percentage could be accepted*”. It is suggested that the threshold for storing ‘difficult species’ should be set at MTS is 1500-4000 and for LTS at 1000 seeds. The threshold for safety duplication can be reduced to 300-500, while for distribution to 30-100 and the viability threshold could be reduced to 50-65%, depending on species.

RECOMMENDATION 5: The reviewers agree that the thresholds of sampling size for MTS and LTS conservation, safety duplication, distribution for forage species and viability test can be reduced, given the difficulties for obtaining adequate number of seeds for certain forage species. However, the normal international standards for these thresholds should continue to be applied for species with normal seed viability and regeneration/multiplication capacity similar to crops (MAJOR)

Action:

The thresholds for storage safety duplication, distribution and viability can be set as follows:

- **Storage threshold: MTS=1500-4000, LTS=1000**
- **Threshold for safety duplication: 300-500 seeds**
- **Distribution: 30-100 seeds depending on quantity of seeds**
- **Viability threshold: 50% to 65% depending on species**
- **Revise SOP accordingly.**

2.1.4 Monitoring of viability

The ILRI genebank has about 1844 species, including forage grasses, herbaceous legumes, and fodder trees. Most species are wild. Because these species are adapted to diverse environments, a wide range of protocols is needed to break seed dormancy and induce germination. The genebank is well positioned to undertake seed testing challenges, given that it has excellent seed germination lab facilities and well-trained technical staff. Although the germination lab supervisor has recently become the Field Operations Manager, he is still responsible for the lab. The recruitment process for his replacement is well underway, and the position should be filled shortly. The seed viability monitoring program procedures are clearly spelled out in ILRI-SOP-VIABILITY v. 5.0-002. The lab has a capacity to test 2000 samples annually. As of 2025, 12,435 accessions have been tested, with 8973 \geq 65% germination (Table 1. LTG-LTA Business Plan). Because of inherent seed dormancy characteristics in forage species, ILRI has proposed viability thresholds of \geq 65% for forage crops and \geq 50% for wild species (see above). Accessions are batched by genus, and 20 seeds are tested in four replicates. Pretreatments are determined using the literature and the lab is well equipped to carry out diverse protocols and develop and record new protocols as needed. The initial test is conducted after cleaning and drying newly harvested regenerated samples. Monitoring tests are conducted every 10 years for legumes and every 5 years for grasses held in MTS. In 2021, the genebank assessed accessions for seed quantity, recent viability data and health testing. They are now systematically testing material that requires viability testing, starting with legumes, then grasses, then trees. Raw data

for initial and monitoring tests are collected using tablets and summary viability data are uploaded into GRIN Global. Since 2012, enough viability data points have been collected so that seed longevity can now be estimated for many species.

RECOMMENDATION 6. It is recommended that

- a) **The genebank should consider monitoring not only MTS (active) samples, but LTS (base) samples, too. Testing efficiency could be gained if active and base samples were stored at the same temperatures (i.e. -20°C), as only one sample need be tested.**
- b) **High priority grasses, trees and legumes that have not been tested in 20 years should be tested, to identify material at risk of loss due to low viability. Also, lower priority accessions need to be monitored, giving priority to accessions that have not been tested in the last 20 years and known short-lived species.**
- c) **Historic viability data should be used to estimate seed longevity of species. Once longevity is known, FAO standards can be followed to determine species-specific monitoring intervals. Because many species are long lived, efficiency gains can be expected with monitoring intervals greater than five years. (MAJOR)**

Actions:

- **Carry out seed viability monitoring on both MTS and LTS samples.**
- **Prioritize testing for grasses and trees with legumes that have not been tested in last 20 years, and known short-lived species**
- **Estimate the seed longevity of species**

2.1.5 Monitoring of germplasm health

The Germplasm Health Unit (GHU) tests newly regenerated accessions, new acquisitions, distribution samples with quarantine requirements and older accessions that have not yet been tested. As of 2025, ILRI has tested 8608 accessions, and 7098 have been certified as clean and healthy (Table 1. LTG-LTA Business Plan). GHU has the capacity to conduct 4000-5000 tests annually. Following standards from the International Seed Testing Association (ISTA), GHU tests for 26 fungal pathogens, 7 virus pathogens and 3 bacterial pathogens. 70 seeds are used for each test. Samples for fungal and virus testing are surface disinfected, placed in petri dishes with blotter paper and incubated. To detect fungus, germinated seedlings are physically examined, and fungal species are identified using morphological attributes. If possible, contaminated seed lots are treated with fungicides. If treatment is not possible, material is regenerated to produce fungal free seed. For virus testing, ELISA tests are used to screen for AMV, SBMV and potyvirus. RT-PCR is used to confirm the presence of viruses. Contaminated material is grown out under greenhouse conditions, to produce virus-free seed. Bacterial diseases are identified by soaking seed in saline solution, placing seed extract on selective or differential media followed by visual inspection of colonies to identify pathogens. Pathogen presence is verified by ELISA or PCR procedures. GHU protocols and procedures are outlined in detail in seven SOPs. Tested accessions are given a certificate of health statement during distribution. In addition to health testing, the GHU works with the Field Regeneration Unit to monitor grow outs in the field conducting inspections on a weekly basis, if possible. The genebank is to be commended for its strong commitment to ensuring seed health.

The reviewers have no recommendations and commend the genebank for having a seed health testing program that is comprehensive, fully equipped, well documented, and with an adequate number of well-trained staff. As such, the reviewers encourage ILRI to continue to health test accessions to ensure performance targets are reached in a timely manner.

2.1.6 Ensuring sufficient stocks of germplasm (*regeneration, multiplication*)

The genebank recognizes that the regeneration and multiplication of its forage accessions remain their biggest challenge, because 90% of their collection is made up of wild forage

species and crop wild relatives, which are known to be difficult species to propagate and to produce large quantities of quality seeds. For example, many forage species, such as *Canavalia* spp, *Gliricidia sepium*, *Trifolium* spp., *Leucaena leucocephala*, and *Cytisus proliferus*, are perennials and cross-pollinated species that require several years to yield seeds and limit the number of accessions that can be regenerated or multiplied per location at any one time due to maintenance of minimum isolation distance between accessions to ensure genetic integrity (self-assessment text). Furthermore, contamination of new harvested seeds under open fields conditions with diverse pathogens, particularly viruses, fungi and bacteria has limited the genebank's capacity of producing clean and quality seeds that meet genebank standards and the performance target on availability. Despite the excellent support provided to the genebank in managing pest and diseases by the Germplasm Health Unit (GHU) through weekly visit to the regeneration fields, the reported number of accessions with clean health status is only 7,098 accessions, representing 37 percent of the collection (self-assessment Table 2). Although cleaning seeds from fungal infections is relatively easy, the cleaning of virus infected accessions is more difficult. However, looking at the trends over the past 5 years, there has been significant progress made in the proportion of clean accessions from the new harvest 2020-2025 (see also section 2.2.2).

Regeneration is normally triggered by low seed viability. While the 2012 review encouraged the genebank to explore new approaches to help them meet their regeneration challenges, the genebank is implementing a strategy for monitoring of seed viability based on prioritized category of their germplasm, with a primary focus on legumes, followed by grasses and trees, with the objective of overcoming their regeneration and seed viability backlogs. While this prioritization approach is commendable, there is a risk that valuable accessions from the lesser priority crops are not regenerated in time and these accessions may be lost, because of rapid decline in seed viability. The genebank accessions that have low quantities of seeds and low viability are being rescued by growing them in new greenhouse facilities under controlled environmental conditions. This is working well. Given the difficulties faced by many accessions which are difficult to regenerate, it is important that such greenhouse facilities be expanded to allow increased regeneration success. The genebank has made tremendous efforts to improve the regeneration of its accessions by implementing the following:

- Training staff to pay more attention to germplasm health and quality seed harvesting
- Increase seed regeneration in main season and doing off season regeneration by using irrigation
- Plant health management
- Greenhouse facility for controlled production
- Isolation mesh/cage for genetic integrity control
- Converting the field accessions to seedbank
- Quality seed harvesting
- Understanding longevity
- Seed regeneration with partners

RECOMMENDATION 7:

- a) **In addition to addressing the difficulties in producing high-quality, disease-free seeds and adequate quantity of seeds, the genebank should consider carrying out regeneration of 'difficult' species in the greenhouse under controlled environmental conditions. The genebank should urgently invest in the restoration of existing greenhouses and the construction of a new greenhouse with controlled environment conditions. This will enable it to increase the number of successful regenerations for the so-called 'difficult' forage and CWR species. (CRITICAL)**

- b) **The use of insect-proof row covers (<https://extension.umd.edu/resource/row-covers/>) should be explored to reduce pest and insect-mediated disease transmission. It is also suggested that for insect-mediated, cross-pollinated species such as *Medicago*, only a single accession be planted in the field since insects such as bees can move pollen more than 1 km. Alternatively, pollinators could be added to isolation cages to ensure controlled pollination occurs. (MAJOR)**

Actions:

- **Renovate existing greenhouse and shade house to increase the capacity for regeneration in more controlled conditions.**
- **Construct a new state of the art greenhouse with environment control, irrigation to produce healthy disease-free plants and seeds.**
- **Provide additional cages for regeneration plots in the field to reduce disease incidence and maintain genetic integrity.**

Characterization and Evaluation

The genebank has been making efforts to characterize their accessions, and characterization data for 15,863 accessions are available on Genesys. The genebank reported that they have characterized 9394 accessions of forage crops for one trait (Thousand Seed Weight (TSW), 1499 accessions for 4 different traits (hundred seed weight, seed length, seed width, and seed surface area) and 418 forage accessions for 18 different traits. It is noted that not all accessions have been evaluated for each of the 23 evaluation traits. Characterization has also been done for 4 crops namely *Medicago* (107 accessions), *Stylosanthes* (65 accessions), lablab (99 accessions), *Trifolium* (370 accessions) and *Centrosema* (37 accessions). In addition, datasets for legumes are available for the year 2023 (214 accessions for 18 traits) and 2024 (204 accessions for 18 traits) and three datasets for forage seed characterization for year 2023 (1499 for 4 traits), year 2024 (4457 accessions for TSW) and year 2025 (4937 accessions for TSW). The forage seeds characterizations were made possible by the acquisition of the Marvin Machine. Further, agro-morphological and feed quality traits have been characterized for cowpea, Napier grass, Buffel grass, Lablab, and Rhodes grass in the period 2023-2024 under various projects. Forage materials from the ILRI genebank were also selected for characterization of traits on low methane forages working closely with the animal nutrition team in ILRI and other CG centres (Alliance of Bioversity International and ICARDA). The genebank also reported that a total of 3253 accessions has been genotyped, using more than 60,000 to 1 million genetic markers for 13 different forage species undertaken by ILRI Genebank in collaboration with other projects.

In discussion with the database manager, characterisation data is being collected from the field using forms on Excel sheets and these data need to be re-organized and uploaded onto Genesys. There are also many datasets still in paper forms which are being digitized, but such information has not yet been uploaded into Genesys. The reviewers had no recommendations other than encouraging the genebank to continue its efforts to characterize and evaluate accessions and upload data as possible onto Genesys to further promote the use of genebank accessions.

2.2 Security of the crop collection and the genebank

2.2.1 Safety and security of the crop collection (first- and second-level safety duplication)

ILRI has been safety duplicating their collection at CIAT Future Seeds and Svalbard Global Seed Vault (SGSV). Accessions in Category 1-3 and unique accessions (the 'baseline collections') have been prioritized for backup. As of 2025, 50% of the total collection is backed

up at CIAT (58% of the baseline collection) and 55% (57% of the baseline collection) is backed up at Svalbard. Fifty percent of the total collection (57% of baseline) is backed up at both locations. ILRI plans to complete the backup of the entire collection at two locations within 3-4 years. The procedures for safety duplication are outlined in ILRI SOP-DUP-004 v. 3.0. To summarize, backup samples are pulled from accessions of species with good longevity that have not yet been safety duplicated and that have over 2000 seeds with viability of 65% or more in MTS. Accessions with low quantity of seeds (less than 2000 seeds) are regenerated before they are backed up. For safety duplication, 500 seeds are placed in laminated aluminum foil packets, one each for CIAT and SGSV. Barcoded labels are affixed to packets, and packets and an inventory list are placed in plastic boxes and shipped to the respective backup institutes on an annual basis. Viability of safety duplicate samples is monitored by monitoring subsamples stored in LTS at ILRI. ILRI also maintains 309 unique accessions exclusively at field sites. About 282 accessions are maintained at two locations.

RECOMMENDATION 8. The reviewers recommend that the genebank should aim to safety duplicate all unique seed and field accessions at two locations to meet performance targets, not just Category 1-3. We also support lowering the threshold safety duplicate seed number to 300 seeds per sample. We would encourage ILRI to increase the number of accessions they backup annually, so the collection is secured in 2-3 years. (CRITICAL)

Actions:

- **Safety duplicate all unique seed and field accessions at two locations**
- **Reduce safety duplicated sample to 300 seeds per sample**

2.2.2 Safety and security of the genebank facilities (*infrastructure, field, equipment, supplies*)

The ILRI genebank is to be commended for its new genebank building, which was completed in 2018. The new building has office space, a viability testing area with a laboratory and climate-controlled incubators, a seed health testing area with separate laboratories for mycology, virology and bacteriology testing, and a molecular characterization lab. Laboratory and seed processing equipment are in excellent condition (Table 7. Self-Assessment Report), and inventories for equipment and supplies are maintained. However, it is also critical that all equipment is regularly serviced and calibrated to ensure that they provide reliable readings. The building also contains an area for fine seed cleaning, seed processing and packaging and seed storage facilities. Twenty upright freezers (-20°C), purchased in 2019, provide LTS for the base collection (there are three backup freezers). Archived seed lots are stored in seven upright freezers. There are three MTS walk-in cold-rooms (5°C, 20% RH). Two of the MTS cold-rooms are used to store the active collection, and the third is used for short term storage. ILRI has 17,642 seed samples in LTS and 16,267 samples in MTS. The reviewers recommend that the genebank should aim to conserve all accessions under LTS storage conditions (-20°C) as soon as possible. This would reduce the workload on viability testing and reduce the need to regenerate since seed longevity will be significantly improved. This is in line with the recommendation of the 2019 report by Brigitte Mass on the harmonization of the ILRI and CIAT collection, which recommended that ILRI immediately and fully implement the recommendation of the 2012 Genebank Review to store all accessions in the collection under LTS. The reviewers recognize that capital improvements will be needed to implement this recommendation since the MTS cold-rooms cannot be converted to -20°C. storage. However, considering the gains in efficiency by reducing the number of viability tests, lengthening regeneration intervals, and reducing electricity costs, this investment will pay off over time.

Another advantage would be to repurpose the vacant upright freezers to provide black box storage to NARS if there is a demand for this service.

Field genebank and field sites: ILRI genebank currently maintains 2282 accessions as live plants in the field, **despite having only 309 accessions that require field conservation due to factors such as apomixis**. Plans are in place to move most of these field accessions into seed-stored accessions, and the reviewers support these plans since it will increase storage security and management efficiency. The genebank has access to fields to conduct regeneration, multiplication and characterization. There are three field areas on the Addis campus, and irrigation is available. This has allowed the genebank to conduct grow outs in the off season, effectively increasing the number of accessions they can regenerate annually. The Genebank has four greenhouses and six screenhouses at different sites. The greenhouses are used to produce field transplants, and to conduct seed rescues. With the exception of one greenhouse, greenhouses and screenhouses are in fair to poor shape (particularly the screenhouse at Addis is unusable). Efforts are underway to renovate some of the greenhouses. The Genebank struggles to produce disease-free seed in a field environment, although recent procedures have improved the situation somewhat. The best solution for overcoming seed-borne disease problems would be to produce seeds of vulnerable material (i.e. legumes) in an insect vector-free, controlled climate greenhouse and screenhouses. Additional greenhouse space could effectively increase the annual number of successful regenerations, by reducing the need for a cleaning and regrow program of field grown material (see also section 2.1.6). In addition to Addis (highland agroecology), the genebank has regeneration sites at Bishoftu (midland), Sodo (midland) and Zwai (lowland). Land, facilities and equipment appear to be sufficient to support operations at these locations. Unfortunately, the reviewers did not manage to visit these sites during this genebank review.

Safety and security measures: The genebank has taken appropriate measures to ensure safety and security measures are in place. The genebank has key-card access entry with separate key access to storage and processing areas. CCTV is installed within the building and in fields. Security guards are also employed at all sites. All essential genebank equipment is monitored and verified by trained staff, calibrated by a certified third party and included in the genebank's maintenance schedule. However, the reviewers did see some equipment tags with older maintenance dates. For the Zebra printers used for barcode labelling, calibration is performed by the database team. The cold rooms, freezers and germination incubators are monitored using the JRI MySirius software. Temperature and humidity are monitored twice a day and key staff receive alarms. Equipment (i.e. coolers) are maintained every three months by an outside contractor. Cabinets and fume hoods are calibrated and certified annually by certified service providers. The calibration and certification of equipment is facilitated by ILRI Environment, Occupational Health and Safety (EOSH) unit. The ILRI facilities department manages institute-wide systems, such as fire alarms, security and electricity. There are two backup generators if power fails.

RECOMMENDATION 9. It is recommended that the ILRI Forage Genebank should aim to conserve all accessions under LTS storage conditions (-20°C) as soon as possible and seriously consider making the required capital investment in LTS (-20°C) cold-rooms for long term sustainability. **(MAJOR)**

Actions:

- **Conserve all accessions under LTS storage conditions.**
- **Consider converting MTS cold-rooms to LTS storage conditions (-20°C) or, if not possible, consider replacing the MTS cold room with LTS cold-rooms.**

RECOMMENDATION 10: The genebank has followed through on the 2012 recommendations to rationalize the seed-lots they store. We encourage them to continue their efforts to rationalize seed-lots, targeting no more than three packets per accession. This will help to streamline packet management and save storage space in their coolers. **(MINOR)**

Actions:

- Rationalize seed-lots targeting three packets per accession.

RECOMMENDATION 11: We recommend that the genebank move forward to store field accessions that produce orthodox seed in LTS and MTS. Since seed storage is much less costly than field storage, this will save on resources and also help to liberate more field plots for regeneration activities. **(MAJOR)**

Actions:

- Assess which of the field genebank accessions are orthodox seeds.
- Develop a plan to transfer the field accessions with orthodox seeds to seed bank.
- Move accessions to seed genebank as feasible.

RECOMMENDATION 12: The reviewers recommend that equipment be regularly maintained, checked and calibrated to ensure equipment is functioning properly. Maintenance dates should be recorded on equipment tags. **(MINOR)**

Actions:

- Develop a timetable for maintenance of all equipment.
- Ensure that the last date of maintenance is clearly marked on a tag attached to all equipment.

2.3 Documentation and data availability

2.3.1 Information management system for monitoring and management (IT system and equipment; barcoding)

The genebank has come a long way from the FoxPro database in use in 2012 and is to be commended. Figure 2 illustrates the information technology architecture currently in use and the information management system is thoroughly described in SOP-ILRI-INFMAN and individual instruction sheets are available to support staff in daily genebank IT activities.

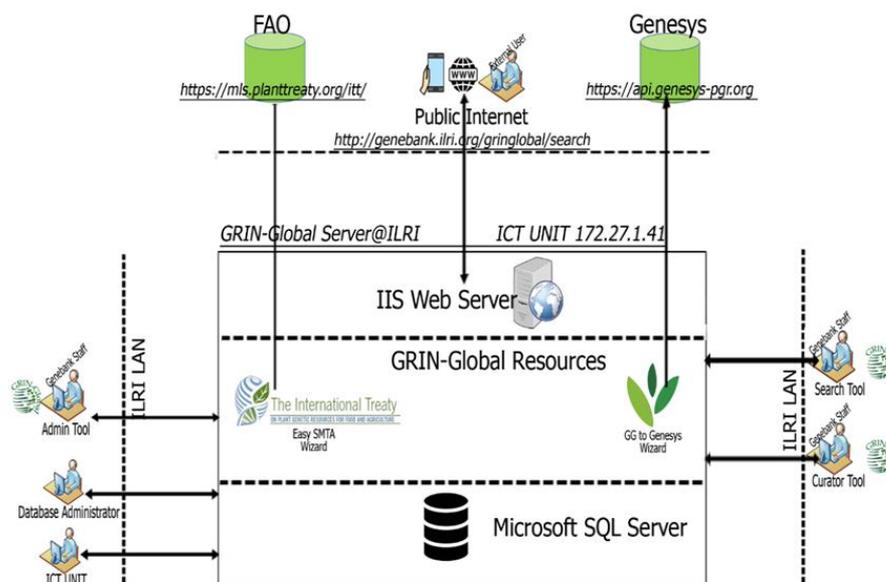


Figure 2: Information technology architecture currently in use in ILRI Forage Genebank.

Three virtual servers managed by the ILRI Information and Communications Technology (ICT) Unit host GRIN-Global, JRI MySirius (an environment monitoring web application), and barcoding application. All three applications have an IIS Web Server (monitoring application) and MSSQL Server. The administrator for both servers is the Genebank Database Specialist. GRIN-Global is available to genebank staff on a local area network. Staff are able to use the Search tool and Curator tool to manage inventory and passport data. GRIN-Global is interconnected one way with EASY-SMTA and Genesys for submitting data. To capture data, ILRI uses KoboToolbox, an app that allows users to develop data collection forms on tablets. KoboToolbox is used to collect descriptor, germination, health testing, seed image and regeneration data. Once collected, data are downloaded into Excel spreadsheets and inspected. Data such as seed quantity, germination, and grow out result data are uploaded into GRIN-Global. Although some characterization data are in GG, the genebank is mainly uploading characterization and images into Genesys using the GG to Genesys upload wizard.

The genebank plans to adopt GRIN-Global Community Edition (GGCE), with a target date of 2026. Since GGCE is designed with inherent interconnection capabilities, they will be able to fully integrate their system. Once fully adopted, two-way interconnection within GGCE will facilitate the seamless exchange of data – both submitting and receiving data. This will improve data consistency and streamline workflows. Currently, data have been migrated to a production server, and GGCE is being customized to accommodate the genebank’s workflow. The reviewers strongly support the genebank’s efforts to adopt GGCE.

The genebank is well-equipped with IT equipment. Key staff members have desktop computers. There are 4 barcode printers, 2 mobile bar code printers, 18 tablets, 9 handheld barcode scanners and six each Bluetooth digital tape measures and callipers. Barcoding has been thoroughly integrated into genebank processes. There are eight types of barcode labels both in 1D and 2D used for specific purposes in the genebank data management workflow. Information printed in each label varies according to the type of barcode and the purpose it is used for. The genebank has started the implementation of barcode in data retrieval in the Germplasm Health, Germination and Conservation units. Currently, the Germination lab and GHU are fully using the new barcoding application to capture and retrieve the germination and health tests (Figure 3).



Figure 3. Seed viability lab uses QR codes to enter germination data. ILRI uses seven labels in the genebank, all with bar codes

2.3.2 Security and availability of germplasm data

(data backups; updates to Genesys; passport, characterization, and evaluation data)

Data Security

To ensure security, the public-facing GRIN-Global website uses a robust security framework that includes an SSL (Secure Sockets Layer) certificate for all external communications. All internet traffic to and from the database is encrypted through a third-party SSL certificate, protecting against unauthorized access and data breaches. Access to the production version of GRIN-Global is carefully controlled. Genebank staff with user-level access can only log in using their authorized GRIN-Global accounts, and permissions are granted by the database officer.

Data backup on the three servers used by the genebank are managed by the ICT Unit, which implements a multi-faceted data backup strategy utilizing the third-party tool, Veeam Agent. Additionally, data stored on the genebank's Microsoft SharePoint sites is backed up using the built-in backup and recovery mechanisms within Microsoft 365. This cloud-based solution provides automated versioning, point-in-time restoration capabilities, and data redundancy to safeguard against data loss. The ICT has also implemented a disaster recovery protocol to recover and restore data in the event of a disruption. A full file server backup runs monthly and incremental backups to local storage are conducted weekly.

Availability of data

The genebank has been making good progress making germplasm data readily available to users, which is reflected in a PDCI of 7.31 on 18,950 accessions. The GRIN-Global public website and Genesys house passport data and images of seed, plants, pods and flowers. Upload of characterization/subset datasets into GG has been problematic, so ILRI has focused on making this data available from Genesys. Table 3 summarizes the ILRI data that is available and update frequency.

Table 3. Public availability of data

Data	System	Update Frequency	Comment
Passport	GG, Genesys	Periodic	
Images	Genesys	Continuous	Seed, flowers
Subset/Research	Genesys	Continuous	13 subsets: core (<i>Urochloa</i> , <i>Sesbania</i> , <i>Chloris</i> , <i>Cenchrus</i> , <i>Lablab</i>), best bets

Data	System	Update Frequency	Comment
			(Napier grass), ILRI cowpea varieties, highland and dryland forage
Characterization	Genesys	Periodic	10 datasets: 2023-2025 seed and legume data, <i>Medicago</i> , <i>Stylosanthes</i> , <i>Lablab</i> , <i>Trifolium</i> , <i>Centrosema</i> historic sets

The reviewers encourage the genebank to continue to make collection data available to collection users -- this includes historic characterization data, and data collected during regeneration. Of value to users are core subsets, best bets and sets of varieties. Availability of these data are valuable for adding value to the collection.

3 Key performance indicators

The status of key performance indicators for the ILRI Forages Genebank is given in Annex 2 and summarized in Table 4. The Crop Trust requires that the genebank achieve five targets to become eligible for an LPA. As can be seen in Table 4, the ILRI genebank has achieved the target with respect to ‘Data availability’ and Passport Data Completeness Index (PDCI) having uploaded almost all its accessions’ passport data on to Genesys and having achieved a score of 7.31, which is above the target of 6.0. It is also close to achieving the targets on QMS and capacity building. However, the genebank is still struggling to make its whole collection available for distribution due to its limitation to produce clean materials and in sufficient quantities (see section 2.1.6). The genebank is making good progress in safety duplication and aims to complete the backup of the entire collection at two locations within 3-4 years (see section 2.2.1).

Table 4. Status on key performance indicators and targets for long-term support

Mission of the Crop Trust	Key performance indicators	KPI status*	Targets for long-term funding support	Target status
Promote the availability of PGRFA	Number of accessions that are legally available for distribution Number of accessions that are available in the Multilateral System (MLS) Number of accessions that are physically available for distribution	18,950 18,950 15,585	Target 1: Availability 90% of collection clean of pathogens of quarantine risk, viable, and in sufficient quantity to be immediately available for national and international distribution from medium-term storage	51%
Endeavor to safeguard collections of unique and valuable PGRFA held <i>ex situ</i>	Number of accessions conserved as seeds in cold storage, as live plants in the field, and other plant materials in <i>in vitro</i> and cryopreservation. Number of accessions conserved in long-term storage (LTS) in two locations, including the Svalbard Global Seed Vault (seed crops) Number of accessions conserved <i>in vitro</i> in slow growth conditions or in cryopreservation at two locations (clonal crops)	18,950 (seed) 2,282 (live plants) 5,252 N/A	Target 2: Safety duplication For seed crops: 90% of collection in LTS at two locations and also in Svalbard Global Seed Vault For clonal crops: 90% of collection duplicated <i>in vitro</i> or in cryopreservation	50% N/A
Promote an efficient goal-oriented, economically efficient and sustainable global system of <i>ex situ</i> conservation in accordance with the	Elements of QMS in place (science and operations, policy, risks, staff, equipment, infrastructure and reagents, user satisfaction, information management, supplies and services)+	Y	Target 3: QMS Eight elements of genebank QMS in place	Partly achieved. some improvements are needed.

Mission of the Crop Trust	Key performance indicators	KPI status*	Targets for long-term funding support	Target status
International Treaty and the GPA				
Promote the regeneration, characterization, documentation and evaluation of PGRFA and the exchange of related information	Number of accessions with passport data uploaded to Genesys Passport data completeness index (PDCI) Number of accessions with characterization and/or evaluation data uploaded to Genesys	18,916 7.31 15,863	Target 4: Data availability and completeness 90% of accessions uploaded to Genesys Average PDCI > 6	Achieved
Promote national and regional capacity building, including the training of key personnel	Capacity building activities with NARS Number of participants, including key genebank staff, trained on performance areas related to above	Yes	Target 5: Capacity building Capacity building with at least five NARS (including other crop genebanks, regional/community organizations, and/or farmer groups)	Achieved

*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 the collection

4.1 Genebank QMS

A Genebank Quality Management System (QMS) is a tool that helps genebanks direct their activities to meet users' needs and meet agreed standards and their regulatory requirements. It provides evidence for continuous improvement of the genebank activities in the most efficient and effective manner by having in place manuals, standard operating procedures (SOPs), improvement plans, audits, mechanisms for monitoring and analysing progress, capacity building plans and knowledge management for each of the genebank operations. At the core of the Genebank QMS, there are eight coordinated elements, referred to as the "QMS octopus", that serve as building blocks for quality management for each genebank operation (Lusty et al., 2021).

It is very satisfying to see that ILRI Genebank has fully embraced all the eight elements of the QMS in their genebank. It is clear that genebank management is committed to implement the QMS fully and institutional support. All 8 elements are adequately fulfilled, although there is some room for improvements as discussed below.

- Science and Operation:** The genebank has produced 15 SOPs for their key activities, covering conservation and distribution, characterization, database management, germination, GHU, and regeneration. The genebank is to be commended for the high quality of the SOP. Generally, the SOP are well adhered to, but in some cases, it was found that there are some disparities between the SOP established procedures and what is practiced in the genebank. For example, in the seed processing procedure (see section 2.1.3). The SOP owner should ensure that any disparities are corrected or if any changes are made in practice, the SOPs are revised.
- Policy:** The genebank was established in 1983 and ILRI then signed an agreement with FAO to hold its collection in trust under the auspices of FAO. In 1996, it also signed an Article 15 agreement with the International Treaty on Plant Genetic Resources for Food and Agriculture. In addition, it follows its hosting institution policy document on

Environment Occupational Health and Safety (EOHS), which provides the highest level of protection to the environment and to safeguard the health, safety and welfare of its employees and other stakeholders. The genebank is part of the institutions' Health and Safety Committee.

3. **Risk:** As recommended by the previous review, the genebank has developed a risk register that is maintained and updated regularly (once a year) to identify, assess and mitigate potential risks (see below). The genebank also has developed a Red Book of Risks, which provides guidance on managing risks in genebanks and contains a risk table (see analysis below).
4. **Staff Management:** The genebank has suffered from high turnover of staff in the last 5 years due to several staff having retired or resigned. Although there is no formal succession plan, the genebank maintains a matrix of core competencies for each task to ensure that there is a core group of staff with relevant competencies for each activity. In each of the SOPs there is a list of activities and each staff member with competences and experience is indicated.
5. **Equipment infrastructure and Reagents (EIR):** The genebank is required, as part of the QMS, to maintain a well-documented inventory of the infrastructure, equipment and reagents, as well as management and calibration schedules and keep this up to date. The staff has provided a comprehensive inventory of its facilities and equipment at the genebank, laboratories and field sites, as well as a list of its supplies and consumables for running the genebank and associated activities. The inventory could be further improved by including maintenance and calibration schedules to establish that they meet the specification requirements and comply with relevant standards. The Crop Trust has a template for properly documenting this information and it is suggested that the genebank request this template from the Crop Trust. The reviewers also observed that security and monitoring systems have been installed in all their cold rooms and freezers to track temperature changes over time, which allows them to intervene and to keep the genebank secure.
6. **User Satisfaction:** It is important that the genebank can gauge the level of satisfaction of their beneficiaries in the service and quality of genebank materials that the genebank provides. In the past the genebank sent out survey forms with the genetic materials, but very little response was obtained. The genebank now uses an online feedback mechanism by which recipients are able to provide feedback on the materials they have received. The genebank also follows up with recipients after sending out materials by mail and if no reply is received, the recipient is contacted by phone. This process seems to be working well and allows a dialogue between the genebank and the recipients. Another important point about user satisfaction is that users are able to get easy access to characterization data on an accession in a friendly way in Genesys and can order either from the genebank website or Genesys. The genebank has also created subsets of characterisation data that allow users to more efficiently find and request a range of genetic material they need for various purposes, like breeding for disease resistance or adapting to climate change (see also characterization section 2.1.6). These efforts will greatly promote the use of its collection and encourage users to come back.
7. **Information Management:** Information management is a key element of the genebank QMS system that ensures that all data generated in genebank are adequately captured, managed and made available to users. When done properly it adds value to the collection. The procedures for database management is well described in the database management SOP (ILRI, 2025. Information Management at the ILRI Genebank (ILRI-INFOMAN ver. 2.0-005) and covers the acquisition of information from genebank processes, its curation, its distribution to those who need it, and its final archiving or

deletion. Additionally, this SOP covers the evidence gathering necessary for QMS purposes. (see section 6.1 for more details).

8. **Supply and services:** The quality of the performance of the genebank is highly dependent on the quality of the products supplied by the genebank service providers. It is very important that suppliers for the genebank equipment, infrastructure and supplies are carefully selected to meet the specific requirements of a genebank. In ILRI the genebank depends on the Supply Chain Unit which deals with all procurement for the institute.

RECOMMENDATION 13: The genebank is to be commended for the efforts it has accomplished in setting up the QMS. There are however some minor issues that should be addressed as described in the report, ensuring that (MINOR):

- a) **All SOPs are well aligned to the practices in the genebank.**
- b) **The risk table is in accordance with the table in the Red Book of risks.**
- c) **Continue to ensure that all heads of units have assigned deputies that can take over when he/she leaves.**
- d) **Ensure that all equipment is adequately maintained and calibrated regularly and proper records well documented in a visible area.**
- e) **Attention is given to making more characterization information easily accessible to users seeking to order accessions and that relevant information on seeds that are dispatched is also provided at distribution.**

Actions

- **Align all SOPs to actual practices in genebank**
- **Assign deputies to all heads of units**
- **Ensure all equipment are properly calibrated and records well documented**
- **Make characterization information more easily accessible.**

4.2 Risk management

The previous review in 2012 strongly recommended that a risk assessment of the collection be carried out. The genebank has prepared a Genebank Operation Risk Assessment and Mitigation table as a stand-alone document in which 114 risks were identified for acquisition (5), conservation (18), regeneration (20), characterization (6), viability (11), seed health (13), distribution (10) and information management (31). While none of the risks were considered to be 'Serious', 26 out of the 114 identified risks were 'High', 70 'Medium' and 18 'Low'. Among the high risks, the categories that have the greatest number are conservation (8), information management (7), regeneration (4), distribution (3) acquisition (3) and characterization (1). The conservation 'high' risks are related to financial unsustainability, security of the conservation facilities (fire, power, failure of the cooling system) as well as physical security of staff working in genebank, succession planning and staff training. The information management 'high' risks include backup of data and information, loss of historic information, and legal status of accessions. The 'high' risk of regeneration includes disasters (such as flooding, waterlogging, and earthquakes), social instability as well as pest and disease incidence. In distribution it was considered that the detection of diseases by the recipient was a high risk as well as requested germplasm not being available.

It is noted that the risk management plan is missing a business continuity plan, a first responder plan and a recovery plan, which are all essential components. A Business Continuity Plan should contain the critical information that the genebank needs to continue operations despite adverse events. It is the process of creating systems of prevention and recovery to deal with

potential threats to genebank. An emergency action plan or First Responder Plan, as it is also sometimes called, provides a protocol that staff must follow when an emergency related to the health and security of staff (e.g. staff injury) or the genebank collection (e.g. fire outbreak in lab or storage room) arises. Precise protocols must be written, and all staff are made aware of the protocols and procedures in cases of emergency. Drills and testing of the plan should be executed at least once a month. It is possible that such a plan already exists at the institutional level, but a specific plan for the genebank would be in order.

Recommendation 14: It is recommended that the genebank develop a Business Continuity Plan and First Responder Plan and that all genebank staff are appropriately trained and responsibilities assigned to specific staff in implementation of these plans. (MINOR).

Actions:

- **Develop a Business Continuity Plan and First Responder Plan.**
- **Train staff in implementation of Business Continuity Plan and First Responder Plan.**
- **Assign responsibilities to staff in the event of disasters.**

4.3 Efficiency of genebank procedures

The genebank has made very good progress in improving the efficiencies of its procedures by addressing in a planned manner the implementation of the eight elements of the QMS (see section 4.1 above). The reviewers feel that as the different elements of QMS are implemented and refined (see recommendation 13 in section 4.1 above), the efficiency of genebank operations will continue to improve. More specifically, it is felt that greater efficiencies can be obtained if the whole collection could be moved to -20°C storage condition (as recommended in section 2.2.2) and as the rationalization of the seed-lots is completed. This will considerably reduce the frequency of seed viability monitoring and regeneration, allowing more efficiencies in genebank management to be gained. Further, the availability of more controlled environments for regeneration of accessions to reduce pest and disease incidence will also greatly improve efficiency of doing regenerations (see recommendation 7 section 2.1.6 regeneration). The development of an effective documentation and management system using GRIN-Global together with the implementation of a barcoding system over the last decade, has greatly improved the efficiency of genebank management. The reviewers feel that greater efficiency will also be gained by moving over to GRIN Global-Community Edition (GGCE), as this will enable more seamless information management across all genebank activities. The genebank also hopes to increase its efficiency by converting field genebank accessions to seed storage, for those species that produce seeds with orthodox seed storage behaviour. This will improve efficiency in the conservation, safety duplication and distribution of these genebank materials.

5 Effective enabling environment to support genebank operations

5.1 Finances

The genebank receives its funding principally from the CGIAR Genebank Accelerator, complemented by the ongoing long-term grant of the Crop Trust for some of the essential operating costs. It also has mobilised some funding through projects. For example, there have been projects that have contributed to the characterization and evaluation of genebank material, enhancing availability of data (genomic, evaluation data) for the collection. In collaboration with CIAT and ICARDA, the genebank is screening genebank materials for low methane

emission lines through the project funded by Bezos Earth Fund and Gates Foundation (project value USD 6.5 million) which runs from October 2023 to September 2028. It aims to characterize 10% of its collection for high yielding, nutritive and low-methane forages. Another project funded by UK FCDO (project value GBP 1.15 million; January 2024 to December 2026) is working on defining phenotypes for forage improvement using genebank materials. Besides these two projects, the genebank does not seem to have any projects in the pipeline.

The 5-year genebank Business Plan 2026 to 2030, estimates that it will require a total budget of more than USD 12 million over the next five years, with an increasing yearly budget from USD 2.18 million in 2026 to USD 2.65 million by 2030. Of the total budget over 5 years, it estimates that USD10.75 million USD will be required for its essential genebank operation. This amount would be covered largely by the CGIAR Genebanks Accelerator USD10.15 million, while USD 595,000 will be covered by LTG of the Crop Trust. Further, the remaining about USD1.3 million covered by CGIAR Genebanks Accelerator to cover non-essential operations such as targeted user engagement, regional/global networking and capacity sharing to support and enhance management of genetic resources and biodiversity conservation. This will strengthen collaboration and partnership with national and regional genebanks. The genebank also hopes to recruit a quality officer to strengthen the QMS implementation and quality assurance and a communication officer to help raise greater awareness of the work carried out by the genebank. The reviewers agree that these investments would greatly help the genebank to raise additional funds. It is suggested that special efforts on fund raising by the genebank be made to seek additional funding through projects to complement the funding from above sources.

5.2 Policy

As part of the CGIAR, the ILRI genebank is committed to ensure the conservation and availability of the in-trust collection of tropical and subtropical forages, held under Article 15 of the International Treaty on Plant Genetic Resources for Food and Agriculture (ITPGRFA). It is noted that the entirety of their accessions (i.e. 18,950 accessions) is legally available and is included in the Multi-Lateral System (MLS) of the ITPGRFA. The genebank uses the Online SMTA Generation and Reporting tool of the Easy-SMTA to distribute its accessions. The genebank states that it has distributed over 45,000 samples and reached users/requestors in over 110 countries (see section 6.1 - distribution). Further, ILRI has signed an MoU with the Ethiopian Institute of Biodiversity to strengthen its partnership on biodiversity conservation and collection availability.

5.3 Staff management and succession planning

The genebank has 39 staff with technical expertise who work in four technical units, namely Regeneration and Field Operations Unit, Germination Unit, Germplasm Health Unit, Conservation Unit, and Database and Information Management Unit, each led by a designated core staff. The Regeneration and Field Operations Unit covers four sites, at Addis, Sodo, Bishoftu and Zwai, where regeneration and field conservation operations are carried out and where temporary staff are also employed to support field operations. Currently, the Research Officer position for overseeing the Germination Unit is vacant, but the work is being overseen by Mr Tamiru Olbana, who is also responsible for the Regeneration and Field operations, to ensure the smooth running of these activities until a replacement is found. It is understood that the recruitment for this position is underway. The business plan summarises very well the status of staffing composition. It notes that there have been many changes in key staff (especially at the head of the genebank) over the past few years, when the genebank has experienced a turnover of about 15 staff, basically two staff per year. At the level of genebank manager, following the retirement of Jean Hanson, who served ILRI for over 30 years, there have been

two genebank managers, who have left after only a few years' service, causing disruptions. This has somewhat affected the smooth running of the operations in the genebank. Despite this, the reviewers note that these changes have not impeded the progress that the genebank has achieved since the last review, as indicated in this report. The genebank was lucky to have Jean Hanson to continue support and guide the work at the genebank. This achievement can be attributed to the dedication of its staff to their work. The role and competencies of each staff member is well defined in the Standard Operating Procedures for all its activities. Although a detailed succession plan is not available, there is no doubt that ILRI is managing staff recruitment and replacement seriously and in a timely manner.

5.4 Leadership

The genebank is now headed by a very capable leader, Dr. Alemayehu Teressa, who has been in office since 2024. The reviewers were very impressed by his motivation and competence during the review process. He is also well supported by the ILRI management and genebank staff. He is working hard to ensure that the genebank will soon meet the performance targets of the Crop Trust to be eligible for Long-Term Partnership Agreement. The genebank has an important role to play in the leadership of tropical and subtropical forage conservation and use globally, as mentioned in the Global Strategy for the Conservation and Utilisation of Tropical and Sub-Tropical Forage Genetic Resources (Pengelly 2015). The strategy's overall objective can be summarized as TSTF genebanks, including ILRI, providing germplasm and leadership for forage research and development, and collaborating through exchange of ideas, data, staff, and germplasm. The three main themes - (1) rebuilding community, (2) achieving greater efficiency in conservation, and (3) improving utilization - require different immediate implementation targets and pathways as they are applied to a range of different genebanks. It is considered that given ILRI's position in Africa, it is well placed to take a leadership role on these specific themes for the conservation of Africa's TSTF on the continent.

6 Contribution to the global system of crop diversity conservation

6.1 User engagement

Distribution

Since the genebank opened in 1983, it has received 1,859 requests from 932 users and has distributed 47,913 samples. The top three user groups are Agricultural Research Institutes and Universities (69%), farmers, farmer groups and NGOs (19%), and international and regional genebanks (7%). In the last five years, 65% of distributions have been requests coming from ILRI, 33% have come from institutes within Ethiopia (excluding ILRI) and 2% have been requests from outside Ethiopia. The Ethiopian Biodiversity Institute has authorized distribution of the majority of non-Annex 1 materials without additional requirements, which will enhance international distribution of the collection. In the last three years, distributions have increased, suggesting that recent improvements in the collection availability, information and access are having a positive impact. The Tropical Forage Selection Tool has been a particularly effective way to promote collection use. 85% of requests come through online forms for GRIN Global and Genesys. 10% come through email and 5% are in person. A user satisfaction survey is sent out twice a year. Follow up emails and phone calls are also made. Most users provide positive feedback on arrival time, performance of seeds, and support received from the genebank team. There have been instances where users required specific information on how to germinate and grow specific species. The genebank then provided advice and information (e.g. fact sheets) on how seeds should be planted and treated.

RECOMMENDATION 15: It is suggested that when seeds are distributed, procedures for seed germination, breaking dormancy, cultural practices, fertilizer applications, pest control etc. be sent with the seed request. (MINOR)

Actions:

- **Growing instructions or fact sheets should be included with seed distribution (could be hardcopy or website link)**

Communication

The genebank has expended time and effort to expand the visibility of its work, mainly through genebank tours (ILRI has organized 87 genebank tours since 2018) and YouTube videos. They have been working with the ILRI Communications, Advocacy and Knowledge Management (CAKM) Unit and Genebank Accelerator communications team to develop signage, posters, artwork and seed and live plant displays throughout the genebank. These efforts help educate visitors and tour guests. To celebrate the 40th anniversary of the genebank, they gave a media briefing and produced YouTube videos on genebank operations and activities.

RECOMMENDATION 16: The genebank should improve the visibility of its work to its various stakeholders to promote the use of its collection. (MINOR)

Actions:

- **Develop and implement a broad reaching communication strategy.**

6.2 Partnership with NARS, other genebanks, and other stakeholders

The genebank partners and collaborates with many institutes to ensure its collection is conserved, duplicated and used. In the last five years, it has built several key partnerships that have supported genebank functioning, especially for international distributions. ILRI has signed an MoU to strengthen the partnership with Ethiopian Biodiversity Institute (EBI). A significant outcome of this partnership has been solving the challenge of international distribution of non-annex I materials since EBI has agreed many of these materials can be distributed without additional requirements and restriction. The relationship with the Ethiopian Agricultural Authority has also been strengthened, benefiting phytosanitary regulation, requirements for germplasm distribution and importing of supplies, consumables and equipment for genebank activities.

Within ILRI, the genebank has developed effective partnerships to further the evaluation of their materials. For example, they are collaborating with the Feed and Nutrition Team to evaluate accessions for productivity, nutrition, digestibility, and protein. This collaborative work has been funded by the UK-Commonwealth and Development Office. A second important collaboration, funded by the Bezos Earth Fund and Gates Foundation, has been on generating information on the methane reduction potential of genebank materials (see Section 5.1 for further details). A third partnership is with the Poultry Diversity Research Facility, which has been evaluating germplasm materials for poultry feed. These partnerships are contributing to the characterization and evaluation of the collection.

Within CGIAR, the ILRI genebank has worked closely with CIAT Genebank to harmonize the conservation and management of tropical and subtropical forages. Along with the Svalbard Global Seed Vault, CIAT serves as a storage site for ILRI safety duplicate samples. ILRI has also partnered with CIAT to harmonize QMS activities, including hosting a QMS

harmonization workshop. Within the CGIAR Genebanks Accelerator, Communities of Practice (CoPs) are an important route for partnering through learning opportunities, knowledge sharing, standards review, and quality management training. ILRI is active in several CoPs. The ILRI data management team is participating in the GGCE CoP, as they move towards adopting GGCE. The GHU is involved in the health testing CoP, sharing protocols and procedures. ILRI has also taken advantage of the Communications Team with the CG Genebanks Accelerator to produce YouTube videos that document genebank activities.

Current partnerships with NARS (research centers and universities) focus on activities to provide breeders with germplasm resources. In the next five years, the genebank plans to foster partnerships that support regeneration and characterization, evaluation and promotion of promising germplasm materials.

The genebank is to be commended for its efforts to build capacity in genebank management among NARS genebanks through training and technical back stopping. Staff of the national genebanks of Zimbabwe and Rwanda were trained on genebank operation and implementation of genebank QMS. In addition, the ILRI genebank manager visited the Zimbabwe national genebank to provide technical support on genebank operations and database management. ILRI Genebank Database Specialist has also visited the Rwanda national genebank to provide support on database management. Together with other CGIAR genebanks in the region, a training workshop was offered to national partners from 20 African countries. In addition, training was offered to EAA on seed quality production and seed quality testing and to EBI staff on genebank operations. Over the years, the GHU has also provided ICRAF and seven African NARS with training on seed health testing and plant pathogen detection.

RECOMMENDATION 17. The genebank should expand its efforts to partner with NARS research centers and universities, farmers and NGOs that are interested in making selections within wild populations of species that can be directly used as forage, fodder or for environmental restoration. This would be in addition to partnerships being made with breeding programs. (MINOR)

Actions:

- **Identify and engage with new potential partners.**

6.3 Germplasm availability in MLS

ILRI has maintained a strong commitment to making germplasm and associated information available through the MLS and has policies, protocols and practices established to ensure ongoing availability of germplasm into the future. All genebank accessions are in the MLS. Unlike most CGIAR genebanks, 71% of ILRI's collection is non-Annex 1 species, which presented a challenge for international distributions. ILRI is to be commended for the relationship they have built with the Ethiopian Biodiversity Institute, which has enabled ILRI to distribute the majority of non-Annex 1 holdings.

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

The global strategy for the conservation of tropical forages was developed in 2015. ILRI was among the 15 tropical forage genebanks surveyed during the development of the strategy. ILRI has been contributing to the implementation of the strategy in several ways. The genebank has been focusing on increasing availability and safety duplication of the collection. ILRI and CIAT

have worked to harmonize the operations of both genebanks, especially around QMS and data management. Collection curation is also being driven by the species prioritization categories proposed in the strategy to focus resources on germplasm having the most value for use (see section 2.1.1). The strategy suggested that low priority species could be archived or transferred to other institutes. Currently, ILRI is fully or partially curating 13,945 accessions (Cat 1-3 plus non prioritized species) and has archived 5005 accessions (Cat 4,5). Archived accessions are stored at -20°C, and are not tested for viability or seed health, nor are they regenerated. Granted, efficiencies have been gained with a smaller curated collection size; the genebank anticipates reaching performance targets sooner because of this. However, they have found that almost 11% of distributions are of archived accessions. Obviously, there is current interest in using Categories 4 and 5 species and it is difficult to predict which species will be of interest in the future. Another issue is that archiving CWR accessions makes them vulnerable to loss. This germplasm may have value to crop breeders and may have potential future value as forage or fodder. The genebank may wish to transfer some of this germplasm to other genebanks specialising in these crops,.

As per Recommendation 1 (see section 2.1.1) we recommend that the genebank review the prioritization categories and reconsider de-archiving 5000 accessions. Although this will push back the date that performance targets are met, efficiencies gained by implementing other recommendations in this report (-20 C storage, additional greenhouse space, moving field grown germplasm to seed storage) will make the process quicker. The Global Tropical Forage Conservation Strategy is now 10 years old and an update would be beneficial. The 2015 strategy points to habitat loss and CWR as important reasons to develop a conservation strategy. However, the strategy mainly focuses on existing *ex situ* collections and how to prioritize collection maintenance based on how useful a species has been. Considering how quickly we are seeing environmental, societal and cultural changes, it might be prudent to conduct a conservation assessment. Are there vulnerable species underrepresented in the genebank? A gap analysis would be especially helpful, as recommended in Recommendation 2 (see section 2.1.2).

7 Next generation conservation

The development of new technologies in the areas of biotechnology, informatics, digital tools, genomics, engineering, artificial intelligence, will undoubtedly bring about major changes in the way that genebanks will function in the future. As part of the CGIAR Genebank Accelerator, the ILRI genebank is well placed to learn from its sister genebanks, particularly CIAT and others, about novel ways for carrying out genebank operations for more effective and efficient genebank management. Already the genebank is exploring the adoption of GGCE, which will enable a full integration of the various genebank activities on this new IT platform for integrated documentation and information management. Another area where new technologies will be of benefit to the genebank is in the use of new genomic tools such as GBS, GWAS and AI tools that will help better characterize accessions and add more value to them and help in improvising the use of the collection. The genebank acknowledges that its key challenge is their ability to produce clean, healthy and adequate quantities of seeds free from seed-borne pathogens. This has limited the capability to increase accessions availability and safety duplication efforts. The reviewers believe that providing a state of art greenhouse facility where environmental conditions can be controlled would greatly improve the ability of the genebank to produce sufficient clean and healthy seeds for distribution (see recommendation 7 above in section 2.1.6).

With the development of new automated tools, many of the genebank activities, particularly in seed processing, viability tests, seed packaging, and storage, could become partially or fully automated, reducing labour time and enabling the genebank to do more with its labour force and improve its efficiency. This may take some years, but the genebank is encouraged to explore such opportunities when they arise.

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

The genebank's 5-year business plan 2026-2030 highlights several measures it aims to take that will help improve its collection coverage and sustainability. The business plan is heavily geared towards meeting the performance target for most of its activities and especially for some of the most challenging targets. The genebank acknowledges the fact that no new collecting of germplasm has been done, and that there is a need to broaden the diversity of its forage collection particularly with unique materials, in the future. The genebank is cognizant of the need to further characterize and evaluate the full breadth of the genetic and traits diversity that remains locked in the collection, using emerging genomic and phenotyping tools, to further develop subsets and identify promising lines and promote the use of the forage collection. The genebank also recognizes the importance of re-assessing the archived accessions and will consider de-archiving and including them in the management as an active part of the collection, as is recommended in this report.

In the next 5 years, the genebank aims to increase seed production to speed up the physical availability and safety duplication of its accessions. It will address this challenge by upgrading existing greenhouses and screenhouses and building new greenhouse facilities with irrigation and controlled environmental conditions to control/minimize seed borne diseases caused by viruses, fungi and bacteria. The genebank also aims to improve the longevity of its seeds shifting its collection in long-term storage, currently contained in freezers that are not frost-free, to the -20°C cold room to reduce the frequency of defrosting that seed quality. The genebank will investigate the seed storage behaviour of the species of grasses, shrubs and trees currently conserved in the field to determine if they can be stored as seeds in the seed bank. This will enable them to improve management and distribution of the accessions of these species in a cost-efficient manner.

To enable them to meet the performance targets, the genebank has set up specific targets that they will endeavour to meet in the next 5 years under the LPA/LTG as shown in the table below from its Business Plan:

Table 5. Plans for essential operations for crops covered by LPA/LTG

Specify crop(s) or crop group: Forage	Average annual number, (last 5 years)		Projected average annual number (next 5 years)	
	Number cessions	Number of samples/lots	Number accessions	Number of samples/lots
1. Acquisition	196	196	NA	NA
2. Viability testing	1018	1987	750	750
3. Regeneration due to low viability or poor health	65	65	50	500
4. Multiplication to increase quantity	820	820	500	500
5. Characterization	4853	5658	500	5,000
6. Health testing	1489	2916	500	1500

7. Disease cleaning	1464	1655	50	500
8. Distribution (internal)	1618	2231	500	500
9. Distribution (external)	882	1178	500	1500

Source: Business Plan, Table 2.

The genebank will ensure that it becomes fully compliant with QMS and international and national policy instruments by reviewing and refining its SOPs for all its key activities to reach the FAO genebank standards. It also plans to work more closely with national partners such as universities and research institutions to promote wider uses of genebank materials. It has already developed an MOU with the Ethiopian Biodiversity Institute and works closely with some universities (e.g Ambo University) and Ethiopian Agricultural Research Institutes and centres, on characterization, adaptation trial and promotion of genebank materials.

While some of the measures discussed above can be easily implemented without many resources, others will require some substantive investment, such as the renovations of existing greenhouse and shade-house and acquisition of new environment-controlled greenhouse, -20°C cold rooms for long term storage. But such investment would be worthwhile and help ILRI genebank fully achieve its performance standard in the next 5 years and obtain LPA that will make its running cost more sustainable in the long term. The reviewers believe that the measures proposed by the genebank in its business plan are achievable but would require some further capital investment that will help it achieve its goal.

9 Overall assessment and conclusions

The ILRI Forage Genebank has made excellent progress in implementing the recommendations of the previous review in 2012, especially with regard to implementing GGCE, and adopting QMS, with the development of 15 SOPs for the key genebank operations and establishing fully dedicated GHU. It has achieved 3 of its 5 performance targets and has reached about 50% accessions that are physically available (free of major diseases, viable, and in sufficient quantities) for distribution and 50% of accessions for safety duplication. The genebank has excellent facilities in place, especially, GHU, germination labs, storage facilities, greenhouse and network of field sites for regeneration and characterization of the collection. It also has well qualified and dedicated staff and a supportive management to ensure the genebank is performing at high standards. Despite these achievements, there are a number of key areas which can be further improved to enable the genebank to meet performance standards and become eligible for LPA support.

Key focus areas, in order of priority (some can be done in parallel), are as follows:

- Review and update the conservation priorities.
- Renovate existing screen-houses and acquire a new greenhouse with environment control to speed up regeneration and production of disease-free genetic materials.
- Safety duplicate all unique accessions and reduce safety duplication of samples to 300 seeds per sample.
- Carry out a gap analysis to widen the diversity of wild forage species in the collection.
- Review genebank workflow to streamline subsampling and packaging.
- Review the thresholds for storage, safety duplication, distribution and viability.
- Carry out seed viability monitoring in both MTS and LTS.
- Conserve all accessions under LTS conditions.
- Transfer field genebank accessions with orthodox seeds to seed bank.
- Increase the visibility of the genebank to its main stakeholders to encourage use of its genetic materials.

- Review and implement succession planning and assign deputy for core staff of ILRI Forage genebank.

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. ILRI Forage Genebank was reviewed by two experts, facilitated by Sarada Krishnan (Director of Programs, Crop Trust) and Nelissa Jamora (Monitoring and Evaluation Manager, Crop Trust). The members of the review panel are:

- *Ehsan Dulloo: Chair of the review panel with experience in conducting genebank reviews with expertise in institutional analysis, diversity assessment, and genebank management.*
- *Stephanie Greene, review panel member, with experience in conducting genebank reviews and expertise in genebank operations, safety duplication, crop wild relatives, gap analysis and forages.*

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 metrics

Indicators	Number*
Composition	
1. Number of accessions in total	18,950
2. Number of seed accessions	18,641
3. Number of accessions in <i>in vitro</i>	NA
4. Number of accessions in cryo conservation	NA
5. Number of field bank accessions	2,282
6. Number of seed accessions conserved in MTS	16,267
7. Number of seed accessions conserved in LTS	17,642
Availability	
8. Number of accessions that are fully-curated	13,945
9. Number of accessions that are legally available	18,950
10. Number of accessions included in MLS	18,950
11. Number of accessions that are physically available	15,585
12. Number of accessions that are physically and legally available for immediate distribution	9,302
13. Number of accessions viability tested	12,435
14. Number of accessions with viability above 85%	8,973
15. Number of accessions health tested	8,608
16. Number of accessions that are clean and healthy	7,098
17. Number of accessions with adequate seed number	15,585
18. Number of seed accessions regenerated or multiplied in last 5 years	6,135
19. Number of samples subcultured in last 5 years (clonal)	NA
20. Number of samples rejuvenated in the field/greenhouse in last 5 years (clonal)	NA
Safety duplication	
21. Number of seed accessions safety duplicated at two locations	5,252
22. Number of seed accessions safety duplicated at Svalbard	8,900
23. Number of clonal accessions held in cryopreservation at two locations	NA
24. Number of clonal accessions held in <i>in vitro</i> at two locations	NA
25. Number of field accessions maintained in at least two locations	258
26. Number of accessions held in <i>in vitro</i> <u>and</u> in field	NA
27. Number of accessions held in <i>in vitro</i> <u>and</u> in cryo	NA
28. Number of accessions maintained in the field <u>and</u> conserved in cryo	NA
Distribution	
29. Total number of accessions distributed internally in the last 5 years (within the institute)	7,930
30. Total number of accessions nationally in the last 5 years (outside the institute)	2,921
31. Total number of accessions distributed internationally in the last 5 years (outside the country)	164
32. Total number of samples distributed in the last 5 years (all recipients)	5,890
33. Total number of SMTAs sent in the last 5 years	218
Information	
34. Number of accessions with passport data available in Genesys	18,916
35. Number of accessions with characterization data available in Genesys	15,863
36. Average passport data completeness index	7.31
QMS	
37. Number of SOPs written	15
38. Staff succession/management plan available and maintained (Y/N)	Y
39. Risk management plan available and maintained (Y/N)	Y
40. Equipment and supplies inventory available and maintained (Y/N)	Y
Use	
41. Annual number of germplasm requests received (average in the last 5 years)	33
42. Regular feedback from genebank users (Y/N)	Y

* Consider crop/location 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 would reduce 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, Themes	Factors to consider	*Score
A. Genebank overview		
Staff management		
<i>Adequacy of staffing</i>	1. The genebank has adequate skilled staff to perform key genebank operations. Identify gaps or shortages in staffing.	0
<i>Succession planning</i>	2. The genebank takes action to mitigate adverse impacts of staff loss from staff movement (e.g., resignation, retirement, promotion).	1
<i>Capacity development</i>	3. The genebank has a clear understanding of capacity building needs. [Identify short- and long-term capacity development needs.]	0
Composition of the collection		
Uniqueness and importance	4. The genebank conserves unique and valuable crop collections, including Annex 1 crops (consider crop importance to national country and to global conservation and use). [Identify unique and valuable crop collections that are at risk; check for redundancies or gaps; Determine if particular crops should be prioritized.]	3
Conservation forms	5. The genebank has multiple forms of conservation (seed, in vitro, field, greenhouse, DNA) corresponding to different crop types in the collection. [Confirm the different conservation forms available in the genebank.]	0
KPIs		
<i>KPI: Collection size</i>	6. The genebank has information/trends on the size and composition of its collection. Check plans and capacity for expansion of collection size.	0
<i>KPI: Availability</i>	7. The genebank has information/trends on the number of accessions that are available for immediate distribution. Determine how "availability" is calculated and if availability has increased or decreased with time.	0
<i>KPI: Data availability</i>	8. The genebank has information on access, availability, and sharing of germplasm related data through their websites and/or Genesys. Identify issues in data sharing.	0
<i>KPI: Data completeness</i>	9. The genebank uses Multi-Crop Passport Descriptors (MCPD) and/or other descriptor lists. Identify issues in the use of MCPD and/or other descriptor lists.	0
Supplies, equipment, facilities & infrastructure		
<i>Infrastructure</i>	10. The storage chambers (LTS and MTS) are fit for purpose (i.e., well suited) for their intended use.	2
	11. The seed processing and packing areas are fit for purpose (i.e., well suited) for their intended use.	2
	12. The drying room/chamber is fit for purpose (i.e., well suited) for its intended use.	0
	13. The seed cleaning area (internal/external) is fit for purpose (i.e., well suited) for its intended use.	0
	14. The viability testing area or laboratory is fit for purpose (i.e., well suited) for its intended use.	0
	15. For clonal crops, the <i>in vitro</i> storage chambers are fit for purpose (i.e., well suited) for their intended use.	na
	16. Environmental records (light, temp, RH) for storage chambers and drying rooms are maintained and periodically monitored.	0
	17. The genebank facilities have safety measures in place (restricted access, cameras, etc.).	0
<i>Equipment</i>	18. The genebank has a replacement plan for infrastructure and equipment.	1
	19. The genebank maintains a list/inventory of key equipment (computers, balances, threshers, etc.).	0
	20. The number, type and condition of the equipment is adequate to carry out activities in the genebank.	0
	21. Maintenance, calibration and replacement is periodically performed on key equipment.	1
<i>Supplies</i>	22. The genebank uses barcoding in the management of genebank operations.	0
	23. The genebank maintains a list/ inventory of key supplies (jars, envelopes, boxes, etc.).	0
<i>Field stations and greenhouses</i>	24. The quantity and types of supplies are adequate to carry out activities in the genebank.	0
	25. The field station(s) is fit for purpose (i.e., well suited) for its intended use. Identify any deficiencies or oversights in field station management.	0
<i>Overall assessment</i>	26. The greenhouse is fit for purpose (i.e., well suited) for its intended use. Identify any deficiencies or oversights in management.	3
	27. Provide an overall assessment of the adequacy of genebank supplies, equipment, facilities & infrastructure. Note any strengths or weaknesses or gaps.	2
B. Genebank operations		
1 Acquisition		
<i>1 Adequacy of procedures</i>	28. The genebank assesses viability and phytosanitary health upon reception of new material.	0
	29. The genebank has post-entry quarantine rules for new materials, prior to introduction into the genebank collection.	0
<i>2 Information management</i>	30. The genebank has a protocol for assigning unique identifiers and accession numbers for new materials, prior to introduction into the genebank collection.	0
	31. Data and information required for and generated during the acquisition procedure is recorded and entered into the documentation system.	0
<i>3 SOP</i>	32. The genebank has a written acquisition procedure/protocol/policy.	0
<i>Overall assessment</i>	33. Provide an overall assessment of the adequacy of the procedure. Note any strengths or weaknesses or gaps.	0
2 Conservation:		
<i>1 Adequacy of procedures</i>	Seed processing, storage, and viability testing 34. The genebank follows an established protocol for seed cleaning.	0

Area, Themes	Factors to consider	*Score
	35. The genebank follows an established protocol for seed drying and testing of moisture content.	0
	36. The genebank follows an established protocol for packing samples in containers or envelopes.	1
	37. The genebank follows an established protocol to maintain germplasm health prior to storage.	0
	38. The genebank periodically conducts viability testing.	0
	39. For long-term storage, samples are stored at a temperature of $-18 \pm 3^{\circ}\text{C}$. For medium-term storage, samples are stored at a temperature of $5-10^{\circ}\text{C}$.	0
2 Information management	40. Samples are properly labeled.	0
	41. Data and information required for and generated during the conservation procedure is recorded and entered into the documentation system.	0
3 SOP	42. The genebank has a written conservation procedure/protocol/policy.	0
KPI: Viability and health testing rates	43. The genebank has information on the viability/vigor and health of the collection. Check the number of viability/health tests done annually, % of accessions viability/health tested.	0
Overall assessment	44. Provide an overall assessment of the adequacy of the procedure. [Note any strengths or weaknesses or gaps.]	1
3 In vitro conservation		
1 Adequacy of procedures	45. Light and temperature regimes are adequate for <i>in vitro</i> culture.	
	46. The genebank regularly monitors the quality of the <i>in vitro</i> culture in slow-growth storage, maintenance of long-term genetic stability and possible contamination.	
2 Information management	47. Samples are properly labeled.	
	48. Data and information required for and generated during the <i>in vitro</i> conservation procedure is recorded and entered into the documentation system.	
3 SOP	49. The genebank has a written <i>in vitro</i> conservation procedure/protocol/policy.	
Overall assessment	50. Provide an overall assessment of the adequacy of the procedure. [Note any strengths or weaknesses or gaps.]	
4 Regeneration and Characterization		
1 Adequacy of procedures	51. Regeneration practices are appropriate to ensure that genetic integrity is maintained. (regarding origin of seed, number of seeds to be planted and harvested, and pollination control).	1
	52. Regeneration practices are appropriate to ensure that germplasm health is maintained.	3
	53. Field sites used are appropriate for the needs of the crops conserved.	0
	54. Field management (land preparation, irrigation, rouging, agrochemical applications) are adequate for regeneration and characterization of genebank accessions.	0
	55. 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).	0
2 Information management	56. Characterization data is publicly available, or available upon request.	0
	57. Samples are properly labeled.	0
	58. Data and information required for and generated during regeneration and characterization is recorded and entered into the documentation system.	0
3 SOP	59. The genebank has a written regeneration and characterization procedure/protocol/policy.	0
KPI: Regeneration and characterization rates	60. The genebank has information on the number of samples regenerated and characterized annually. [Check whether the annual rates are justifiable given the crop and status of the collection.]	0
Overall assessment	61. Provide an overall assessment of the adequacy of the procedure. [Note any strengths or weaknesses or gaps.]	2
5 Distribution		
1 Adequacy of procedures	62. Prior to distribution, the seed quantity, viability, and phytosanitary status of the samples to be distributed is known/checked.	0
	63. 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
	64. Samples are distributed in compliance with national laws and relevant international treaties and conventions. [Check the use of transfer agreements.]	0
2 Information management	65. Samples are properly labeled.	0
	66. Data and information required for and generated from germplasm request to distribution is recorded and entered into the documentation system is updated in timely manner.	0
	67. 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	68. The genebank has a written distribution procedure/protocol/policy.	0
KPI: Distribution	69. The genebank has information/trends on the distribution of its accessions. Check the number of accessions distributed annually in the last decade, extent and scope of distribution (national, vs international, key genebank users and most distributed crops and/or accessions).	0
KPI: User satisfaction	70. The genebank requests feedback from users to improve the delivery of genebank service. [Check recent examples of feedback from users.]	0
Overall assessment	71. Provide an overall assessment of the adequacy of the procedure. Note any strengths or weaknesses or gaps.	0
6 Safety duplication		
1 Adequacy of procedures	72. Safety duplicate samples are stored nationally, under the same or better conditions than those in the original genebank. [Identify safety duplication sites.]	0
	73. Safety duplicate samples are stored internationally, for second-level safety duplication. Identify safety duplication sites.	0
	74. The size of safety duplicated samples is sufficient to conduct at least three regenerations.	0
2 Information management	75. Samples are properly labeled.	0
	76. Data and information required for and generated during safety duplication is recorded and entered into the documentation system.	0
3 SOP	77. The genebank has a written safety duplication procedure/protocol.	0
KPI: Safety duplication	78. The genebank has information/trends on the percent of the collection that is safety duplicated in one or more locations or geographically distant sites. Check the number of accessions safety duplicated. Confirm willingness and capacity to safety duplicate materials to Svalbard.	0

Area, Themes	Factors to consider	*Score
<i>Overall assessment</i>	79. Provide an overall assessment of the adequacy of the procedure. Note any strengths or weaknesses or gaps.	0
7 Field genebank		
<i>1 Adequacy of procedures</i>	80. The genebank follows an established protocol for field conservation, and regularly monitors the quality of plants.	0
<i>2 Information management</i>	81. Samples are properly labeled.	0
	82. Data and information required for and generated in field genebank is recorded and entered into the documentation system.	0
<i>3 SOP</i>	83. The genebank has a written field genebank conservation procedure/protocol/policy.	0
<i>Overall assessment</i>	84. Provide an overall assessment of the adequacy of the procedure. Note any strengths or weaknesses or gaps.	0
C. Genebank management		
<i>QMS</i>	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).	1
<i>Information management</i>	86. Information management system is available and used in the management and monitoring of the collection.	0
	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
<i>Phytosanitary procedures</i>	89. The genebank (or its health unit) maintains and updates a list of quarantine pests and diseases and monitors and manages contamination incidents.	0
	90. Phytosanitary procedures are followed in germplasm transfers (import and export).	0
<i>Risk management</i>	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). [Identify recent risks encountered and actions taken.]	0
<i>Efficiency of procedures</i>	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 amounts of time). [Identify any backlogs or bottlenecks.]	0
<i>Overall capacity</i>	93. The genebank's overall capacity to conserve seeds, clonal crops and field collections is adequate.	1
D. Enabling environment		
<i>Finance</i>	94. The institution has clear policy on overhead charges on projects and/or international collaborations.	0
<i>Procurement processes</i>	95. The institution has an established procurement process.	0
<i>Genebank routine funding</i>	96. The genebank has reliable and continuous funding sources for routine operations (e.g., core vs project funding). Determine how staff salaries and annual routine operations are supported.	0
<i>Policy</i>	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 Plant Treaty country focal point).	0
<i>Leadership</i>	98. Commitment to quality of leadership, staffing, and vision.	0
<i>External linkages to users</i>	99. The genebank actively works with farmers, and other user groups to promote awareness and use of materials from the genebank.	1
<i>Contribution to the global system</i>	100. The genebank works with NARS, other national genebanks or other partners on crop conservation-related activities.	0

THE GLOBAL CROP DIVERSITY TRUST

Platz der Vereinten Nationen 7
53113 Bonn
Germany

MEDIA CONTACT

publications@croptrust.org

GENERAL CONTACT

info@croptrust.org

